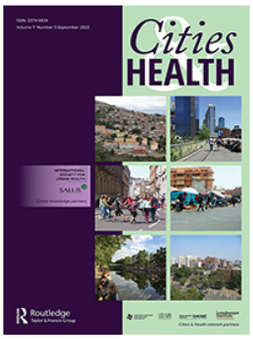

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Liveability research creating real world impact: connecting urban planning and public health through the Australian Urban Observatory

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ABSTRACT

Urbanisation is occurring globally and rapidly with potential to compromise the development of sustainable, liveable and healthy cities. Urban observatories have also existed for many years addressing a range of relevant urban issues. These observatories provide a unique method to translate research into practice, support evidence-informed policy and planning, target actions of the sustainable development goals, address spatially based health inequities and improve the liveability of cities. This paper provides an analysis of the Australian Urban Observatory, a digital liveability planning platform using urban analytics to observe and enhance understanding of liveability inequities in Australian cities that is linked to policy and planning. The analysis aims to share learnings about development of the Australian Urban Observatory, including the conceptual framework of liveability, planning tools, and the resulting impact in policy and planning applications. This is the first urban observatory in Australia that will continue to expand and develop over time, supporting urban governance, democratic process and creating real world policy impact through partnership between academia, government, industry and the community.

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liveability; indicators; knowledge translation; observatory

Introduction

Urban development, population growth and urban systems

Urbanisation is not a new phenomenon but the speed of urban development over the past 70 years has become increasingly rapid. In 1950, only 171 million people lived in urbanised areas compared to 4.2 billion in 2018, with 68% of the world's population projected to live in urban areas by 2050 (United Nations 2019). The shift towards living in urban areas also places additional challenges on population health, sustainable urban development and the targets of the Sustainable Development Goals (United Nations Development Program 2015). With such a large proportion of the population residing in cities, Goal 11 of making cities inclusive, safe, resilient and sustainable is challenging but critical. To achieve this, cities must provide equitable access to employment, housing, transport, education, local services and open spaces and embrace both participatory and evidence-informed planning methods. All of these factors are also essential for the development of healthy and liveable cities that comprise interrelated and dynamic urban systems (Murayama 2000, Stevenson and Gleeson 2019).

Increasing interest in urban observatories has developed over the past 30 years. Urban observatories are designed to study the dynamic processes of complex urban systems (Dobler *et al.* 2021) with growing interest in the topic due to social, economic and environmental implications associated with revolutions of urbanisation, transport and data availability and technological developments (Miller *et al.* 2021). Urban observatories have been adopted by the United Nations as important mechanisms that support policy development and action towards the 2030 Agenda for Sustainable Development, particularly Sustainable Development Goal (SDG) 11 of Sustainable cities and communities, SDG 3 of Good health and well-being and SDG 17 of Partnership for the goals encouraging measurement, monitoring and reporting of progress (Habitat 2020b). The UN has even developed a guide on setting up an urban observatory (Habitat 2020a) to help governments and local authorities to collect, analyse and disseminate information on urban development at the city and national levels to support decision making and evidence-informed policy development. Observatories can provide both an awareness and evaluation of the SDGs when directly linked to their 169 targets.

Digital urban data platforms like observatories play an important role in bringing together academic research, government and the private sector (Miller *et al.* 2021), and link urban policies to public health and spatially based health inequities (Caiaffa *et al.*

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2014). These platforms have an important role in translating and connecting urban planning, sustainability and social determinants of health research using indicators to link evidence to public policy and planning practice (Bannan *et al.* 2022). Urban observatories have been used to identify urban health inequities, support good governance and democratic decision making (Corburn and Cohen 2012) and sustainable recovery from the COVID-19 pandemic (Acuto *et al.* 2021).

Before development of the Australian Urban Observatory (AUO),[1] there was no capacity for governments or local authorities in Australia to assess the impact of urban policies and urban development over time on the liveability of local neighbourhoods, municipalities, or cities. Australia is a country characterised by cities with sprawling low density development and ongoing consumption of urban land (Rahnama *et al.* 2020) readily available on the boundaries of urban areas. Early research showed that the liveability of Australian cities was being compromised by urban policy and planning practices (Arundel *et al.* 2017), despite liveability being a preeminent goal in urban planning and awareness that built environment planning influences health (McGreevy *et al.* 2020). Consequently, the AUO was developed to share detailed evidence on the (changing) liveability of Australian cities with urban policy and planning decision-makers and influence evidence-informed policy development.

The concept of the urban observatory has been credited to Robert Wood in 1962 and his objective to connect urban science to political form and for academics to improve their methods of translating urban research knowledge into accessible tools for government audiences to solve metropolitan problems (Williams 1972). It could also be argued that Sir Patrick Geddes was an earlier proponent of the urban observatory, connecting urban and spatial form based on sociological and geographical approaches to town planning and regional self-determination (Meller 2005). Geddes designed an Outlook Tower in the 1890s that used a camera obscura to observe the city of Edinburgh. He has been described as a patriarch of modern urban planning connecting visual interpretation, dwellings, society, citizenship, regional surveying and immersive learning (Amati *et al.* 2017). He argued that observations of geographical and social environments, and associated inequity, should be interpreted and understood with knowledge of the past to really discern and identify future needs and city design (Geddes 1919). He was a transdisciplinary leader of the 19th century, well before the term 'transdisciplinary' would be commonly understood. All of his work was based on assumptions of life phenomena and sciences being intrinsically related despite their descriptions as different and independent disciplines (Goist 1974). At the same time that Geddes was connecting geography, housing and sociology in Scotland, Charles Booth had begun his census like surveys into London life and labour connecting place to poverty, industry and religion across London streets (Booth 1893).

Observatories of the 20th century

More modern history associated with the development of urban observatories can be traced back to a developing indicators movement of the late 20th century in the USA. The US Department of Housing and Urban Development developed the program in 1968 with cooperation from the National League of cities (Williams, 1972) and expanded the program across 10 cities from 1974 to 1977. The programs involved matched funding from partner cities to test the idea that university research and resources could be applied to improve public policy and administration. During this initial program testing phase, smaller cities were the focus, supporting public officials who lacked the resources needed to effectively deal with planning problems. The ingenuity of the urban observatory program was partnership between scholars, public administrators and politicians to address public policy agendas with applied objective inquiry (Irwin 1972).

Several public health observatories were also developed during the 1970s. Beginning in Canada and France in 1974, the first public health observatories were concerned with social and physical environments, health outcomes and inequities, and were designed to aid evidence-informed health planning (Hemmings and Wilkinson 2003). Later in 1990, the Liverpool Public Health Observatory was developed and the initiative was later supported by national public health policy in the Blair government that developed public health observatories in partnerships with universities across the UK (Ashton 2000). These public health observatories were designed to identify gaps in health information, increase accessibility to data, facilitate the use of evidence working with all tiers of government, non-government and private sectors and support evidence-informed policy and practice (Hunter *et al.* 2000). The term 'observatory' was used to emphasise objectivity in analysis and descriptions of patterns and interrelationships, with eight regional public health observatories developed in the UK and numerous others in France, Switzerland and Western Europe (Ashton 2000). Later this would be expanded to Africa, Asia, Latin America and North America with many established with support of the World Health Organisation (Aspinall *et al.* 2016). Although numerous public health observatories have been established across the globe (Hemmings and Wilkinson 2003, Caiaffa *et al.* 2014, Castillo-Salgado 2015), others have focused on sustainability (Holden 2006) and most recently, real-time dashboarding of COVID-19 incidence and social determinants of health (Brakefield *et al.* 2020).

UN-Habitat has continued to play a key role in facilitating partnership and collaboration with urban observatories worldwide with interest in applied data and indicators to support decision making and monitoring progress towards the SDGs. This has included establishment of a global urban network of observatories in 1997 through the Global Urban Observatory (GUO) Unit that is currently coordinating 374 observatories worldwide (UN-Habitat 2022) and developed a guide on how to set up an observatory (UN-HABITAT 2020). Although not specific to health, common characteristics of observatories include the following: indicators produced at neighbourhood-level geography; strong partnership engagement with public and private sectors; capacity building support; dissemination of meaningful indicators prioritising sustainable development; measurement and monitoring that supports sustainable urban systems and decision making; and participatory planning across society to support good governance, democracy and information sharing. The first Australian Urban Observatory (Davern *et al.* 2020) was established in 2020 and developed based on these principles as well as the learnings of current and historical urban observatories.

Methods

This paper provides a case study analysis of the Australian Urban Observatory including the rationale and theory behind development, the conceptual framework, intended audience, capacity building activities, tools and resources, current policy applications and future directions.

Results

Introducing the Australian Urban Observatory

Development of the AUO occurred over several years with the major stages summarised in Figure 1. This process was based on five major stages as described in Figure 2: (i) a program of published liveability

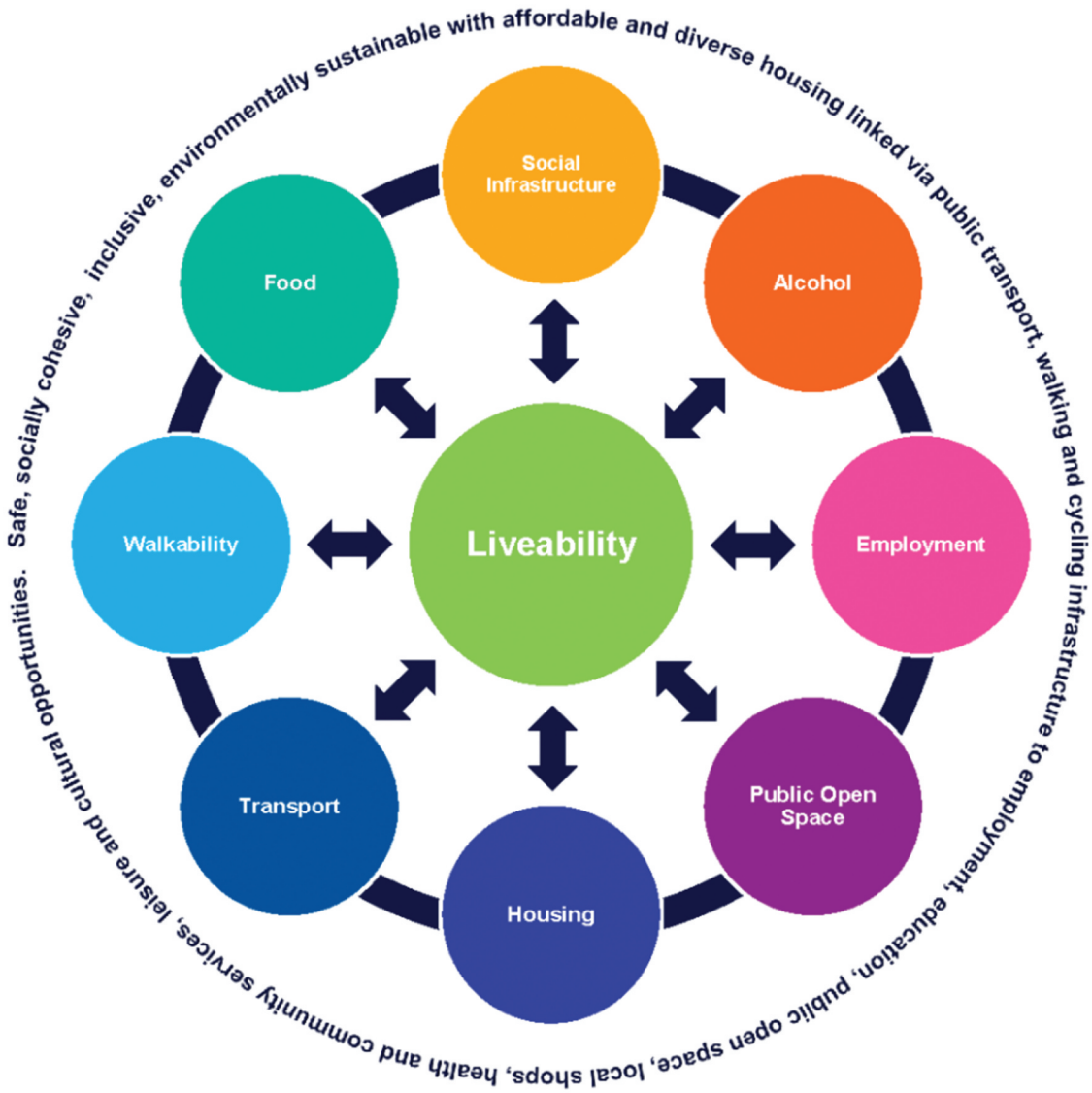

Figure 1. Liveability systems thinking framework and indicator domains included in the Australian Urban Observatory.

Figure 2. The multiple roles of the Australian Urban Observatory.

research with contributions from a team of academics; (ii) development, testing and production of area-based liveability indicators across 21 Australian cities; (iii) development of an open-source digital platform to support research translation, dissemination and analysis; (iv) ongoing development of a system of resources, features and support tools in the digital platform in response to decision-maker's needs; and (v) ongoing development of new liveability indicators in the portal and replication of existing indicators to support time series analysis. The idea for a digital urban observatory in Australia was conceived during stage 2 when liveability indicators were being developed and based on previous expertise in the development of indicator systems as explained below.

Liveability is the conceptual framework and inspiration behind the AUO developed through a program of liveability research and can be understood as the connection between urban planning and the social determinants of health. This conception of liveability is based on extensive review of both academic and grey literature that identified key neighbourhood indicators that support liveable, healthy and sustainable neighbourhoods (Lowe *et al.* 2013, 2015). The review addressed growing international and Australian interest on the use of the term 'liveability' and the application of evidence-based indicators in policy development. A clear definition of liveability was developed through the review with a liveable place described as: *safe, attractive, cohesive and inclusive, environmentally sustainable with affordable public transport, walking and cycling infrastructure, connected to affordable and diverse housing, employment, education and public open space, local shops and services, leisure and culture opportunities* (Lowe *et al.* 2013). In short, liveable places consist of three key components – a quality place, linked by active and sustainable transport to local services and amenities. These components of liveability are all influenced by urban planning and also represent the social determinants of health, linking the social environment to health, and the need for research evidence in the development of public policy (Wilkinson and Marmot 2003).

Conceptual frameworks and liveability indicator development

Neighbourhood area liveability indicators included in the AUO are based on this definition of liveability (Badland *et al.* 2014) and an extensive body of previously published research. The development of these indicators was also informed by Community Indicators Victoria which was the first state-based indicators system in Australia (Davern *et al.* 2017). Community Indicators Victoria was in operation between 2007 and 2016 and effective in supporting evidence-informed health planning in Victoria through the use of aggregated municipal-level indicators (Browne *et al.* 2017). However, planning, policy and advocacy organisations had expressed the need for

more fine-grained analysis of social, economic, and environmental issues specific to local areas. Social and health planners were dealing with local-level health inequities that were masked by aggregated municipal-level results. Consequently, smaller area spatial analyses were trialled using Geographic Information Systems (GIS) to develop neighbourhood or Census tract indicators (Davern *et al.* 2015) to identify neighbourhood-level differences within larger municipalities. These indicators proved useful in detecting local area strengths and weaknesses, facilitating community engagement and discussion, building partnership across organisations and identifying shared priority areas for strategic planning (Davern *et al.* 2020). The model proved worthy of further expansion linking applied research to current policy and planning needs that was mutually beneficial for all partners.

While experimentation with local area indicators occurred in practice, conceptual models of liveability indicators were also being developed and tested over a number of years. This began with a broad understanding of the social determinants and liveability at the local level (Badland *et al.* 2014), and then conceptual models of public open space (Villanueva *et al.* 2015), transport and walkability (Badland *et al.* 2015, 2017), employment (Badland *et al.* 2016), housing (Badland *et al.* 2017) social infrastructure (Davern *et al.* 2017) food environments (Murphy *et al.* 2018) and an overall liveability index (Higgs *et al.* 2019). Social Infrastructure, housing, food environments and walkability were also validated using health outcomes data to confirm the connection between the social determinants of health, liveability, urban planning and health outcomes.

Development and validation of these liveability indicators built conceptual knowledge of liveability in Australia, as was also tested in other international cities (Alderton *et al.* 2019, 2021). However, this suite of liveability indicators needed to be accessible to decision makers for it to be used in policy and planning. National indicators had been developed but limited to print resources (Arundel *et al.* 2017). Consequently, new customised technology was designed to create an interactive liveability planning platform that would become the AUO. The major objective in creating the digital platform was to communicate and disseminate evidence-informed liveability indicators for the largest cities of Australia that could be easily visualised at the neighbourhood, suburb and municipal levels. Urban environments are a key influence of health and wellbeing, and spatial indicators are critical because this type of measurement is linked to monitoring, reporting, identifying spatial inequities and informing future policy action (De Sa *et al.* 2022).

Whilst developing this granular understanding of individual liveability indicators, our work with the NHMRC-funded Australian Prevention Partnership Centre sought to take a Systems Thinking approach to liveability. This approach provides a framework for the AUO to visualize both the urban system and its component parts. The AUO maps liveability indicators for specific ABS geographies: (i) Local Government Areas (LGA); (ii) Suburbs (SSC); and (iii) Neighbourhoods (SA1). Using scorecards to present a range of liveability domains at the same time was also important to emphasise the interactive and dynamic nature of an urban system.

Development of the Australian Urban Observatory (AUO) digital liveability planning platform

Data-driven digital platforms that support urban governance play an important role in strengthening and fostering a culture of urban experimentation and innovation in sustainability planning (Rehm *et al.* 2021). However, off-the —shelf software can limit the co-creation of new digital support tools that are relevant to a range of target audiences including policymakers and planners. Our approach to software design can be described as end-user software engineering (Ko *et al.* 2011) and was iteratively co-produced understanding the needs of the end-user, from ideation through to design and testing. To be adopted by policymakers it was essential that the platform responded to their needs, was easy to use and not just created for a technical audience. Smart city platforms have previously been criticised as being too techno-centric (Rehm *et al.* 2021). To be successful these platforms need to incorporate holistic and people-driven factors into development to bring together researchers, policymakers and practitioners (Mora *et al.* 2019).

The AUO platform was designed based on three major sources of information: (i) extensive experience working in partnership with policymakers, planners, practitioners, community and advocacy organisations; (ii) product development workshops with these key audiences and academic researchers; and (iii) customized software engineering supporting the development of new tools to support indicator visualisation and application. The aim was to turn social, economic and environmental raw urban data into curated policy-relevant, evidence-informed, neighbourhood-level liveability indicators visualised and disseminated to decision makers through a customised digital platform. The longer-term aim was to support evidence-informed policy development, planning and evaluation of metropolitan and regional city growth across Australia.

A suite of liveability indicators were developed for inclusion in the AUO based on a liveability framework aligned to the conceptual understanding and definition described earlier (Lowe *et al.* 2013, Badland *et al.* 2014). The framework of liveability underpinning the AUO (Figure 1) connects this liveability definition to indicators within an interconnected and dynamic urban system.

AUO geographic coverage

Liveability indicators are calculated for the largest Australian cities. This includes all 8 capital cities and 13 regional cities (Table 1) and accounts for approximately 70% of the Australian population (State Government of Victoria 2017). The cities of Sydney and Melbourne are located in the states of New South Wales and Victoria respectively, with these states home to over 57% of Australia's population (Australian Government Department of Infrastructure, Transport, Regional Development and Communications 2021). The 21 cities included in the AUO are also aligned with the National Cities Performance Framework in Australia responsible for major infrastructure policy, planning and city monitoring (Australian Government Department of Infrastructure, Transport, Regional Development and Communications 2021). This Performance Framework also provides city-level indicators that are some of the most appropriate measures for tracking progress on the SDGs (particularly Goal 11) in Australia.

AUO liveability indicators (Table 2) were calculated for all 21 cities at the geographic areas of Local Government Area (i.e. municipality), suburb, and neighbourhood level. These liveability indicators are currently available for two time periods: 2018 and 2021. The 2018 indicators were made available when the AUO was first launched in February 2020, and the 2021 indicators have been replicated and released across 2022. Liveability indicator results will continue to be replicated every three years to monitor and measure liveability changes within and across cities. This replication schedule also balances the time needed to capture implemented changes to city-based policy and planning, and the resource intensive activity of measuring liveability across 40,000 neighbourhoods, 3100 suburbs and 170 municipalities within the 21 cities of the AUO.

A number of demographic indicators are also planned for release in the AUO in 2023 and will be derived from 2021 and 2016 Census data (State Government of Victoria 2017) collected every 5 years in Australia. This adds additional capability to the AUO connecting liveability assessment of place with demographic analysis of the people who reside in those places. Future research will also be supported by linking both liveability and demographic indicators with additional area-based health outcomes indicators to demonstrate health inequities related to decision making and liveability. This includes new health indicators derived from a new 2021 Census question on doctor diagnosed long-term health conditions including cardiovascular disease, diabetes, dementia, cancer, asthma, lung, and mental health conditions.

Geospatial methodology supporting development of AUO liveability indicators

A range of geospatial methodologies support the development of the liveability indicators in the AUO. Initially, this included identification of in-scope geographic areas for the 21 cities defined by the Australian Bureau of Statistics (ABS) including Greater Capital City Statistical Areas and urban areas within Significant Urban Areas for capital cities and regional cities respectively. Mesh Blocks are the smallest unit of aggregated geography used by the ABS and are the building blocks of larger regions in the social geography of the Australian Statistical Geography Standard (Australian Bureau of Statistics 2016). These Mesh Blocks were used as the unit of analysis in creation of spatial liveability indicators for all 21 cities included in the AUO to enable accurate and efficient spatial processing across areas.

To generate the indicators, three primary components were required: a set of home locations (residential dwellings); a road network to route through; and set of destination locations to reach. Destination locations are meaningful places people want to reach from their homes, such as public transport stops, supermarkets and public open spaces. In order to better represent the reality of navigating cities on foot, routing between homes and destinations was restricted to the road network, meaning that network distance was used instead of Euclidean distance, which is simpler to calculate, but less accurate (Lu *et al.* 2014). Processing a road dataset into a format suitable for routing is detailed in Jafari *et al.* (2022). In order to make use of network-based routing, homes and destinations were 'snapped' to the closest part of the road network.

Two categories of measures were then constructed based on the distances between homes and destinations: density-based measures, which counts the number of destinations within a specific distance (e.g. number of cafes within 800 m); and distance-based

Table 1. Major cities included in the Australian Urban Observatory.

Australian State	Australian Cities
Australian Capital Territory	• Canberra
New South Wales	• Sydney, Albury-Wodonga, Newcastle-Maitland, Wollongong
Northern Territory	• Darwin
Queensland	• Brisbane, Cairns, Gold Coast-Tweed Heads, Mackay, Sunshine Coast, Toowoomba, Townsville
South Australia	• Adelaide
Tasmania	• Hobart, Launceston
Victoria	• Melbourne, Albury-Wodonga, Ballarat, Bendigo, Geelong
Western Australia	• Perth

Table 2. Liveability indicators included in the Australian Urban Observatory.

Domain	Liveability Indicators
Liveability	• Liveability Index
Social Infrastructure	• Social Infrastructure Index
	• Cultural Social Infrastructure
	• Community and Sport Social Infrastructure
	• Education Social Infrastructure
	• Health Social Infrastructure
	• Average distance to nearest General Practitioner (GP) clinic
	• Average distance to closest playground
Walkability	• Average distance to closest activity centre
	• Average dwelling density per hectare
	• Average street connectivity per square kilometre
	• Average number of daily living destinations present (0-3) within 1600 m
	• Walkability for Transport Index
Transport	• Average distance to closest public transport stop
	• % of dwellings within 400 m of a bus stop
	• % of dwellings within 400 m of public transport with a regular 30-minute weekday service
	• Average distance to closest train station
	• Average distance to closest bus stop with a regular 15-min weekday service
	• Average distance to closest bus stop with a regular 30-min weekday service
	• Average distance to closest bus stop with a regular 45-min weekday service
	• % of employed persons using active transport (walking/cycling) as main mode of travel to work
	• % of employed persons using public transport as main mode of travel to work
	• % of employed persons using a private vehicle as main mode of travel to work
Employment	• % of employed persons living and working in the same area
Public Open Space	• Average distance to closest public open space
	• % of dwellings within 400 m or less of public open space
	• Average distance to closest public open space larger than 1.5 hectares
	• % of dwellings within 400 m of public open space larger than 1.5 hectares
	• % of dwellings within 400 m or less distance of any local park (> 0.4 to. < = 1 ha)
	• % of dwellings within 800 m of less distance of any neighbourhood park (>1 to <= 5 ha)
	• % of dwellings within 400 m of less distance of a neighbourhood recreation park (> 0.5 ha)
	• Average distance to closest public open space with a nearby public toilet (within 100 m)
Housing	• % of dwellings that are government owned or community housing
	• % of households in the bottom 40% of incomes spending more than 30% of income on housing costs
	• % of rental households in the bottom 40% of incomes spending more than 30% of income on housing costs
	• % of mortgaged households in the bottom 40% of incomes spending more than 30% of income on housing costs
	• % of rental or mortgaged households in the bottom 40% of incomes spending more than 30% of income on housing costs
	• % of households spending more than 30% of household income on housing costs
Food	• % of dwellings without any food outlet within 3.2km
	• % of dwellings within 1km of a supermarket
	• Average distance to closest healthy food outlet (supermarket or greengrocer)
	• Average distance to closest fast-food outlet
	• Average distance to closest café, restaurant or hotel
Alcohol	• Average number of on-license alcohol outlets within 400m
	• Average number of off-license alcohol outlet within 800m
	• Average distance to closest on-license alcohol outlet
	• Average distance to closest off-license alcohol outlet

measures, which reports the closest destination (e.g. distance to closest bus stop). By combining and analysing these various measures, indicators could then be constructed. For example, the indicator 'percentage of dwellings within 400 m of a bus stop' was created by calculating the distance to the closest bus stop for all homes within a Mesh Block (the smallest geographic area defined by the Australian Bureau of Statistics), and then determining which percentage of them had a distance of 400 m or less. Similarly, the indicator 'average number of off-licences within 800 m' was created by calculating the number of off-licences within 800 m of each home within a Mesh Block, and then averaging the number.

Results were aggregated to municipality, suburb, and neighbourhood-level using the population-weighted average of the indicators calculated for the Mesh Blocks. Population-based weighting was used instead of area-based weighting to ensure that results accurately reflect the underlying population's experience, and not just what areas are larger in size.

The workflow for generating these results consists of a set of modular scripts written in the R and SQL programming languages, with the R scripts making use of libraries for manipulating data, interfacing with databases, performing spatial analysis, and calculating routes between homes and destinations. Results from all stages of the workflow were stored within a Postgres database with PostGIS functionality for ease of access and processing.

Capacity building, tools and resources in the Australian Urban Observatory

One of the major objectives of the AUO is the translation of research knowledge into policy and planning practice. The first major challenge to achieving this goal is making people aware of the existence of the AUO and assessment of liveability across Australian cities. Since being launched 3 years ago in 2020, the AUO has been accessed by approximately 40,000 people in 60,000 sessions with 245,000 page views from over 164 countries. The majority of people using the

AUO are located in Australia, United States, India, China, United Kingdom, Japan, Saudi Arabia, Canada, Malaysia, Spain and New Zealand. Capacity building, tools and resources, local knowledge and policy uptake are critical to the success of any indicator (Holden 2006, Davern *et al.* 2017) or observatory system (Williams 1972). The AUO is a system of resources and support on planning liveable and healthy places well beyond dissemination of area-based evidence-informed liveability indicators (as described in Figure 1). The project was designed to achieve the following objectives: (i) make research knowledge and evidence available and accessible to decision-makers; (ii) support democratic process by making this knowledge available and accessible to the public; and (iii), bring research evidence into the development, monitoring and evaluation of urban and health policy and planning across Australia. Research evidence is made accessible via a customised digital platform developed with open-source software applications to enable full flexibility for future development and co-designed in response to decision-maker's needs.

Scorecards and capacity building tools

One of the most frequently accessed resources in the AUO have been city-level Liveability Scorecards (https://auo.org.au/measure/scorecards/). These scorecards provide high-level city-wide results for all nine liveability domains enabling city-to-city (or inter-city) comparison. This is different to the detailed within city (intra-city) liveability assessments according to neighbourhoods, suburbs and municipalities included in the AUO digital map portal. These multiple assessment methods were developed with knowledge of the target audience and varying needs of largely local, state and federal government audiences with policy and planning responsibilities. More members of the target audience sought intra-city comparison with research evidence addressing localised policy issues relating to health, planning and inequities. Caiaffa *et al.* (2014) has noted a global shortage of capacity analysing intra-urban health issues with neighbourhood-level analysis restricted by data availability, accuracy and mechanisms supporting collation, analysis and dissemination. The AUO has addressed these problems by first trialling the concept (Davern *et al.* 2020) then providing national capability for both inter-city (between cities) and intra-city (within city) liveability linking urban health evidence (observation) and improved understanding to support action across Australia.

Additional scorecards are also being developed to assist with policy implementation and evaluation and have been developed in response to local and state government planning needs In Victoria. Plan Melbourne is the strategic metropolitan planning strategy for Melbourne, the second largest capital city in Australia. The strategy will operate over the next 35 years and liveable local 20-Minute Neighbourhoods are one of nine key principles guiding implementation of the plan (State Government of Victoria 2017). In terms of urban design and health, the 20-Minute Neighbourhood principle encourages walking and cycling to local services and a good example of integrated strategic planning promoting health and wellbeing. One of the major barriers to adoption of the principle in planning has been that it can be unattainable if applied literally (Thornton *et al.* 2022) rather than using the principles to encourage policy aspiration. Many local governments have sought assistance in understanding how to measure this key planning principle, so the AUO developed a scorecard template tool to support self-assessment of 20-Minute Neighbourhoods applied at the neighbourhood, suburb or municipal level. The tool and was developed in partnership with local and state government partners in response to planning needs. It also provides another example of how the AUO is translating and linking research evidence from liveability indicators into tools that support policy evaluation and urban planning that promotes health and wellbeing. Guidance notes are also available in the AUO and describe how area-based liveability indicators can be used to support municipal-level public health planning and meet the United Nations Sustainable Development Goals. The tools are designed to support the development of policies that support health and wellbeing planning and promotion, strategic planning, monitoring, evaluation and goal setting, good governance (van Doeveren 2011), partnership and advocacy.

Beyond the scorecards and Guidance Notes, the AUO enables capacity building through a range of digital and in-person activities that include: (i) presentations and demonstrations of the AUO and intra-city liveability inequities and digital portal functionality; (ii) Community of Practice events with practitioners, enabling both the sharing of implementation experiences and an opportunity for the AUO to understand issues of immediate importance to our partners; (iii) downloadable advocacy resources to support the use of the AUO by practitioners for infrastructure planning, policy development and deliberative democracy; (iv) regular newsletters advising our users of relevant RMIT research, indicator development and mapping tools; (v) news blog posts to the AUO website; and (vi) social media updates through Twitter and LinkedIn. As members of the RMIT academic community the AUO is also regularly used in urban planning and computer science teaching and research. Finally, the AUO is currently working with the Geography Teachers Association of Victoria to develop curriculum materials for use by teachers and students. The AUO provides a valuable and engaging geospatial teaching resource relevant to Year 7 curriculum on *Place and*

Liveability, Year 9 *Geographies of Interconnection* and Year 10 *Human Wellbeing* units.

Impact and policy applications

AUO liveability evidence has been used to shape city-based policy and planning across Australia working in partnership with decision-makers across local, state and federal jurisdictions. Translating research evidence into practice is well aligned with global interest in measuring research impact (Deeming *et al.* 2018) and achieving economic and social benefit from research beyond academia. In Canada, this is reflected through knowledge mobilization policies, while the UK uses the Research Excellence Framework and Australia uses the Excellence in Research Australia with many researchers personally and emotionally committed to research impact (Chubb *et al.* 2017). The AUO was created with the objective to translate applied research and inform public policy by providing evidence that connected four priority issues: local lived environments comprising built and natural environments (Davern *et al.* 2020); the social determinants of health; urban policy and planning (i.e. liveability) and deliberative democracy (Curato *et al.* 2020). Consequently, the AUO has shaped planning policies in cities across Australia. This includes the most populous capital cities of Sydney and Melbourne, regional cities of Victoria and large growth area cities in Australia's northern state of Queensland. Together, Sydney, Melbourne and South-East Queensland account for approximately 75% of Australia's population (Australian Bureau of Statistics 2022).

National examples of policy and planning impact of the AUO include partnership with the Federal Department of Infrastructure, Transport, Regional Development, Communications and the Arts. City deals are described as place-based partnerships between federal, state and local governments, business and the community (Pill *et al.* 2020). City deal partnerships aim to align planning, investment, job creation and urban renewal to ensure future liveability (Department of Prime Minister and Cabinet 2017). The Federal Department of Infrastructure have used AUO liveability indicators, particularly liveability, transport and social infrastructure indicators to identify existing area-based planning gaps and needs for the future. The social infrastructure index (Davern *et al.* 2017) included in the AUO has been of particular interest to the Department for planning new local services in growth areas. The original index included 16 essential societal service types supporting wellbeing and the Department requested separation of the index into 4 major sub-domains: health infrastructure; education infrastructure; community and sport infrastructure; and cultural infrastructure. All of these indicators were used to identify planning needs and future gaps in service provision in growth areas related to city deals. They were also replicated for 2018 indicators and made publicly available to identify social infrastructure planning gaps and changes over time for all cities included in the AUO. Similarly, public transport needs and the impact and benefits of large-scale public transport infrastructure projects have been evaluated using AUO liveability indicators in city deal locations across the time periods of 2018 and 2021.

A state example of AUO policy and planning impact includes partnership with the Victorian government Department of Planning who are using AUO liveability indicators to inform and evaluate 'Plan Melbourne' the 30-year strategic plan for the city (Department of Environment, Land Water and Planning 2019). Melbourne is predicted to be th e largest city in Australia by 2031 (Centre for Population 2022) and the 'Plan Melbourne' aims to enhance neighbourhood liveability across the city throughout this period based on the concept of 20-Minute Neighbourhoods (Department of Environment 2019) where most important local services are accessible within 800 m or a 10-minute walk. Both 2018 and 2021 AUO liveability indicators are being used to assess key features of 20-Minute Neighbourhoods including walkability, social infrastructure and local services, access to supermarkets and activity centres, density, housing affordability, public transport, public open space and local employment. All of these neighbourhood features affect the way that local residents live, work, play and learn and have direct impact on physical and mental health outcomes. The AUO has even created additional customised liveability indicators for the Victorian government to support additional planning evaluation needs and shaping policy and planning needs across the city.

Local Health Districts in New South Wales have also been innovators and early adopters (Kaminski 2011) of the AUO and provide a good example of how the AUO is shaping local health planning. These Local Health Districts (LHDs) are responsible for local area health service planning and health promotion activities across the state of New South Wales, currently the most populous state of Australia. LHDs cover large geographic areas and usually include multiple municipalities with service agreements to the state-led New South Wales Ministry of Health addressing broad health planning needs (Merritt *et al.* 2016, Rychetnik *et al.* 2018, Clarke *et al.* 2019). Fifteen LHDs exist across the state of New South Wales and numerous LHDs have partnered with the AUO. Their partnerships have been driven by the need to improve understanding about local area built and natural environment factors and community demographics in place-based strategic health planning. This has

already included submissions to local and state government using AUO indicators as evidence to support health promotion. Some of the most popular indicators used by LHDs in health planning have included overall liveability, walkability, access to supermarkets, schools, public open space, public transport, active transport and access to alcohol. Specific examples of how AUO indicators have been used include advocating for improved walking or cycling infrastructure to increase physical activity, using indicator results to advocate against additional alcohol outlets in areas of high alcohol consumption or increased access to shops selling healthy foods. This evidence has helped to build partnerships between health planners and local governments and informed Community Strategic Plans with municipalities and informed liquor licensing submissions, open space planning and advocacy actions. A Community of Practice has also been established between LHD partners of the AUO (covering 30 municipalities of Sydney) to share knowledge and experience about how they are using AUO evidence and resources in strategic health planning and promotion. This is a mutually beneficial practice informing the development of future tools, features and indicators included in the AUO, ensuring policy and practice relevance. It also emphasises the interrelated cyclic nature and co-design in AUO development and expansion over time (Figure 3).

An additional research into practice tool included in the AUO designed for planning practitioners and creating research impact is the Transport Health Assessment Tool for Melbourne (THAT-Melbourne) developed in collaboration with the Victorian Government Department of Transport. The interactive tool is based on a physical activity population-level health impact assessment (Zapata-Diomedi *et al.* 2019) where short car trips are replaced with walking or cycling (Gunn *et al.* 2022). The tool was designed to provide health evidence of the benefits of active transport and support advocacy and planning actions for new walking and cycling infrastructure in communities (Gunn *et al.* 2021). In 2022, THAT-Melbourne was awarded a national research excellence award from the Planning Institute of Australia and has been accessed over 4,500 times since being launched in April 2021. The tool is currently being replicated for the Australian city of Brisbane with plans for replication in other cities included in the AUO.

Figure 3. The cyclic nature of research, policy and practice in development and expansion of the Australian Urban Observatory.

Journalists have also made use of AUO liveability indicators during analysis of infrastructure and planning policy announcements and community debate supporting democratic decision-making principles. A prime example relates to a federal government policy announcement in 2019 to fund car parks near train stations in marginal electorates that were largely held by the government of that time. Journalists sought AUO walkability and access to transport indicators to cast doubt on the policy decision and demonstrated that 50% of the locations targeted were in highly walkable areas with frequent public transport (Curtis and Wright 2021). Other examples include the use of AUO indicators to identify needs and inequities related to health planning and service provision (Nicholas 2022) particularly in greenfield development locations common to sprawling Australian cities (Newton 2010, Newton and Glackin 2014, Kroen and De Gruyter 2021).

Lessons learnt and limitations

Development of the AUO was a long-term project that culminated with the launch of a digital portal and access to the public in 2020. However, it required many years of research before this occurred and a similar amount to enable ongoing development and improvement. Funding has been one of the greatest challenges for an urban observatory partnering with government, while simultaneously creating new research and supporting evidence-informed policymaking and planning. Urban observatories cross both research and government sectors, and each sector has unique concerns and limitations. The government sector is concerned about the changing policy environment, the need for quick responses, timelines, trust, and political implications of negative results. In contrast, researchers operate with limited funding and resources, complex or missing urban datasets across multiple jurisdictions, negotiations with data custodians and large area spatial analysis (e.g. over 40,000 neighbourhoods included in the AUO). Respectful, realistic, and open relationship management has been essential to overcoming these challenges and essential to developing the AUO as an observatory that responds to the needs of the decision-makers that it has been targeted at. This has also been supported by decision to use of open-source software in the digital platform development. Including commercial software might have been more cost effective in the early stages of the project, but it wouldn't have

supported iterative and user-informed development. It also would have increased operational costs and required users to have access to associated proprietary software and licensing. The AUO being located in a university has also been helpful with computer science student projects focusing on usability research that has resulted in improved usability and design.

The AUO was developed to improve health and liveability using evidence-informed policy and planning with community engagement but ongoing sustainability and funding were also priority concerns. This resulted in the development of a hybrid model of access to liveability indicators which has proved successful to date. All liveability indicators are available free to the public at the Local Government Area or municipal area-level in all 21 cities included in the AUO. In addition, the overall Liveability Index and social infrastructure indicators are also freely available at the detailed suburb and neighbourhood levels to encourage investigation of local liveability and support community access. Remaining indicators at the suburb and neighbourhood levels require financial contribution to the AUO to support ongoing development of new indicators and features. This not-for-profit sustainability approach was a leap in faith in the beginning of the AUO but has proven itself to be a successful hybrid approach. Additional research funding supports staff salaries and ongoing development activities, and has been a benefit of being located in a university setting.

An additional challenge of working with government partners is tracking the impact of the AUO in organisations where privacy and public scrutiny is a concern. Web analytics help to understand the reach of the AUO but documenting policy application has often been restricted to the availability and release of public documents. This is an ongoing challenge and ongoing engagement with policy partners important to determine 'hidden' policy impact. Future research directly aimed at understanding research impact will be an important activity for the AUO or any newly established urban observatory in the future.

Transferability of the AUO liveability framework and application is another topic of future interest with urban observatories of interest to government and researchers across the world. This has already been tested in additional international contexts and proven successful in both Thailand and Japan. The Australian liveability definition provides a useful place to begin from with customisation according to the specific context, culture and country. Bangkok has been the city of focus in Thailand (Alderton *et al.* 2019, 2021), while the Smart Cities Institute of Japan has been working with federal and municipal governments across Japan to apply a modified liveability model across Japan.

Summary and conclusion

This paper introduces the Australian Urban Observatory, the first national-level urban observatory measuring liveability of Australian cities certified by the UN-Habitat Global Urban Observatories network. The AUO includes a comprehensive suite of aggregated, place-based urban liveability indicators linked to the Sustainable Development Goals, social determinants of health and urban planning. Like many other urban observatories across the globe, the AUO employs digital infrastructure and derived indicators to generate transdisciplinary insights, engage with decision-makers and mobilize knowledge on urbanisation (Acuto *et al.* 2021, Miller *et al.* 2021). In Australia, the AUO was developed to translate research evidence to improve observation, understanding about inequities, and action through policy, planning and advocacy to create equitable, sustainable, healthy and liveable places. Bi-directional and authentic partnership (e.g. Figure 3) between researchers and decision-makers guides AUO development. It is based on responsive technological innovation, small area liveability indicators and time series monitoring have been critical components of early success of the AUO.

Urban observatories are built on the growing interest in the connection between place, health and urban design. These relationships are well established (McCormack *et al.* 2014, Kärmeniemi *et al.* 2018, Frehlich *et al.* 2021) and transdisciplinary (Stokols *et al.* 2013, Pineo *et al.* 2021) research models and spatial planning (UN Habitat 2021) are necessary to address the complex relationships between cities and health. The way we plan, build and design cities is an important determinant of individual health and global environments (Barton and Tsourou 2013) and easy-to-use tools provide a critical link between policy and research evidence and knowledge mobilization into policy and practice (Fudge *et al.* 2020). Liveability indicators included in the AUO are representative of transdisciplinary research and aim to support integrated policy and planning development across policy portfolios and enhance deliberative democracy. Importantly, indicators developed with consideration for health also provide evidence to strengthen urban governance and support health equity (Corburn and Cohen 2012). The AUO model will continue to grow and expand over time with additional indicators, tools and features that are co-designed in response to the needs and applications of decision-makers.

Note

1. auo.org.au.

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Notes on contributors

All authors are based within the Centre for Urban Research at RMIT University in Melbourne Australia where the Australian Urban Observatory is located. Research in the Centre for Urban Research focuses on dynamic interdisciplinary research of global importance to cities that are liveable, equitable and sustainable.

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