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ABSTRACT

Urban liveability is a global priority for creating healthy, sustainable cities. Measurement of policy-relevant spatial indicators of the built and natural environment supports city planning at all levels of government. Analysis of their spatial distribution within cities, and impacts on individuals and communities, is crucial to ensure planning decisions are effective and equitable. This paper outlines challenges and lessons from a 5-year collaborative research program, scaling up a software workflow for calculating a composite indicator of urban liveability for residential address points across Melbourne, to Australia's 21 largest cities, and further extension to 25 global cities in diverse contexts.

摘要

城市宜居性是创建健康、可持续城市的全球优先事项。对建筑和自然环境的政策相关空间指标的测量支持各级政府的城市规划。分析它们在城市中的空间分布，以及对个人和社区的影响，对于确保规划决策的有效性和公平性至关重要。本文概述了一个为期5年的合作研究项目所面临的挑战和经验教训，该项目将计算墨尔本住宅地址点的城市宜居性综合指标的软件工作流程扩大到澳大利亚21个最大的城市，并进一步扩展到25个不同背景的全球城市。

1. Introduction

Urban liveability is a global priority, underpinning the creation of healthy, sustainable cities (United Nations 2016). Considered through the lens of the United Nations Sustainable Development Goals (SDGs; United Nations 2015) the concept broadly reflects an aspiration for cities to be "inclusive,
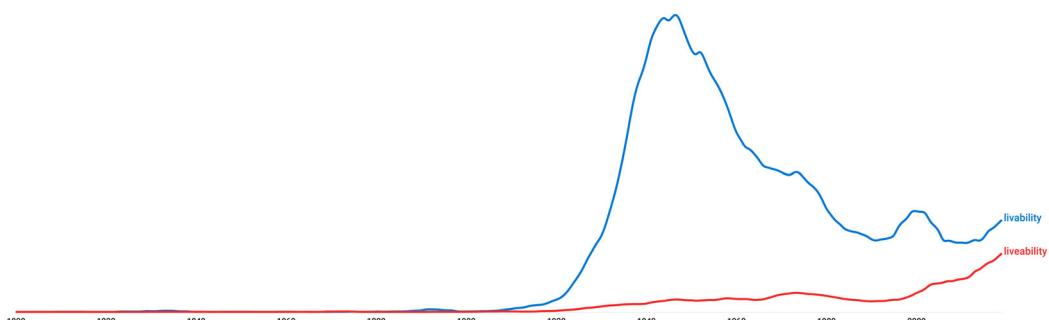
safe, resilient and sustainable" (SDG 11) such that they promote "healthy lives and well-being for all at all ages" (SDG 3). Effective city planning relies on measurable policy targets; moreover, measurement of policy-relevant spatial indicators of the built and natural environment supports integrated city planning at local, state and federal levels of government (Giles-Corti *et al.* 2020). Analysis of the spatial distribution of indicators within cities, and their impacts on the health and wellbeing of individuals and communities, can help ensure planning decisions are effective and equitable (Badland and Pearce 2019).

Concern for liveability in the context of urban planning is not new (Storer 1870). However, its growth in the context of planning and policy through the course of the twentieth century has been well documented (Figure 1; Woolcock 2009, Casey 2011, Kaal 2011, Lowe *et al.* 2013, Ruth and Franklin 2014), and reflects the confluence of two concurrent, global trends: increasing urbanisation, and a shift towards lifestyle factors such as diet and physical activity as the major contributors to burden of disease (Omran 1971, Murray and Lopez 1997, Mathers *et al.* 2001, de Hollander and Staatsen 2003, Stanaway *et al.* 2018, AIHW 2019). In the twenty-first century, the need for liveable cities has been underscored by increased awareness of existential ecosystem challenges posed by rapid population growth and climate change (McPhearson *et al.* 2021, Clark *et al.* 2020). Indicators of subjective and objective well-being and quality of living (Pacione 1982, Pacione 1990, UNDP 1990, Davern *et al.* 2008) have long been used to inform policy and legislation through the provision of evidence of health and wellbeing impacts. Spatial indicators of urban liveability aim to measure the impact of and inform planning decisions, and can be used to estimate downstream social, economic and health impacts (Giles-Corti *et al.* 2016). There exist a number of liveability indicator and composite indicator frameworks designed for use in diverse contexts which are essentially non-spatial, calculated as summary statistics for entire cities or other large urban regions (Valcárcel-Aguiar and Murias 2019, Economist Intelligence Unit 2021, Government of India 2016). Other authors have developed spatial liveability or sustainability indicator frameworks in different settings previously (Harrell 2017, Martino *et al.* 2021, Chi and Mak 2021, Gómez-Varo *et al.* 2022). In general, though, the existing frameworks for policy-relevant spatial urban indicators of liveability have limited scope for reproducibility, replicability and generalisability. This is due to the lack of publication of clear methods or open release of code or software supporting their usage, the reliance on commercially licenced data or data that otherwise may not be generally available in other global contexts, and the over-reliance on standardisation based on cross-sectional observations that impede the core objective of indicators for monitoring progress across time.

This paper presents the challenges, lessons, and outputs from the scaling up of a 5-year collaborative research program for the calculation of policy-relevant, evidence-based spatial indicators of urban liveability with outputs designed to be used by urban planners, policy makers and

**Figure 1.** A Google Ngram of known occurrences of "livability" or "liveability" from 1800 to 2019 provides a crude if illustrative sketch of the increase in circulation of the term; as spelt in Australia its frequency of usage appears to have been more or less increasing in the last two decades. https://books.google.com/ngrams/graph?content=livability%2C+liveability&year_start=1800&year_end=2019&corpus=26&smoothing=3

researchers in diverse contexts. Lessons learned from these experiences can be used to further strengthen the evidence and tools used by urban planners, policy makers and researchers for creating healthy, sustainable cities.

2. Developing a Composite Indicator of Urban Liveability

The Urban Liveability Index (2016–2021; Higgs *et al.* 2019) was developed as a policy-relevant composite indicator of urban liveability calculated for residential parcels, allowing for flexible aggregation and supporting comparisons both within- and between-cities. Underpinned by a detailed socio-ecological model of associations between the built environment and health and wellbeing, the index was founded on a definition of a liveable community as being:

> … safe, attractive, socially cohesive and inclusive, and environmentally sustainable; with affordable and diverse housing linked to employment, education, public open space, local shops, health and community services, and leisure and cultural opportunities; via convenient public transport, walking and cycling infrastructure. [2013]
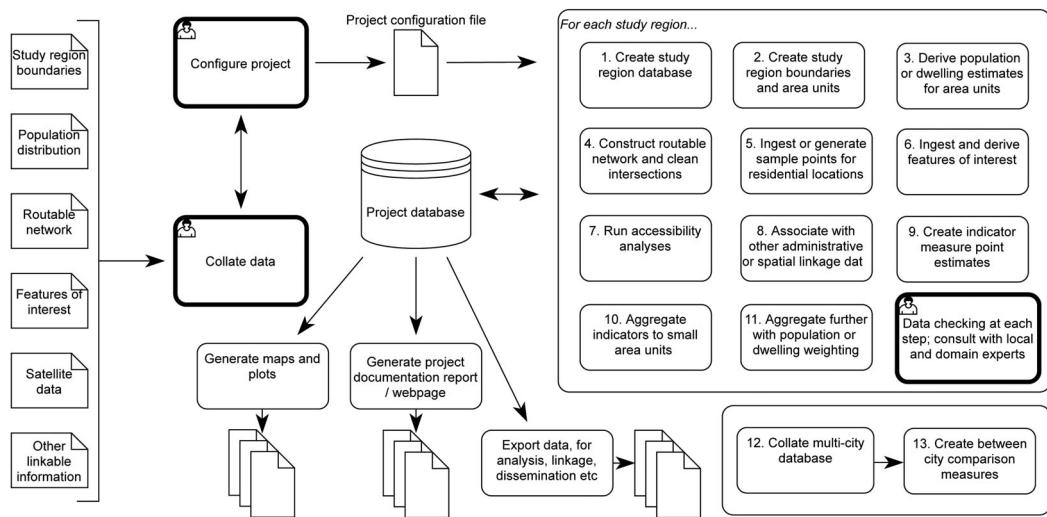
Using this framework, we developed methods for calculating a high-resolution spatial urban liveability index, encompassing conceptually-derived and empirically-tested indicators across liveability domains, including walkability (Frank *et al.* 2010, Mavoa et al, 2018), access to community and health services (Davern *et al.* 2018), local employment (Badland *et al.* 2016), food (Murphy *et al.* 2017), affordable housing (Badland *et al.* 2017a), public open space (Villanueva *et al.* 2015), and public transport (Badland *et al.* 2017b). The resulting spatial indicators supported analysis and mapping of spatial access to health-promoting resources, as well as within-city inequities in liveability (Arundel *et al.* 2017, Higgs *et al.* 2018, Higgs *et al.* 2019, Davern *et al.* 2020, Gunn *et al.* 2020a, Boeing *et al.* 2022).

An initial workflow to calculate address-level liveability measures was developed through a pilot project (Higgs *et al.* 2018, Davern *et al.* 2018, Higgs *et al.* 2019, Higgs *et al.* 2021). Focused on Melbourne, a city on Australia's south-eastern coast experiencing rapid and sprawling population growth (Foster *et al.* 2013, State of Victoria DELWP 2017), this workflow was later extended to capital and regional cities, towns and local government areas around Australia (the Australian National Liveability Study, 2016–2021; Arundel *et al.* 2017, Davern *et al.* 2019a, Davern *et al.* 2019b, Davern *et al.* 2019c, Davern *et al.* 2020, Lowe *et al.* 2020), and to 25 cities located in diverse international contexts across two distinct projects (Bangkok Liveability, 2018–2021, Alderton *et al.* 2020; Global Healthy and Sustainable City-Indicators Collaboration study, 2018–2022, Liu *et al.* 2021, Boeing *et al.* 2022).
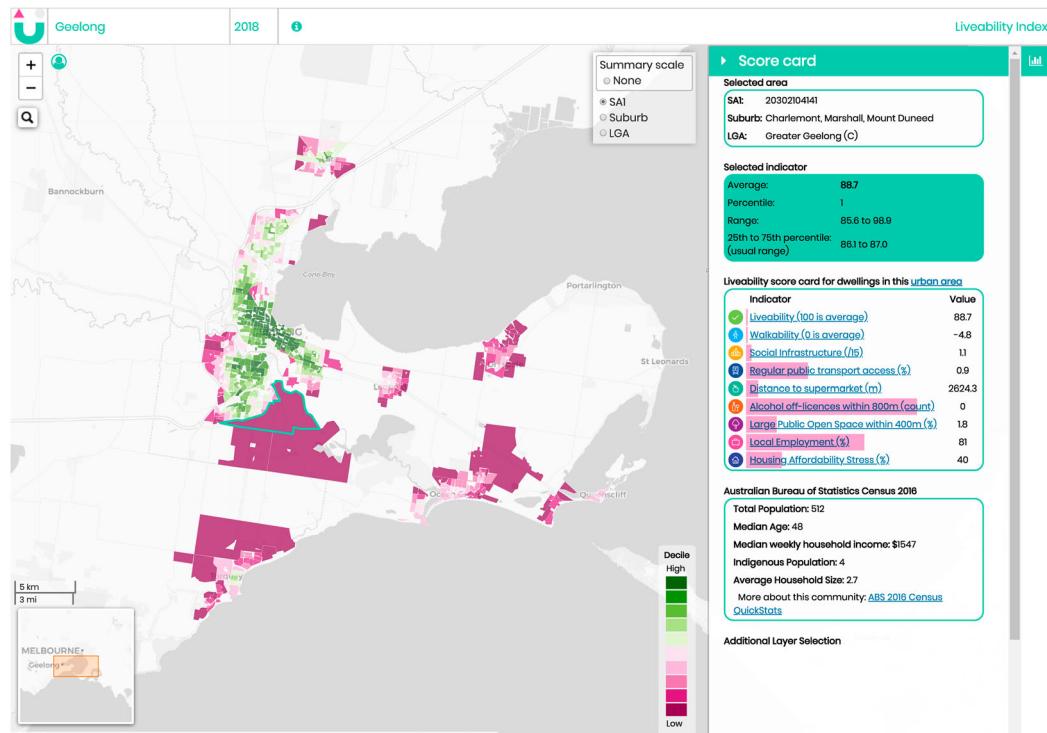
Figure 2 illustrates the generic urban liveability indicator workflow, which enables flexible and reproducible production of liveability indicators for different cities, at different times, given available data, and with outputs tailored for the needs of distinct stakeholders. The results informed scorecard reports of urban liveability (Gunn *et al.* 2020a, Salvo *et al.* 2022), interactive indicator map portals (Alderton *et al.* 2020, Davern *et al.* 2020), analysis of behavioural and health outcomes (Villanueva *et al.* 2022, Fortune *et al.* 2020a, Fortune *et al.* 2020b, Foster *et al.* 2019, VicHealth 2020), and amenity provision in new urban developments (Gunn *et al.* 2020b). Open source software was developed to support spatial analysis of urban liveability for cities in diverse contexts using open and custom data (Liu *et al.* 2021, Boeing *et al.* 2022). Figure 3 provides an example of the spatial distribution of liveability for Geelong, and a score card report of indicator estimates for a particular statistical area on the urban fringe.

3. Study Planning: Definitions and Data Sourcing

Measuring and evaluating spatial indicators across cities and over time requires detailed, comparable data, and clear, consistent study region definitions. However, data are more likely to be

Figure 2. Process model for a scripted workflow for calculation, validation, analysis, and dissemination of spatial urban indicators. Human icons in the boxes indicate steps requiring researchers to undertake configuration of project and study region parameters including definition of required indicators and measures, sourcing valid data, and data checking in coordination with local and domain experts. This process may be adapted for production of specific indicators or measures across a broad range of contexts given available data.

Figure 3. A liveability score card report for a particular Statistical Area 1 region in Geelong sourced from the RMIT Australian Urban Observatory (https://auo.org.au) in 2020.

available, accurate, and complete in higher populated urban areas of high-income countries (Taylor *et al.* 2018). Measuring liveability indicators is particularly challenging in peri-urban areas with dynamic growth, and in lower-income settings, with an increased risk of data being inaccurate, incomplete or unavailable (Johnson *et al.* 2016, Fonte *et al.* 2017). To support comparisons between cities we sourced established urban boundaries; for example, using data from the Australian Bureau of Statistics (ABS 2017) or the Global Human Settlements Urban Centres Database (Florczyk *et al.* 2019). We used OpenStreetMap to determine residential access to specific services and amenities for multi-city studies, where sourcing consistent and complete data was otherwise challenging. OpenStreetMap is a community contributed open map database, that provides a valuable longitudinal resource of built and natural environment data with global scope, ostensibly up-to-date, and coded according to consistent and transparent guidelines (OpenStreetMap contributors 2021).

OpenStreetMap has some advantages to routinely collected official data, in that new developments and pedestrian paths may be better represented (Barrington-Leigh and Millard-Ball 2017, Boeing 2017). Collated from user contributions, and with regular archival of the "planet" database back to 2006, OpenStreetMap provides opportunities for longitudinal study of built environment data. OpenStreetMap is also readily accessible, allowing for multiple ways of retrieving and working with the data depending on need: for example, planet archives, regional excerpts, or the Overpass API for retrieval of the current state. Consideration should be given when using OpenStreetMap data in a study to the methods used to retrieve data to ensure reproducibility of the results of a particular analysis; for example, if the Overpass API is used to retrieve OSM features for a particular analysis, the analysis may not be readily reproducible without the sourcing of a matching planet archive, requiring care to be taken to record the exact time and date of the "current state" data retrieval. For this reason, working with archive data from specific fixed time points is recommended. The degree of uptake of OpenStreetMap by mappers in the region of interest for the features of interest being studied should also be verified. For example, by working with local collaborators in the Global Healthy and Sustainable City-Indicators Collaboration study (Boeing *et al.* 2022) we were able to confirm that although street network infrastructure was adequately represented, a range of local amenities and services were not. Hence, we ensured our framework was able to function by using custom prepared data, which we were able to source from our collaborators as an alternative to OpenStreetMap (Liu *et al.* 2021). The sourcing of custom data for such projects may present opportunities for building on identified gaps through contribution back into OpenStreetMap.

With any data source, care must be taken to consider positional, temporal and semantic accuracy of features of interest, as well as, completeness of study region coverage (Guptill *et al.* 1995, Zhang and Pfoser 2019). Seeking advice from experts on specific subject matter, local contexts and cultural nuances is essential to ensure the validity of representation (Liu *et al.* 2021).

4. Scale and Units of Analysis

The ability to produce indicators at multiple scales of aggregation for analysis, visualisation and linkage according to the needs of different stakeholders and projects requires high-resolution measurement of built environment exposures. Providing this level of flexibility can guard against issues such as the modifiable areal unit problem, and allow for sensitivity analyses to investigate the influence of choice of scale on estimates modelled using indicator data (Higgs *et al.* 2019, O'Sullivan and Unwin 2010). Through the Australian National Liveability Study, we measured local neighbourhood environments using address points in urban residential locations (Arundel *et al.* 2017, Lowe *et al.* 2020). Internationally, where address data were not always available, point locations were identified at regular intervals along a pedestrian accessible street network in populated regions of the city (Alderton *et al.* 2020, Liu *et al.* 2021). These methods served to identify residential locations, for which local neighbourhood environments could be evaluated and

aggregated to produce measures for larger geographical areas, in conjunction with additional data on dwelling and population distributions.

The use of small area gridded data, if available and at an appropriate resolution for the analysis being undertaken, is worth considering as an alternative to administrative or statistical area data. The latter can lack a consistent scale and may not well support comparative analysis with different jurisdictions. In contrast, grid cell data, where available, supports aggregation and analysis at a standard, fixed resolution across different study regions. Even within a single study region, using grid cell data ensures consistency of measurement; conversely, using variable scale small statistical area data can disadvantage the representation of areas on the urban fringe. Figure 3 illustrates how aggregation of indicators to the smallest administrative unit for which most census data is publicly realised in Australia (Statistical Area 1) can lack precision for lower population areas outside urban centres.

Various gridded population datasets with global scope across a range of time points are now available, for example, WorldPop (Lloyd *et al.* 2017) or the Global Human Settlements population grids (GHS-POP; Schiavina *et al.* 2019), which we used as a common source of population in our 25 city international study (Liu *et al.* 2021, Boeing *et al.* 2022). Modelled datasets such as these still must be used critically, however, as they depend in part on country specific small area census results and land use analysis of satellite imagery. Modelled results may be more or less accurate for representing specific neighbourhoods at specific points in time. For example, the North Sea port area of Ghent was recorded as having a population, which our local experts advised was misleading; as such, we revised our study region definition to exclude this area to ensure it wasn't erroneously represented, and therefore, analysed in our study as residential. Notwithstanding such challenges of modelling population levels accurately at high resolution using available data, the increasing availability and release of global high-resolution gridded datasets greatly support large scale comparative analyses, by supporting analysis using consistent spatial units of analysis. Where gridded datasets are available sharing common scales and spatial coordinate references, these further mitigate the risk of spatial misalignment when linking data from different sources.

5. Relative or Absolute Comparisons?

The spatial urban liveability indicator workflow supported large-scale comparative analyses of inequities, within and between cities. The walkability index and urban liveability index composite scores were formulated to yield a performance score – for an address point, or as an area average – relative to the average residential exposure across the study region or regions of interest. There are two important limitations of using relative composite indicators such as these. First, these relative measures cannot be meaningfully calculated for a single, or small clustered collection of address points, as the analyses do not provide a valid average reference value against which to compare. Second, measures subsequently calculated for different study regions and/or time points cannot be meaningfully compared, as they do not share common reference standards. For example, the mapped spatial distribution of a walkability index calculated for residential locations in a regional Australian city – following standardisation of each of the walkability components of dwelling density, street connectivity and walkable access to diverse amenities against the city average – would appear quite different if the standardisation were undertaken relative to locations across Australia 21 largest cities. For the Australian National Liveability Study, walkability and liveability measures were calculated using both methods (relative to the city average, and relative to the national average). However, when the analysis is undertaken for a new time point the average values will have shifted, thus limiting capacity for direct longitudinal comparisons of change for specific locations in 2018. This is an important limitation which future research should seek to address.

Targets for meeting specific aspects related to the SDGs have been published previously, which can provide alternatives to comparison against study region or multi-city averages. For example, The OECD (2019) provide a set of targets which may be used in studies concerned with meeting the SDGs. Dickens et al. (2019) describe a framework for determining benchmarks according to

the local contexts and priorities of different countries seeking to meet the SDGs, which could be used to determine benchmarks that are meaningful and may be nuanced to the needs of distinct cities in different contexts globally.

The scoring of composite indicators against established, or location contextualised, policy-relevant targets and evidence-based thresholds would provide an "absolute" assessment that would be comparable across sites and across time. For example, in the Australian National Liveability Study (Arundel *et al.* 2017) indicators of local policies were assessed (e.g. 70% of dwellings should be within 400 m of public transport stop), which allowed local policymakers to assess local policy implementation (Lowe *et al.* 2020). Although presenting challenges for between city comparison, the development of composite indices of walkability or urban liveability based on local policy would provide more objective comparisons across time and within cities, better serving tracking and monitoring (in)equity of policy delivery. However, while the calculation of indicators using locally contextualised policy standards may support tracking of policy implementation for those areas, this does not necessarily mean the policy standard is appropriate and it also does not solve the problem of between area comparisons using objective standards which can highlight important variations in policy ambition across jurisdictions: a policy for a particular topic (for example, the percentage of dwellings with access to public transport) in one particular state's capital city may be being achieved, but the city may compare poorly against other cities when using a common evidence-supported standard of greater ambition (Arundel *et al.* 2017, Lowe *et al.* 2020).

Notwithstanding the challenges of determining appropriate target thresholds, the use of these instead of sample based averages as a source of comparison would not only better support longitudinal comparisons. Real time queries of walkability and liveability for a single address point would be more feasible and meaningful, as they would not require comparison against the average value across a region or sub-region (i.e. requiring analysis of an arbitrarily large set of locations; comparison against the average value of which, does not indicate "good" or "bad" performance), but instead could be compared directly against an agreed performance criteria to indicate whether goals have been met.

6. Reproducible Scientific Workflows for Urban Analysis

The development of a Python-based reproducible scientific workflow for large scale neighbourhood level built environment analysis – abstracting project and study region specific parameters such as data sources, thresholds, study region definitions from the general code used to perform a series of analyses – meant that methods could readily be extended to distinct study regions and policy locales, given availability of appropriate data. However, while a programmed configurable workflow can in principle allow a user to apply this to new context, exactly "how" the process can be configured is an important consideration to ensure usability in practice. An early awareness of the need to support non-programmers to use the workflow led to the adoption of Excel Workbooks as an accessible medium for defining parameters (annotated, and formatted in tables) in the Australian and Bangkok studies. The global indicators collaborative study extended the Bangkok project's Excel configuration with parameterisation in JSON text files for its main analysis. Future studies could consider using a human readable, plain text file format supporting annotation like YAML (Greenfield *et al.* 2015, Ben-Kiki *et al.* 2005) to support accessible project configuration, whilst avoiding the use of a proprietary file format.

7. Software Development Practices Supporting Urban Environment Research Cycles

The evolving needs of expansive, multi-output projects can require on-going coding and collaboration between team members with different research background and skills. Agile software development practices can support meeting project deadlines and keeping development on track with

project aims (Rodriguez *et al.* 2021, Beck *et al.* 2001). The Australian National Liveability Study analysis team used version control, stand-up meetings and task boards to support timely scaling-up. However, the capacity for code review was limited, and lack of a clearly defined end-point contributed to scope-creep, delaying project documentation to prioritise emerging additional uses and requirements.

For the Global Healthy and Sustainable City-Indicators Collaboration study (Boeing *et al.* 2022), the project team collaborated on a public repository to deliver an open source tool that is now freely accessible to the public (Liu *et al.* 2021). Adopting open source practices such as these supports collaborators and other users to reuse the code and implement the analytical process within a stable computational environment, enhancing the transparency, reproducibility and replicability of the research. The use of a public code repository platform meant that team members and public stakeholders could have open conversations about issues encountered and collaborate to resolve these, with documentation of the history of these interactions recorded for future reference or review.

It may be that the act of developing generalisable software for a project, with a view to supporting flexible re-usage in different contexts and to address different research questions, contributes to scope creep. While Agile software development methods aim to support project management, maintaining shared focus and understanding of project objectives and priorities is crucial to its success (Sithambaram *et al.* 2021).

8. Project Documentation

Public-ready documentation is essential for project posterity and for making the data available for use by others, but achieving this after time allocations have passed is challenging. Building on lessons from previous projects, the Bangkok Liveability Project guarded against this potential project risk by incorporating automated documentation of results, technical methods and metadata into the workflow from project commencement to support the project's "continuous development" approach and was deliberately planned into the project deliverables (Alderton *et al.* 2020). For this project, on-going sharing of project outputs with project partners ensured project expectations were met, despite geographical distance, while also supporting local capacity-building. Further, ongoing sharing of documentation and outputs helped facilitate knowledge exchange and built trust amongst the collaborating organisations, strengthening the partnership. In the Bangkok Liveability project, training materials were provided in multiple formats, including the generated static (PDF) and interactive (HTML; Figure 4) project documentation, as well as recorded video webinars detailing usage of the tools.

9. Balancing Utility and Parsimony in Urban Analysis Tool Development

Simultaneous output of documentation and data in multiple formats in the Bangkok and Global Indicators projects proved useful, ensuring stakeholders received data, maps, figures and reports in formats tailored to their needs, ahead of the completion of these projects. Software and package management frameworks – for example, Docker (Merkel 2014) and Anaconda (Anaconda 2020) – streamlined installation procedures, and facilitated the use of open source software as an alternative to the commercial software (ArcPy; ESRI 2016) dependent approach of the National Liveability project. However, the large number of underlying software libraries – used to support spatial and network analyses, report generation, database management – meant that the final software size was large, and software dependency management was still complicated. Further simplifying the software requirements would encourage more people to use this workflow for urban liveability analysis.

10. Data Linkage for Analysis with Behavioural and Health Outcomes

To further enhance the use of liveability indicators in a wider range of public health research applications, liveability indicators can be linked to health data. The urban liveability indicator workflow

Figure 4. A screenshot excerpt of generated offline HTML documentation for the Bangkok Liveability project, in which the pre-specification of project parameters to configure analysis allowed for on demand reporting on the current state of the project.

was designed to support linkage or analysis of participant locations to supplement surveys with built environment exposure measures, and this has been undertaken for a number of projects (Alderton *et al.* 2022, Foster *et al.* 2019, Higgs *et al.* 2019, Higgs *et al.* 2021, VicHealth 2020). However, the process of working with geolocated and identifiable survey data items such as participant data must be well planned in order to protect the identify of study participants.

For instance, a current ongoing project involves linkage of liveability indicators with a nationally representative population health cohort data, namely the Australian Diabetes, Obesity and Lifestyle (AusDiab; Chandrabose *et al.* 2020), with participants from diverse geographical settings across Australia. It is, therefore, possible to use measures from the Australian National Liveability Study to investigate how variation in environmental attributes supporting urban liveability may influence health outcomes, with generalisation of the findings to the broader Australian context.

However, several challenges needed to be overcome to support data linkage. The health datasets contain highly confidential information (specific health-related conditions), and hence the data custodian does not share the individual-level residential address data of the participants to third parties. Several security procedures were, therefore, adopted to protect the identity of AusDiab study participants: (1) the geocoding of study participant residential addresses was undertaken by the data custodian at their premises, and they undertook "geographic masking" (offsetting the actual coordinates with new coordinates that are some randomly generated distance away from the actual coordinates) and an id-linking variable was created; (2) fake geocodes were added into a file with the masked geocodes and the id-link variable, and these were linked to the national liveability data; (3) the data custodian then re-linked the geospatial data to the survey data; and (4) the analysis was undertaken on a de-identified data set. A similar approach was used for data linkage of indicator measures for the Australian Early Development Census (Alderton *et al.* 2019, Villanueva *et al.* 2022). Similar security protocols will need to be considered when scaling-up and linking liveability indicators for analysis of large scale national and multi-country health datasets to protect the identity of study participants.

11. Future Directions for Spatial Urban Liveability Indicators

The spatial indicators of urban liveability developed through this programme have proved flexible for a broad range of uses: assessing the availability of health supportive environments and policy implementation (Arundel *et al.* 2017, Lowe *et al.* 2020); examining the relationship between environmental attributes and child development (Villanueva *et al.* 2022), transport behaviours (Higgs *et al.* 2019), biomedical risk factors of chronic diseases (Higgs *et al.* 2021), high-density housing residents (Foster *et al.* 2019), and COVID-19 exposure (VicHealth 2020); as well as area level analysis (Fortune *et al.* 2020b), mapping and city indicator summaries supporting local, state and federal government planners and policy makers in diverse contexts (Gunn *et al.* 2020a, Liu *et al.* 2021, Horne *et al.* 2020, Alderton *et al.* 2020, Boeing *et al.* 2022), including through the Australian Urban Observatory (Davern *et al.* 2020) and Global Observatory of Healthy and Sustainable Cities (Salvo *et al.* 2022) online indicator observatories.

Through the course of the work, we have developed and made publicly available code and tools to support others to both reproduce our work and extend it to new contexts using popular open data sets with global scope. However, we also confronted a number of challenges, which are not fully resolved: the need for careful validation of data, particularly when community contributed (Guptill *et al.* 1995, Zhang and Pfoser 2019, Liu *et al.* 2021); the influence of indicator scale on modelling estimates (Higgs *et al.* 2019, O'Sullivan and Unwin 2010); contextualisation of benchmarks and thresholds to according local priorities (Dickens *et al.* 2019); human readable project documentation (Greenfield *et al.* 2015, Ben-Kiki *et al.* 2005); and overall project planning and management (Rodriguez *et al.* 2021, Beck *et al.* 2001, Sithambaram *et al.* 2021). This paper has summarised some approaches to addressing these challenges. Through doing so, future research can advance the accessibility, utility and meaningfulness of spatial indicators of urban liveability to better monitor progress and inform strategies for achieving the SDGs, and building healthier, more sustainable cities.

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