Title: Adaptation and testing of a microscale audit tool to assess liveability using Google Street View: MAPS-Liveability.

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ABSTRACT

Background: Liveability is a complex, multifaceted concept with various definitions, but with an agreed core set of features (e.g., safety, walkability). Typically, liveability is measured at the macro-level (city or regional-level), and has been used in advocacy by local populations. However, micro-level (street-level) liveability measurements could also/alternatively be used to identify modifiable environmental features impacting health and well-being. To date, no micro-level liveability tools exist. This study investigates the reliability and rater agreement of a new micro-level audit tool designed for use with Google Street View (GSV).

Methods: MAPS-Liveability (GSV), was adapted from the Microscale Audit of Pedestrian Streetscapes (MAPS). This study had two phases: 1) MAPS-Liveability development (rapid literature review identifying core liveability concepts, focus groups confirming liveability concepts and tool adaptation); 2) reliability investigation (researcher agreement). Assessment was made of: total liveability; nine liveability sub-characteristics (e.g., safety, health); and 12 proxy measures of behaviour including active travel (e.g., bicycle racks, presence of bicycles in racks). Inter-rater reliability and sensitivity to change were assessed by percentage agreement, inter-class correlation coefficients (ICC) and Wilcoxon signed-ranked tests ($p<0.05$).

Results: Inter-rater reliability was *excellent* (ICC 0.905-0.968) for total liveability, parked cars and total number of cars (moving/parked); *good* (ICC 0.754-0.885) for health, sustainability, places, number of bicycle racks, bicycle rack capacity, number of bicycles in the racks (time-point 2), cyclists (time-point 2), moving cars (time-point 2) and pedestrians; and *moderate* (ICC 0.550-0.742) for safety, inclusivity, education, traffic/transport, pavements, roads, cyclists (time-point 1), number of bicycles in the racks (time-point 1) and moving cars (time-point 1).

Conclusion: MAPS-Liveability provides a reliable assessment of micro-level liveability features. MAPS-Liveability has excellent inter-rater reliability for total liveability and moderate-excellent inter-rater reliability for liveability attributes and behavioural indicators. GSV at street-level supports safe, large-scale objective data collection, and collection of historical data where primary data is unavailable.

KEYWORDS

Liveability, MAPS, street audit, Google Street View, reliability, sensitivity to change

1. INTRODUCTION

Liveability is a complex, multi-faceted concept, with varying definitions informed by different theoretical frameworks spanning over twenty years of environmental and health research (Lowe et al., 2013; Giap et al., 2014; Giles-Corti et al., 2014; Valcarcel-Aguiar & Murias, 2019). It is a concept that links public health, urban planning and urban design; and has become a significant focus for policy makers and practitioners, informing their work on infrastructure, construction, health and urban planning (Adam et al., 2017; Higgs et al., 2019; King et al., 2020). By investigating liveability and gaining a greater understanding of the built environment and its characteristics such as accessibility, safety, aesthetics, green and open spaces, we can open up new possibilities for environmental maintenance, regeneration and/or sustainability that can

ultimately help lead to improved health and well-being (Adams et al., 2017, Higgs et al., 2019). Such investigations would be considered timely given the United Nations Sustainable Development Goals which calls for cities to be made "inclusive, safe, resilient and sustainable" by 2030 (United Nations, 2018).

However, despite the upwards trajectory of liveability research over recent decades, there is still currently no standardized and accepted definition of 'liveability' (Adam et al., 2017; Higgs et al., 2019; Valcarcel-Aguiar & Murias, 2019). Upon review of the differing definitions, it is apparent that although each has been refined to suit the focus of specific applications, all definitions to varying degrees, include the concepts of safety, health, sustainability, inclusivity, education, sense of place, transport (including walkability), amenities and living standards which relate to health and well-being; and align with key elements of the social determinants of health (Balas, 2004; Lowe et al., 2013; Giap et al., 2014; Giles-Corti et al., 2014; Valcarcel-Aguiar & Murias, 2019).

Currently, numerous tools exist to audit the environment locally, including the Pedestrian Environment Data Scan (PEDS), the Irvine-Minnesota Inventory, the Analytic Audit Tool, the Systematic Pedestrian and Cycling Environmental Scan (SPACES) and the Revised Block Environmental Inventory (RBI) (Pikora et al., 2002; Brownson et al., 2003; Day et al., 2005; Clifton et al., 2007). These tools were designed with specific dimensions of urban life in mind such as active travel (e.g., PEDS, SPACES) or quality of life/crime prevention (e.g., RBI). Walkable, bikeable, and safe neighborhoods are thought to be more liveable and conducive to better population health and well-being. At present, liveability indicators exist that are routinely used at the macro-scale (e.g., liveable cities) enabling cities to be ranked for investment, policy-making and for impact assessment (Badland et al., 2014; Lowe et al., 2015; Giles-Corti et al., 2016). However, tools combining several aspects of liveability for environmental audits (e.g., trees, cycle lanes, parks) and at lower geographical scales (e.g., neighbourhoods, streets) are not yet well-developed but

would be useful in facilitating a more nuanced measurement approach for research (Barton & Grant, 2006; Newman, 2006; NSW Department of Health, 2009; San Francisco Department of Public Health, 2010; Economist Intelligent Unit, 2011).

The Microscale Audit of Pedestrian Streetscapes (MAPS) was designed to audit the pedestrian environment and walkability of neighbourhoods (Brownson et al., 2004) and has been adapted over time to provide a broad and inclusive method of assessing destinations, land use, streetscapes, aesthetics and social variables at street-level (Millstein et al., 2013). Therefore, MAPS-Full was an appropriate starting point for developing a liveability assessment tool, providing a better understanding of influencing environmental factors. In addition, it has utility for research, policy and practice regarding environmental attributes that: i) influence health behaviour; ii) reflect the propensity of an area to support physical activity (including walking and cycling); iii) establish how individuals access and interact with and within their environment; iv) provide information regarding better living, socializing and working conditions; v) and can identify the impact of environmental changes on liveability and health and well-being (Astell-Burt et al., 2013; Millstein et al., 2013; Astell-Burt et al., 2014; Giles-Corti et al., 2014).

Therefore, the objective of this paper is to introduce a modified version of the MAPS, MAPS-Liveability. Our modified version augments it with items that relate to safety, sustainability, health, traffic/transport and roads. Moreover, the rise in programmes, including Google Street view (GSV) that permit remote, retrospective and safe observation of streetscapes without the need for specific expertise, makes a compelling case for designing a tool that is usable for virtual audits (Griew et al., 2013). For this reason, in addition to the modified version of MAPS, we conducted a study to assess the inter-rater reliability of MAPS-Liveability via GSV.

2. METHODS

2.1 Development of the MAPS-Liveability

MAPS-Full was modified by completing the following steps. 1) establishment of a comprehensive list of characteristics that influence liveability via a rapid review of the literature; 2) assessment of MAPS-Full against the list to determine its comprehensiveness; 3) creation of new items to address the areas missing in MAPS-Full to create MAPS-Liveability; and 4) testing the reliability of the new MAPS-liveability tool. The development of MAPS-Liveability followed the adaptation framework outlined by Stewart and colleagues (2012). This included: 1) qualitative research to explore concepts and to review the tool; 2) literature reviews to determine the "adequacy or appropriateness of measures"; and 3) researcher experience and knowledge to provide guidance and the rationale for any proposed tool modifications.

2.1.1 MAPS-Full

As stated, MAPS-Full was originally developed from the Analytic Audit Tool to collect data on the pedestrian environment, streetscapes and walkability (Brownson et al., 2004). When the assessment of MAPS-Full was performed to determine its comprehensiveness via literature reviews and qualitative research, we found significant overlap between the liveability characteristics and MAPS-Full (Figure 1) (Stewart et al., 2012). This mapping exercise demonstrated that only eleven additional items were required for MAPS-Liveability (Figure 1).

MAPS-Full has previously been evaluated for reliability, and the majority of items (75.6%) and had moderate or good/excellent reliability (96.1%) (Millstein et al., 2013). Furthermore, MAPS-Full has also been specifically tested for online street view versus field observations, with findings showing that online audits using GSV are valid replacements of field measures when assessing land use (Milstein et al., 2013;

Kurka et al., 2016). Therefore, because of the reliability testing and its inclusion of micro-level attributes, it was decided that it only required minimal adaptation to assess liveability.

2.1.2 MAPS-Liveability

To adapt MAPS-Full for the purposes of liveability, the content of the original questionnaire was amended, such that: 1) three qualitative open ended questions were added, and 2) twelve proxy indicators of behaviour (including active travel behaviour) were included (Appendix A-B). The proxy indicators of behaviour included: the number of bicycle racks; number of bicycles in the racks; and the number of moving or parked cars. Proxy indicators were added as current methods for tapping into these measures usually rely on household travel surveys which are costly or infrequently performed, usually only providing data at larger geographical scales (e.g., city, county or nationally), and are time intensive and expensive to implement (Goel et al., 2018). In addition, current active travel counts can be inadequate for research purposes as the coverage of cyclist and pedestrian counters (in person or sensors) has been limited, with many of the installed sensors found to be broken or absent during periods when data collection would have been important for research (Goel et al., 2018). Furthermore, other detailed counts relating to cycling such as the number of bicycle racks or bicycle rack capacity, are infrequently assessed, but data relating to their presence is required as inclusion of such cycle infrastructure has been found to encourage cycling (Hull & O'Holleran, 2014).

When adaptations were complete, the contents of the new 'MAPS-Liveability' tool were sense checked to determine the adequacy, appropriateness and coverage of the measures and it was determined by the research team that MAPS-Liveability was suitable (Table 1) (Stewart et al., 2012).

2.1.3 Pilot study

A pilot study was undertaken by two auditors who rated the same streets, at the same point in time, to determine whether the original MAPS-Full data collection protocol was appropriate and feasible for use with the newly developed MAPS-Liveability questionnaire via GSV. The MAPS-Full data collection protocol was implemented on five streets (selected at random within Belfast city centre) with MAPS-Liveability. When both auditors discussed their findings it was determined that only four changes were required to the original MAPS-Full data collection protocol for use with the new MAPS-Liveability tool (Appendix C).

The four changes included: 1) the audit starting point (i.e. either end of a street rather than at a participant's house); 2) the size of the audit area (i.e. the entire street or a pre-selected route (beginning to end) rather than 0.25 miles); 3) auditing a single complete street/route rather than a segmented street/route (both sides of the street); and 4) the removal of questions relating to sensory perceptions such as noise (Appendix C).

2.1.4 Scoring protocol

We developed a new scoring protocol in line with the original protocol for each of the nine characteristics of liveability and for the total liveability score (Appendix D-G) (Cain et al., 2012). Scores for the proxy indicators of behaviour including active travel can also be obtained and quantitatively analyzed (Appendix G).

2.2 MAPS-Liveability reliability testing

The current study was performed in Belfast, UK between February and July 2019. The city has seen many changes over the last decade in terms of its micro- and macro-level environment (i.e. cycle lane investment, speed limit reductions to 20mph, pedestrianisation of streets within the city's core, renovation and rejuvenation of amenities and facilities and improvements to public transport). Data were

collected at two time points within Belfast city centre, with virtual audits enabling historical data to be collected via GSV. In Belfast city centre, 50 streets (i.e. the entire street as one complete route) were selected at random from those in the city centre. Audit dates for GSV time-point 1, were pre-February, 2016; and for time-point 2, July 2019. The mean timeline between each audit was 38 months. Each street was audited at two time-points by two independent auditors (not always the same pair, as there was a pool of seven auditors) using the newly adapted MAPS-Liveability tool and data collection protocol (Appendix H).

2.3 Statistical analysis

Statistical analysis was performed using SPSS Data Analysis Version 23 (SPSS Inc,). Spearman's rank correlation coefficients were calculated to establish if there was a relationship between street length (determined by geographical information system mapping, in metres) and audit time (in minutes). Descriptive statistics (mean and standard deviation (SD)) were analyzed and presented, for audit time, street length, each of the nine liveability characteristic scores, total liveability score and the twelve proxy measures of behaviour including active travel behaviour. Inter-class correlation coefficients (ICC) were used to assess how similar scores were between each rater, with a high degree of similarity signifying a high degree of reliability (<0.5 poor, 0.5-0.75 moderate, 0.75-0.90 good and >0.90 excellent (Koo & Li, 2016)). One-way random-effects models were implemented, due to the raters being different and randomly selected from a pool of seven raters. ICCs were performed for each liveability characteristic (n=9), total liveability score and proxy measures of behaviour (n=12) as reported by auditor 1 versus auditor 2 (time-point 1 and time-point 2). Regarding sensitivity to change, Wilcoxon signed-rank tests were performed to determine whether the change scores were significantly different between time-points and between auditors for the nine characteristics of liveability, the overall liveability score and the twelve proxy measures of behaviour. Significance was set at $p < 0.05$.

3. RESULTS

3.1 Results for MAPS-Liveability

Agreement for audit dates (selected on GSV) for time-point 1 was 96% (n=48 of 50) and for time-point 2 was 86% (n=43 of 50). Disagreements were due to: auditor error selecting the most appropriate date (n=4); GSV being updated between the time that the two auditors selected the most relevant date (n=2); route discrepancy (n=2); and auditor error when two names were used on one street (n=1). The mean length of time to audit a street at time-point 1 was: 57.8 minutes (*SD*31.0; range 15 -150 minutes) for auditor 1; and 54.6 minutes (*SD*27.1; range 10 - 120 minutes) for auditor 2. At time-point 2 the mean length of time to audit a street was: 37.5 minutes (*SD*21.0; range 15 -120 minutes) for auditor 1; and 37.2 minutes (*SD*25.3; range 10 - 120 minutes) for auditor 2. There were no significant differences between auditors for the mean length of time to audit a street ($p>0.05$). However, the length of time between time-point 1 and time-point 2 for each auditor significantly decreased ($p<0.001$). The mean street length was 200.4 metres (*SD*131.8; range 20.2 – 616.7 metres), with analysis showing positive correlations between street length and audit time. Longer streets were associated with lengthier audit times (r 0.326-0.547).

3.2 Time-point 1: Auditor 1 versus Auditor 2

The ICC for total liveability score was 0.929 (95% CI 0.875-.0959, n=50) and is considered excellent (Table 2). For the nine liveability characteristics, three were considered to have good ICC 0.816-0.885 (health, sustainability and places); and six were considered moderate, ranging from ICC 0.598-0.742 (safety, inclusivity, education, traffic/transport, pavements and roads) (Table 2). For the twelve proxy measures of behaviour, the number of parked cars and total number of cars (moving/parked) were considered as excellent (ICC 0.905-0.910) (Table 3). For the number of bicycle racks (whole unit), bicycle rack capacity and the number of pedestrians, the ICCs were considered good (ICC 0.754-0.832) while the ICCs for the number of bicycles in the rack, the number of cyclists and the number of moving cars were considered

moderate (ICC 0.585-0.653) (Table 3). The only proxy measures to show poor results were the total number of activities being performed and the presence of static people (ICC -0.216-0.275). Finally, for the two remaining indicators, the data collected was limited due to low counts, which meant that accurate ICCs could not be calculated for the number of individuals exercising (not walking or cycling) and the presence of large groups of people (Table 3).

3.3 Time-point 2: Auditor 1 versus Auditor 2

The ICC for the total liveability score was 0.916 (95% CI 0.852-0.952, n=50) and this would be considered as excellent (Table 2). For the nine liveability characteristics, three were considered to have ICCs in the "good" range 0.782-0.812 (health, sustainability and places) and six in the moderate range, ICC 0.550-0.698 (safety, inclusivity, education, traffic/transport, pavements and roads) (Table 2). When compared between auditor 1 versus auditor 2 (time-point 2), the ICC was in the "excellent range" (0.939-0.968) for the number of parked cars and total number of cars (moving/parked) (Table 3). The ICCs were good (0.755-0.878) for the number of bicycle racks (whole unit), bicycle rack capacity, the number of bicycles in the racks, the number of cyclists, the number of moving cars and pedestrians (Table 3). The number of activities being performed being found to result in a poor ICC of -0.319. For the number of individuals exercising (not walking or cycling) the ICC could not be calculated due to low counts. Finally, presence of large groups of people and presence of people static were considered to have moderate to excellent ICCs (ICC 0.700-0.911) however only four streets were included in the analysis (Table 3).

3.4 Change time-point 1 to time-point 2: Auditor 1 and Auditor 2 separately (sensitivity to change)

Overall changes were reported by both auditors for the total liveability score and each of the nine characteristics of liveability (Table 2). The greatest change overall between time-point 1 and time-point 2 was for the traffic/transport characteristic and for both auditors this change was found to be significant

263 ($p<0.05$). Overall changes were also reported by both auditors for each of the twelve proxy measures of
264 behaviour including active travel, the change in number of bicycles in the racks and the total number of
265 cars (moving/parked) found by auditor two was significant ($p<0.05$) (Table 3).
266
267 **3.5 Change time-point 1 to time-point 2: Auditor 1 versus Auditor 2 (inter-rater agreement on sensitivity**
268 **to change)**
269 Using Wilcoxon signed-rank tests (2-tailed), there was no statistically significant differences in the degree
270 of change recorded by the two auditors for total overall liveability score, for each of the nine
271 characteristics of liveability, nor for eleven of the proxy measures of behaviour including active travel
272 ($p>0.05$) (Tables 2 and 3).
273
274 **4. DISCUSSION**
275 To our knowledge, MAPS-Liveability is the first measure of liveability at the micro level. We have used GSV
276 and a consensus definition of liveability to adapt the existing MAPS-Full tool for the UK context. The
277 current study shows that the new MAPS-Liveability tool can provide researchers, practitioners and policy
278 makers with a reliable measure that can be used to assess liveability and active travel at the street-level
279 with the potential to aggregate scores to a neighbourhood or city level. MAPS-Liveability also provides a
280 method of direct observation online via GSV, an extensive and frequently updated database, which
281 provides a safe, inexpensive and desk-based method of data collection on any location where Google has
282 collected street view data.
283
284 **4.1 Assessing Liveability**
285 When liveability results were reported by two independent auditors the inter-rater reliability for total
286 liveability was considered to be excellent, with each of the nine characteristics of liveability having inter-

rater reliability ICC correlations of moderate to good. MAPS-Liveability was also found to be sensitive to change, with both auditors reporting similar score changes over time.

The greatest change reported from time-point 1 to time-point 2 related to the liveability characteristic of 'traffic/transport'. This finding was to be expected considering the micro- and macro-level built environmental changes (cycle lanes, pedestrianisation, amenity and facility improvements, public transport developments, speed limit reductions) that have been implemented within Belfast city centre over the course of recent years. Consequently, this study showed that MAPS-Liveability can reliably utilize comprehensive liveability data via GSV and detect changes over time. However, we note that some liveability attributes identified in Phase 1, such as anti-social behaviour, signalization at crossings, noise and air pollution, and the pleasantness of a street, could not be assessed via GSV as they required sensory perceptions or finer attention to detail (noted within 4.4 Strengths and limitations).

4.2 Proxy indicators of behaviour including active travel behaviour

In addition to the measures of liveability the adapted tool also showed moderate to excellent reliability for the majority of behavioural indicators including travel behaviour via GSV. This is a positive finding as to date measures of active travel are lacking for a number of reasons, including: (i) surveys are usually focused on transport planning as opposed to surveillance; (ii) there is often inadequate coverage of cyclist and pedestrian counters (in person or sensors); (iii) broken sensors are out of action for variable periods of time; and (iv) data are not usually available at the level of the individual but at city or regional level (Goel et al., 2018). Therefore, providing a reliable tool that can assess active travel has the potential to move local, regional and international surveillance and research forward. The current method also provides an indication of cycling in an area and the potential to assess preferred mode of transport (i.e. car, bicycle or on foot) which has been lacking in previously proposed methods (Goel et al., 2018).

However, for three of our indicators of behaviour (i.e. presence of large groups of people, presence of static groups and number of individuals exercising (not walking or cycling)), accurate reliability assessments were not possible. The current study took place in Belfast city centre where individuals are, for the most part, transient pedestrians commuting through the city's core for work, shopping or socializing. Infrequently, would there be individuals congregating in large groups, standing still (other than waiting for public transport for instance) or exercising (not walking or cycling). This does not mean that the indicators are unreliable, but rather reliability testing should be performed in other locations and contexts, and at different times of day, to assess the three indicators more fully.

4.3 Tool Adaptation

In regards to MAPS-Full, the tool required only minimal content changes, and minor alterations to the data collection protocol for the purpose of auditing the local environment to assess liveability and active travel. The new scoring protocol allowed for total liveability, the nine characteristics of liveability and twelve proxy measures of behaviour including active travel to be assessed. In addition, the adapted tool enabled comparisons to be drawn between streets, collecting data both cross-sectionally and longitudinally to capture change.

4.4 Strengths and limitations

Strengths included the comprehensive staged approach that was implemented to develop MAPS-Liveability. In addition, two independent researchers audited 50 streets (at two time-points with a mean timeline of 38 months apart) to provide a comprehensive dataset. Within the current study, GSV enabled researchers to collect historical data and auditors could retrospectively assess liveability and proxy measures of behaviour including active travel. GSV also provides a low cost, efficient and safe method of data collection regardless of the auditor's location (Philips et al., 2017). Having calculated that one street

can be audited in 46.7 minutes (mean), this equated to approximately 59 hours (one time-point) or 118 hours (two time-points) for the current study. In addition, no time was spent by auditors travelling to a location, nor was there auditor travel costs. Therefore, we feel MAPS-Liveability via GSV may be a feasible replacement for expensive in-person auditing.

However, GSV does have limitations. When using GSV it is not possible to assess air pollution, noise, or perceived safety, as presence on the street would be required for such assessments. Temporality may be an issue as Google only provides an image for one point in time and does not make available specific information such as exact time of day, day of the week or date. In addition, when assessing transport, an important construct of liveability, and one which would be considered as highly variable across the day, a single point-in-time observation online (via GSV) could be considered insufficient.

Contemporality can also be a problem as although attempts can be made by the research team to audit in line with the implementation of an intervention or the measurement of another outcome (e.g., health or physical activity), time lapses can occur between GSV images being taken and uploaded and data collection. In addition, the uploading of images to GSV is more frequent in urban areas in comparison to rural areas, which may result in problems for those implementing studies in rural settings. Finally, when using GSV for auditing the presence of street furniture (e.g., bicycle racks) it is not possible for auditors to record those which are not visible, because of obstructions by moving and/or parked vehicles, resulting in the potential for inaccurate counts.

A limitation of MAPS-Liveability, is that the tool would be considered a presence/absence measure rather than gathering information on the quality of the environment, which may be considered

necessary for liveability assessments. Nonetheless, MAPS-Liveability provides researchers, practitioners and policy makers with a useful, reliable and feasible tool for assessing liveability.

4.5 Implications for future research

This study was implemented in a UK context where land use mix and density and urban form may differ in comparison to other countries such as the US and Australia. Therefore, given these important contextual differences, further testing regarding reliability and validity of MAPS-Liveability should be conducted in different contexts. Additionally, we implemented this study within a city centre where land use mix could be considered homogeneous across streets (i.e. highly commercial and recreational, with some residential and no agricultural land) and this could artefactually inflate inter-rater reliability. Therefore, it would be useful to test the tool on streets with differing land use mix in future research, for example: other towns and cities across the UK; and in different area types (e.g., rural or suburban areas) to test in heterogeneous environments. In addition, future research could aim to implement MAPS-Liveability to detect change following differing environmental rejuvenation or regeneration interventions. Finally, in regards to GSV, further research could provide a more in depth understanding of the accuracy of date/time stamps when using the software to collect data at differing time-points and to provide guidance for researchers in relation to the reliability of this.

5. CONCLUSIONS

MAPS-Liveability provides researchers, policy makers and practitioners with a reliable tool to examine liveability and proxy measures of behaviour including active travel behaviour. MAPS-Liveability enables assessments of micro-level characteristics (such as pavements, bicycle lanes, and softscape features) and active travel. This can inform recommendations for amenity/facility installation, rejuvenation and/or modification.

6. ACKNOWLEDGEMENTS

We would like to acknowledge the wider “is 20 plenty for health?” project team for their input to the current study and the resulting manuscript.

7. FUNDING

The ‘Is 20 plenty for health?’ project is funded by a National Institute for Health Research (NIHR) Public Health Research (PHR) grant 15/82/12. This paper presents independent research funded by the National Institute for Health Research (NIHR). The views expressed are those of the authors and not necessarily those of the National Health Service, the NIHR or the Department of Health and Social Care.’

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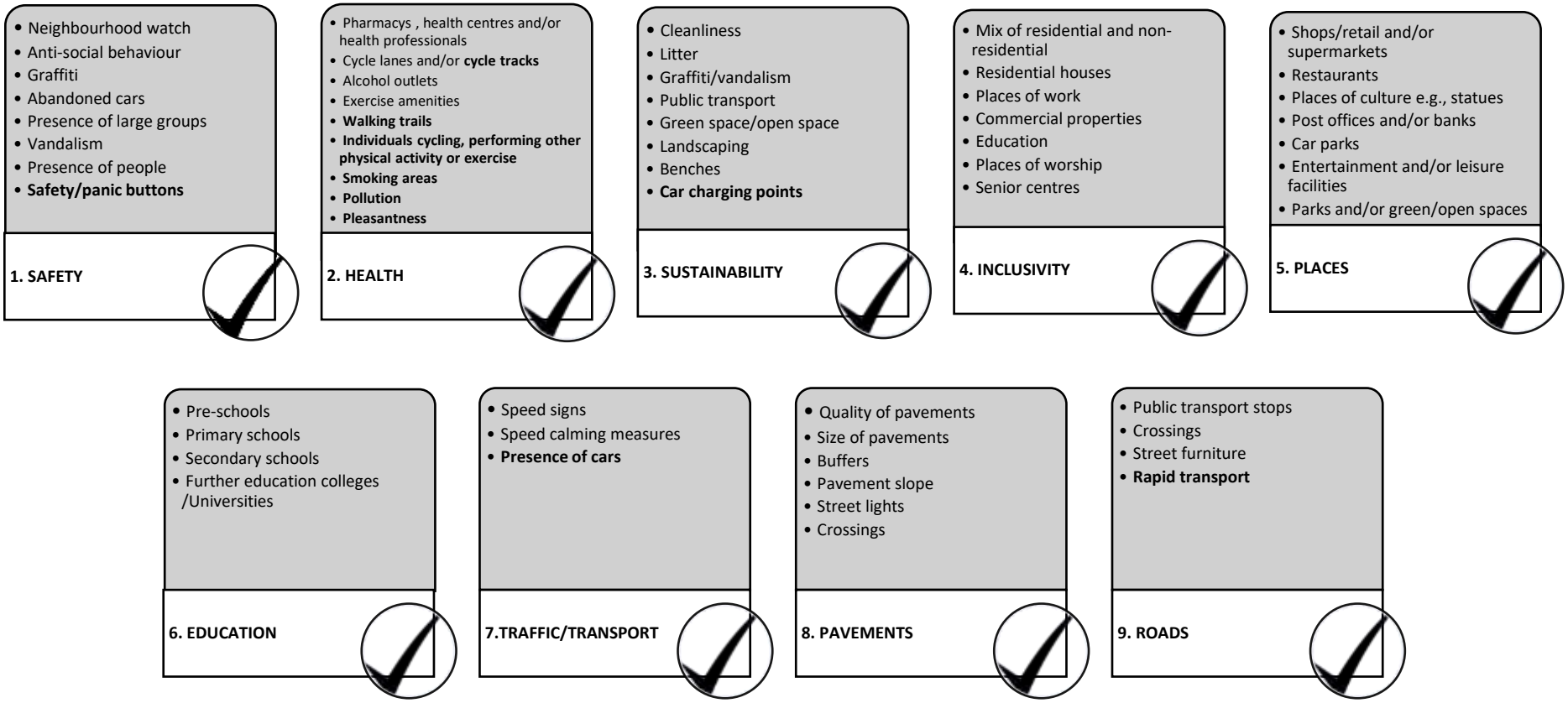
Figure 1. Overarching characteristics of liveability and the associated attributes



Bold font highlights liveability attributes that were not included within MAPS-Full but were recommended to be added for the purposes of MAPS-Liveability; and standard font highlights the liveability attributes that were already included within MAPS-Full.

Table 1. Summary of liveability characteristics and associated attributes by MAPS-Liveability question

Characteristics	Attributes	MAPS-Liveability question reference
SAFETY	Neighbourhood watch	Aesthetics and social question 6
	Anti-social behaviour	Aesthetics and social questions 6 and 7
	Graffiti/Vandalism	Aesthetics and social questions 6 and 7
	Abandoned cars	Aesthetics and social questions 6 and 7
	Presence of large groups	Behavioural outcomes questions regarding 'Groups' and 'Static people'
	Presence of people	Behavioural outcomes questions regarding 'Groups', 'Pedestrians', 'Exercise', 'Static people' and Aesthetics and social questions 9-12
	Safety/panic button	Aesthetics and social question 6
HEALTH	Pharmacy	Land use/destinations question 5i
	Health centre/professionals	Land use/destinations questions 5k and 5o
	Cycle lanes	Pavements/roads questions 14a and 14ai
	Alcohol outlets	Land use/destinations question 5f
	Exercise amenities	Land use/destinations questions 5z and 5aa-ac
	Walking trails	Land use/destinations question 5e
	Bicycle tracks	Pavements/roads questions 14b and 14bi
	Individuals cycling	Behavioural outcomes question regarding 'Cycling'
	Individuals performing other physical activity or exercise	Behavioural outcomes question regarding 'Exercise'
	Smoking areas	Land use/destinations question 8
SUSTAINABILITY	Cleanliness	Aesthetics and social questions 6 and 7
	Litter	Aesthetics and social questions 6 and 7
	Graffiti/Vandalism	Aesthetics and social questions 6 and 7
	Public transport	Streetscape questions 1 and 2
	Green space/Open space	Land use/destinations questions 5ad and Cul-de-sac question 10c
	Landscaping	Aesthetics and social questions 2 and 5
	Benches	Streetscape question 8
	Car charging points	Streetscape question 8
INCLUSIVITY	Mix of residential and non-residential	Land use/destinations questions 2, 3, 5 and 6
	Residential houses	Land use/destinations question 2
	Places of work	Land use/destinations questions 5 and 6
	Commercial	Land use/destinations questions 5 and 6
	Education	Land use/destinations question 5t
	Places of worship	Land use/destinations question 5s
	Senior centres	Land use/destinations question 5r
PLACES	Shops	Land use/destinations questions 5c, d, f-i, n and 6

	Restaurants	Land use/destinations questions 5a, b, e
	Culture	Land use/destinations question 5p, s and Aesthetics and social questions 1-3
	Post office	Land use/destinations question 5q
	Car parks	Land use/destinations questions 1 and 4
	Bank	Land use/destinations question 5j
	Supermarkets	Land use/destinations questions 5c, g and 6
	Entertainment	Land use/destinations questions 5a, b, e, l, p, x
	Park	Land use/destinations question 5ad
	Leisure facilities	Land use/destinations questions 5y, z, aa-ae
	Green/open space	Land use/destinations questions 5w, y, ab, ad, ae
	Other services	Land use/destinations questions 5 and 6
EDUCATION	Pre-schools	Land use/destinations question 5t
	Primary schools	Land use/destinations question 5t
	Secondary schools	Land use/destinations question 5t
	Further education colleges /Universities	Land use/destinations question 5t
TRAFFIC/TRANSPORT	Speed signs	Streetscape questions 3, 3a, 3b, 4, 5
	Speed calming measures	Streetscape questions 3, 3a, 3b, 4, 5
	Presence of cars	Aesthetics and social questions 6, 7, Pavements and roads question 9 and behavioural outcomes question regarding 'Traffic'
PAVEMENTS	Quality	Pavements/roads questions 1, 5, 8, 9, 12, Crossings question 11 and Cul-de-sac question 4
	Size	Pavements/roads questions 2-4 and 13
	Buffers	Pavements/roads questions 3, 4 and 12
	Slope	Pavements/roads questions 6, 7, Crossings question 6 and Cul-de-sac question 2
	Lights	Streetscape question 6, Crossings question 11 and Cul-de-sac question 5
	Crossings	Crossings questions 1-11 and Streetscape question 9
ROADS	Public transport stops including rapid transport	Streetscape questions 1-2
	Crossings	Crossings questions 1-11 and Streetscape question 9
	Street amenities	Streetscape question 8

Table 2. Descriptive statistics for each liveability characteristic

	Time-point 1						Time-point 2						Change time-point 1 to time-point 2					
	A1 Mean (SD)	n	A2 Mean (SD)	n	ICC A1 vs A2 (95% CI)	n	A1 Mean (SD)	n	A2 Mean (SD)	n	ICC A1 vs A2 (95% CI)	n	A1 Mean (SD)	n	A2 Mean (SD)	n	WSRT (Z score)	n
Safety	10.50 (2.77)	50	10.49 (2.91)	49	0.607 (0.305-0.778)	49	10.68 (2.61)	50	10.36 (2.97)	50	0.657 (0.397-0.805)	50	0.18 (0.96)	50	-0.06 (0.97)	49	-1.589	49
Health	8.34 (3.17)	50	8.02 (2.78)	49	0.816 (0.676-0.896)	49	8.68 (3.61)	50	8.16 (2.80)	50	0.796 (0.642-0.884)	50	0.34 (1.95)	50	0.16 (1.23)	49	-0.344	49
Sustainability	11.08 (4.67)	50	10.28 (5.36)	50	0.885 (0.798-0.935)	50	11.38 (4.40)	50	10.59 (4.73)	49	0.812 (0.668-0.894)	49	0.30 (1.09)	50	0.10 (1.82)	49	-1.531	49
Inclusivity	1.42 (0.84)	50	1.38 (1.03)	50	0.598 (0.297-0.772)	50	1.44 (0.84)	50	1.43 (0.98)	49	0.550 (0.205-0.746)	49	0.02 (0.14)	50	0.02 (0.32)	49	0.000	49
Places	13.66 (5.34)	50	13.56 (6.20)	50	0.851 (0.738-0.915)	50	13.88 (5.57)	50	14.55 (5.77)	49	0.782 (0.616-0.877)	49	0.22 (1.22)	50	0.71 (3.00)	49	-0.309	49
Education	0.22 (0.47)	50	0.12 (0.33)	50	0.620 (0.333-0.784)	50	0.24 (0.48)	50	0.10 (0.30)	50	0.620 (0.333-0.784)	50	0.02 (0.14)	50	-0.02 (0.14)	50	-1.414	50
Traffic/ transport	1.78 (1.34)	50	1.69 (1.58)	49	0.645 (0.373-0.799)	49	2.88 (1.90)	50	2.55 (2.25)	49	0.664 (0.4.07-0.810)	49	1.10 (1.15)*	50	0.88 (1.04)*	48	-1.665	48
Pavements	25.68 (5.68)	50	24.38 (8.67)	50	0.741 (0.545-0.853)	50	25.94 (4.91)	50	25.32 (7.51)	50	0.698 (0.470-0.828)	50	0.26 (2.27)	50	0.94 (5.08)	50	-0.667	50
Roads	13.34 (3.70)	47	12.67 (6.37)	48	0.742 (0.532-0.858)	45	13.66 (3.99)	47	13.28 (5.94)	46	0.605 (0.275-0.786)	43	0.32 (1.71)	47	0.07 (2.71)	46	-0.420	43
Total score	67.22 (16.77)	50	67.54 (18.07)	50	0.929 (0.875-0.959)	50	69.30 (16.79)	50	69.02 (17.65)	50	0.916 (0.852-0.952)	50	2.08 (4.05)	50	1.48 (3.70)	50	-1.036	50

*p<0.05; A1: auditor 1; A2: auditor 2; CI: confidence intervals; ICC: intra-class correlations; SD: standard deviation; vs: versus; WSRT: Wilcoxon-sign rank test.

Table 3. Descriptive statistics for each proxy measure of behaviour

	Time-point 1						Time-point 2						Change time-point 1 to time-point 2					
	A1 Mean (SD)	n	A2 Mean (SD)	n	ICC A1 vs A2 (95% CI)	n	A1 Mean (SD)	n	A2 Mean (SD)	n	ICC A1 vs A2 (95% CI)	n	A1 Mean (SD)	n	A2 Mean (SD)	n	WSRT (Z score)	n
No. of bicycle racks	3.16 (4.83)	50	3.52 (6.38)	50	0.832 (0.705-0.905)	50	3.38 (5.13)	50	3.74 (6.40)	50	0.871 (0.774-0.927)	50	0.22 (1.09)	50	0.22 (1.56)	50	-0.140	50
No. of bicycles the rack can hold	8.93 (8.34)	27	10.22 (12.00)	27	0.774 (0.493-0.900)	25	11.07 (10.66)	27	10.48 (11.88)	27	0.878 (0.727-0.946)	25	2.15 (6.10)	27	0.26 (3.43)	27	-1.682	25
No. of bicycles in the racks (total)	2.74 (4.03)	27	1.74 (2.12)	27	0.585 (0.069-0.816)	25	2.63 (3.28)	27	2.78 (3.14)	27	0.844 (0.649-0.931)	25	-0.04 (2.82)	27	1.04* (1.97)	27	-0.849	25
No. of cyclists	0.35 (0.69)	49	0.25 (0.60)	48	0.652 (0.378-0.806)	47	0.41 (0.73)	49	0.37 (0.78)	49	0.755 (0.565-0.862)	48	0.06 (0.75)	49	0.13 (0.82)	48	-0.353	47
No. of moving cars	3.76 (5.62)	50	4.83 (8.19)	48	0.653 (0.383-0.805)	48	3.50 (5.56)	50	3.27 (4.67)	49	0.847 (0.731-0.914)	49	-0.26 (3.64)	50	-1.50 (5.74)	48	-0.722	48
No. of parked cars	9.04 (11.30)	50	11.33 (13.64)	48	0.905 (0.832-0.947)	48	8.36 (10.67)	50	9.31 (11.19)	48	0.939 (0.892-0.965)	49	-0.68 (4.10	50	-1.92 (6.22)	48	-1.411	48
Total number of cars (moving/parked)	12.80 (14.98)	50	16.17 (17.35)	48	0.910 (0.840-0.949)	48	11.80 (13.48)	50	12.55 (13.79)	49	0.968 (0.944-0.985)	49	-1.00 (4.93)	50	-3.44* (7.70)	48	-1.815	48
No. of individuals exercising (not walking or cycling)	0.00 (0.00)	49	0.00 (0.00)	48	-	-	0.02 (0.14)	50	0.00 (0.00)	49	-	-	0.01 (0.14)	49	0.00 (0.00)	48	-1.000	47
Total no. of activities being performed	0.14 (0.50)	49	0.17 (0.48)	47	-0.216 (-1.189-.325)	46	0.18 (0.44)	50	0.25 (0.66)	49	-0.319 (-1.329-0.255)	49	0.04 (0.41)	49	0.09 (0.35)	47	-0.879	46
No. of pedestrians	28.18 (34.49)	49	38.55 (54.05)	47	0.754 (0.558-0.864)	46	29.38 (39.53)	50	37.63 (61.41)	49	0.814 (0.671-0.895)	49	1.80 (28.98)	49	-0.26 (39.77)	47	-1.050	46

Presence of large groups of people	1.23 (1.36)	13	0.25 (0.72)	20	-	-	1.36 (1.28)	14	0.23 (0.53)	22	0.700 (-1.994-0.980)	4	0.23 (1.69)	13	0.00 (0.86)	20	-0.447	2
Presence of people static	13.31 (14.50)	13	4.05 (10.48)	20	0.275 (-26.917-0.999)	2	14.29 (14.78)	14	3.55 (5.83)	22	0.911 (0.115-0.994)	4	2.08 (17.70)	13	-0.70 (7.46)	20	-0.447	2

*p<0.05; A1: auditor 1; A2: auditor 2; CI: confidence intervals; ICC: intra-class correlations; no.: number; SD: standard deviation; vs: versus; WSRT: Wilcoxon-sign rank test.

Appendix A. Changes made to MAPS-Full

As MAPS-Full was developed in the United States of America and the current study is based within the United Kingdom (UK), MAPS-Full was modified by changing English (American) to English (UK) and any American examples were changed to relevant UK examples (Appendix B).

The eleven additional items identified to investigate liveability were added and the list below details these additions:

1) 'Safety/panic buttons' added as a sub-response to Section Aesthetics and Social, 6: Which of the following physical disorders are present? "Safety/panic buttons connecting to police".
2) Walking trails added as a sub-response to Section Land use/destinations, 6. How many of the following types of non-residential destinations are present? "Public walking trail".
3) Bicycle tracks added as a question to Section Pavements/roads, 14b. Is there a marked bicycle track separated from traffic and pedestrians? (yes or no).
   14bi. Does the marked bicycle track run for the entire route? (100%, 75-99%, 51-75%, 25-50% or 1-25%).
4) Presence of anyone cycling (yes or no) added as a question to Section Aesthetics and Social.
5) Presence of anyone performing other physical activity or exercising (not walking or cycling) (yes or no) added as a question to Section Aesthetics and Social.
6) Smoking areas added as a sub-response to Section Streetscape, 7: Presence of street amenities? "Smoking areas".
7) Car charging points added as a sub-response to Section Streetscape, 7: Presence of street amenities? "Car charging points".
8) Rapid transport added as a sub-response to Section Streetscape, 1: Number of public transport stops? "Rapid transport stops".
9) Presence of cars – see additional adaptions.
10) Pleasantness and 11) Pollution – see phase 1iii.

As a 20mph speed limit intervention and a rapid transport system were implemented within Belfast city centre, specific questions were added (Appendix B).

Several of the MAPS-Full questions did not require complete revisions but rather slight additions to provide clarification for the auditor e.g., when asked about schools, additional guidance was added to also ensure pre-schools, colleges, universities were accounted for (Appendix B).

Twelve proxy indicators of behaviour including active transport behaviour were added as it was felt that not only could MAPS-Liveability be used to assess liveability but it also has the capability to gather specific outcomes and could enable researchers to obtain 'counts'. Therefore the following were added: 1) bicycle racks (as a whole unit); 2) number of bicycle racks (how many bicycles can the rack hold); 3) number of bicycles in each of the racks (total); 4) number of cyclists; 5) number of moving cars; 6) number of parked cars; 7) total number of cars on the road (moving and/or parked); 8) number of individuals exercising (not walking or cycling (e.g., running, jogging, rollerblading etc.); 9) total number of activities being performed (not walking or cycling); 10) number of pedestrians; 11) presence of large groups or people or groups of people; and 12) presence of static people (presence of people waiting for the bus or talking etc.).

As liveability has been suggested to be a qualitative assessment (Giap et al., 2014) an open text box was added to provide where appropriate a qualitative summary of the area: "any other comments on the street regarding liveability: safety, health, sustainability, inclusivity, places, education, traffic, pavements or roads", "make a note of any temporary street furniture e.g., road works, traffic lights" and "make a comment regarding the weather of the Google Street View at time-point 1 and time-point 2".

Appendix B. Summary of changes made to MAPS-Full

Section	Original MAPS-Full question number	MAPS-Full question	MAPS-Liveability question (italics represents added detail)
Land use/destinations	3	What type of residential uses? *Other (mobile home, dormitory)*	What type of residential uses? Other (mobile home, dormitory, students)
Land use/destinations	6d	How many of the following types of non-residential destinations are present? *Convenience store (may also be a gas station)*	How many of the following types of non-residential destinations are present? *Convenience store (may also be a petrol station)*
Land use/destinations	6f	How many of the following types of non-residential destinations are present? *Liquor/alcohol store (primarily sells alcohol, wine bar, strip club)*	How many of the following types of non-residential destinations are present? *Liquor/alcohol store (primarily sells alcohol, wine bar)*
Land use/destinations	6g	How many of the following types of non-residential destinations are present? *Big box store (e.g.,, Home Depot, Best Buy, Sears, Super Walmart, Target)*	How many of the following types of non-residential destinations are present? *Big box store (e.g.,, Asda, Tesco, Sainsburys, B&Q)*
Land use/destinations	6h	How many of the following types of non-residential destinations are present? *Specialty Food Store (e.g.,, ice cream, candy, bakery)*	How many of the following types of non-residential destinations are present? *Specialty Food Store (e.g.,, ice cream, sweets, bakery)*
Land use/destinations	6t	How many of the following types of non-residential destinations are present? *School*	How many of the following types of non-residential destinations are present? *School (including pre-school, college and university*
Land use/destinations	6ae	How many of the following types of non-residential destinations are present?	How many of the following types of non-residential destinations are present? *Public walking trail* *0 1 2+*
Streetscape	1	Number of public transit stops	Number of public transit stops *Rapid transport stops*
Streetscape			*How many 20mph speed limit signs are along the route?* *_____painted on ground _____sign on a pole_____* *Other* *If other, please state_____*
Streetscape	3	Special zone speed limits *(school, construction)* ☐ Yes _____ mph ☐ No	Special zone speed limits *(school, construction)* ☐ Yes _____ mph ☐ No *Please state_____*
Streetscape	4	4. What other street characteristics are present? (specify # of each type) *Check all that apply* ☐ Traffic calming (signs, circles, speed tables, speed humps, curb extension) _____ ☐ Roll-over curbs _____ (if whole segment = 1) ☐ Drainage ditches _____ (count one side of street) ☐ Instructional signs for pedestrian's _____ ☐ Crosswalk signage or other pedestrian signage (for drivers) _____	What other street characteristics are present? (specify # of each type) *Check all that apply* ☐ *Traffic calming signs_____* ☐ *Traffic calming circles_____* ☐ *Traffic calming speed tables_____* ☐ *Traffic calming speed humps____* ☐ *Traffic calming curb extension_____* ☐ Roll-over curbs _____ (if whole segment = 1) ☐ Drainage ditches

		☐ None of the Above	☐ Instructional signs for pedestrian's _____ ☐ Crosswalk signage or other pedestrian signage (for drivers) _____ ☐ None of the Above
Streetscape	7	Presence of street amenities *Check all that apply* ☐ Building overhangs that provide shelter from inclement weather in public space (i.e. sidewalks) ☐ Trash bins (public) ☐ Benches or other places to sit ☐ Bicycle racks ☐ Working drinking fountain ☐ Working public telephones ☐ Kiosks or information booths ☐ None of the Above	Presence of street amenities *Check all that apply* ☐ Building overhangs that provide shelter from inclement weather in public space (i.e. *pavements*) ☐ *Rubbish* bins (public) ☐ Benches or other places to sit ☐ Bicycle racks ☐ Working drinking fountain ☐ Working public telephones ☐ Kiosks or information booths ☐ Car charging points ☐ Smoking areas ☐ None of the Above
Aesthetics and social	3	Are there observable <u>historic or cultural features</u> along the route (*not further than one street segment away from route and can be seen from the route*)? ☐ Yes ☐ No	Are there observable <u>historic or cultural features</u> along the route (statues, murals etc.? ☐ Yes ☐ No *Please state*_____
Aesthetics and social	6	Which of the following physical disorders are present? *Check all that apply* ☐ Graffiti/tagging (not murals) ☐ Abandoned cars ☐ Buildings with broken/boarded windows ☐ Drug paraphernalia ☐ Broken glass ☐ Beer/liquor bottles/cans ☐ Litter in yards ☐ Noticeable/excessive litter in street/sidewalk ☐ Neighborhood watch signs ☐ Signage for commercial destinations or parks ☐ None of these	Which of the following physical disorders are present? *Check all that apply* ☐ Graffiti/tagging (not murals or street art) ☐ Abandoned cars ☐ Buildings with broken/boarded windows ☐ Drug paraphernalia ☐ Broken glass ☐ Beer/liquor bottles/cans ☐ Litter in yards ☐ Noticeable/excessive litter in street/sidewalk ☐ Neighbourhood watch signs ☐ Signage for commercial destinations or parks ☐ *Safety button connecting to police* ☐ None of these
Aesthetics and social			*Presence of anyone cycling? ☐Yes ☐No*
Aesthetics and social			*Presence of anyone performing other physical activity or exercising? (not walking or cycling) ☐Yes ☐No*
Walkways / sidewalks (now Pavements / roads)	Changed throughout section	Sidewalk	*Pavements*
Walkways / sidewalks (now Pavements / roads)	9	Are there <u>temporary obstructions</u> in the sidewalk? *(e.g.,, parked cars, sandwich boards, garbage cans)* ☐ None ☐ Some ☐ Many ☐ No sidewalk	Are there <u>temporary obstructions</u> in the pavement? *(e.g.,, parked cars, sandwich boards, rubbish bins)* ☐ None ☐ Some ☐ Many ☐ No pavement

Walkways / sidewalks (now Pavements / roads)	14	*Does the marked bicycle lane run for the entire route?* *□100% □75-99% □51-75%* *□25-50% □1-25%*
Walkways / sidewalks (now Pavements / roads)	14	*Is there a <u>marked bicycle track</u> separated from traffic and pedestrians?* *□Yes □No* *Does the marked bicycle track run for the entire route?* *□100% □75-99% □51-75%* *□25-50% □1-25%*
Additional qualitative detail		*Any other comments on the street regarding liveability: safety, health, sustainability, inclusivity, places, education, traffic, pavements or roads?* *Please make a noted of any temporary street furniture e.g., road works, traffic lights* *Please make a comment regarding the weather of the google street view both pre-20mph and post-20mph*
Additional count detail		*Number of bicycle racks (as a whole unit)* *Number of bicycle racks (how many bicycles can the rack hold)* *Number of bicycles in each of the racks (total)* *Number of cyclists* *Number of moving cars* *Number of parked cars* *Total number of cars on the road (moving and/or parked)* *Number of individuals exercising (not walking or cycling e.g., running, jogging rollerblading etc.)* *Type of activities being performed (not walking or cycling e.g., running, jogging, rollerblading etc.)* *Total number of activities being performed (not walking or cycling)* *Number of pedestrians* *Presence of large groups of people or groups of people* *Presence of people waiting for the bus or talking etc.*

Appendix C. Pilot testing of the newly developed MAPS-Liveability.

Following each of the adaptations, a pilot study was implemented to test the newly developed MAPS-Liveability via Google Street View. The data collection procedures were carried out in line with those that were developed for MAPS-Full. Five streets were selected at random and a total of four adaptations were made to the data collection procedures for the purposes of implementing MAPS-Liveability:

1. Location starting point

As liveability may be assessed in a street/area rather than attached to a participant and their participation in a study, it is not always possible to start from an individual's address. Therefore, MAPS-Liveability needs to have the capability of starting at any location. Due to this change, three questions were removed from the Section cul-de-sac:

1) How close is the cul-de-sac or dead-end to the participants' home?
Check one
- □ On the cul-de-sac
- □ Adjacent to the cul-de-sac (one or two homes/houses removed from cul-de-sac opening)
- □ Non-adjacent, but less than 200 feet away
- □ More than 200 feet away

7) Can most of the cul-de-sac or dead-end area be seen from the participant's home (using the most optimal viewpoint from the home, including higher story windows)?
□ Yes □ No

8) Can most of the cul-de-sac or dead-end area be seen from other homes (using the most optimal viewpoint from the home, including higher story windows)?
□ Yes □ No

MAPS is a tool originally developed in the US where land use and urban form differ in comparison to the UK (Tucker & Gilliland, 2007; Sallis et al., 2016). In the UK, towns and cities are often smaller with mixed and multifunctional land use and also higher levels of land use density. In addition, streets are shorter in terms of the overall length and have fewer and/or smaller segments. Therefore, taking these factors into consideration and previous work which has detailed the need for specific European environmental audit tools (Stockton et al., 2016; Benton et al., 2020). Based on the results of our pilot study, to achieve meaningful assessments of liveability in a European/UK context, changes were required to the length of the assessment area (point 2) and route segments (point 3).

2. Length of assessment area

Therefore, it was decided that MAPS-Liveability would assess the entire street (beginning to end) rather than only 0.25 miles of a route. Alternatively, a second option is to assess the entirety of a pre-established route (e.g., bus station to place of work, or train station to shopping complex). The decision on which option to audit would be dependent on the type of study. However, in the case of the current study, entire streets were audited.

3. Single rather than segmented route

MAPS-Full operates by assessing the route, segments, crossings and if applicable cul-de-sacs. However, similar to point 2 it was felt that liveability cannot be gauged in a restrictive manner so for MAPS-Liveability an entire route should be audited, as one (entire length of the street). By assessing the route as a whole it will provide an overall assessment as opposed to separate segments/crossings which are applicable to the pedestrian streetscape but for the purpose of liveability a broader assessment is required.

4. Removal of questions relating to sensory perceptions (e.g., noise)

During the pilot researchers found it difficult to assess particular characteristics and/or concepts (anti-social behaviour and social disorder) and impossible to answer questions relating to sound, finer details such as signalization at crossings, pollution and the pleasantness of a street (a limitation of using Google Street View). Therefore, two questions (Section: Aesthetics and Social, question 8; Section: Crossings, question 4) and two sub-responses (Section: Crossings, question 3) were removed and questions relating to pleasantness and pollution which were intended to be added following phase 1i-ii could not be added.

Appendix D. Development of a scoring protocol for MAPS-Liveability

Following the completion of MAPS-Full in its original form sub-scores can be obtained for the route, segments crossings, cul-de-sacs (if applicable) and a summed score (Appendix E). This scoring protocol had minimal adaptations to account for the removal and addition of a limited number of questions and sub-responses for MAPS-Liveability (Appendix F).

In addition to the original scoring protocol, it was established during the pilot phase that it may also be beneficial if scores were available and could be assessed for each of the nine characteristics of liveability and a summed total liveability score (Appendix E). If following the adapted liveability scoring and a cul-de-sac is present an additional cul-de-sac score can be obtained via the original MAPS-Liveability scoring protocol.

Furthermore, the adapted survey also enables qualitative data to be obtained, analysed and interpreted by the research team as they see fit and for the purposes of their study; and specific behavioural outcomes to be obtained and quantitatively analysed by the number of counts and yes/no answers (Appendix G).

Appendix E. MAPS-Liveability scoring protocol

MAPS-Liveability	Characteristics	MAPS-Liveability subscale	Liveability attribute scores	Liveability total score (adjusted)
Safety	**A6 -** Safety buttons (+)	Safety button connecting to police (No = 0, Yes = 1)		
	A6 - Neighbourhood watch (+)	Neighbourhood watch signs (No = 0, Yes = 1)		
	A6 – Physical disorder (+/-)	Graffiti/tagging (not murals or street art) (No = 1, Yes = 0) + Abandoned cars (No = 1, Yes = 0) + Buildings with broken/boarded windows (No = 1, Yes = 0) + Drug paraphernalia (No = 1, Yes = 0) + Broken glass (No = 1, Yes = 0) + Beer/liquor bottles/can (No = 1, Yes = 0)		
	A7 – Physical disorder (-)	Rate the extent of physical disorder (None = 3, A little = 2, Some = 1, A lot = 0)		
	A9-12 - Presence of people (+)	Presence of anyone walking (No = 0 Yes = 1) + Presence of anyone running (No = 0, Yes = 1) + Presence of anyone cycling (No = 0, Yes = 1) + Presence of anyone performing other physical activity or exercising (No = 0, Yes = 1)	**21**	**21**
	SS6 - Street lights (+)	Are street lights installed (No = 0, Some = 1 (e.g., overhead street lights on utility poles with wide spacing) or Ample = 2 (e.g., regularly spaced pedestrian lampposts)		
	SS8 – Telephones (+)	Working public telephones (No = 0, Yes = 1)		
	SS8 – Information (+)	Kiosks or information booths (No = 0, Yes = 1)		
	P19 – Eyes on the street (+)	Estimate the proportion of street segment that has ground floor or street-level windows within 40 feet of the pavement/walkway (or street if no pavement/walkway) (No windows – 25% = 0 26%-75% = 1 >76% = 2)		
Health	**LU5 -** Pharmacy (+)	Pharmacy or drug store (No = 0, Yes = 1)		
	LU5 - Health centre (+)	Health-related professional (No = 0, Yes = 1) + Health or social services (No = 0, Yes = 1)		
	LU5 - Alcohol (-)	Liquor/alcohol store (No = 1, Yes = 0)		
	A9-12 – People performing activity (+)	Presence of anyone walking (No = 0, Yes = 1) + Presence of anyone running (No = 0, Yes = 1) + Presence of anyone cycling (No = 0, Yes = 1) + Presence of anyone performing other physical activity or exercising (No = 0, Yes = 1)		
	SS8 - Smoking areas (-)	(No = 1, Yes = 0)		
	SS8 – Water (+)	Working drinking fountain (No = 0, Yes = 1)		
	SS8 – Bicycle racks (+)	Bicycle racks (No = 0, Yes = 1)	**35**	**31**
	LU5 – Leisure facilities (+)	Private indoor (No = 0, Yes = 1) + Public indoor (No = 0, Yes = 1) + Private outdoor (No = 0, Yes = 1) + Public outdoor pay (No = 0, Yes = 1)		
	LU5 – Green & open space (+)	Public park (No = 0, Yes = 1) + Public walking trail (No = 0, Yes = 1) + Community garden (No = 0, Yes = 1)		
	A1-2 – Hardscape & softscape features (+)	Do you observe pleasant hardscape features such as fountains, sculptures or art (public or private (No = 0, Yes = 1) + Do you observe softscape features such as gardens or landscaping (e.g., Public: bodies of water, designated viewpoints; Private: retaining walls, bark, ponds) (No = 0, Yes = 1)		
	A5 – Landscaping maintenance	Is landscaping well maintained (0-99% = 0, 100% = 1)		

	A8 – Obstructions to walking (-)	Railroad tracks (No = 1, Yes = 0) + Highway nearby (No = 1, Yes = 0) + Other (No = 1, Yes = 0)		
	P14, 15 – Bicycle lane/use (+)	Is there a marked bicycle lane marked with a lane (No = 0, Yes = 1) + Does the marked bicycle lane run for the entire route (100% = 4; 75-99% = 3; 51-75% = 2; 25-50% = 1; 1-25% = 0) + Is there a marked bicycle track separated from traffic and pedestrians (No = 0, Yes = 1) + Does the marked bicycle track run for the entire route (100% = 4; 75-99% = 3; 51-75% = 2; 25-50% = 1; 1-25% = 0) + Are there any signs indicating bicycle use (No = 0, Yes = 1)		
Sustainability	**SS8 –** Rubbish bins (+)	Rubbish bins (public) (No = 0, Yes = 1)		
	A6 – Physical disorder (+/-)	Graffiti/tagging (not murals or street art) (No = 1, Yes = 0) + Abandoned cars (No = 1, Yes = 0) + Buildings with broken/boarded windows (No = 1, Yes = 0) + Drug paraphernalia (No = 1, Yes = 0) + Broken glass (No = 1, Yes = 0) + Beer/liquor bottles/can (No = 1, Yes = 0) + Litter in yards (No = 1, Yes = 0) + Noticeable/excessive litter in street/pavement (No = 1, Yes = 0) + Neighbourhood watch signs (No = 0, Yes = 1) + Signage for commercial destinations or parks (No = 0, Yes = 1) + Safety button connecting to police (No = 0, Yes = 1)		
	A7 – Physical disorder (-)	Rate the extent of physical disorder (None = 3, A little = 2, Some = 1, A lot = 0)		
	SS1 - Public transport (+)	If answered 1 or more to **SS1a-c** (No = 0, Yes = 1 (**SS1a or SS1b or SS1c),** Yes = 2 **(two from SS1a-c**) or Yes = 3 (**each of SS1a-c)**		
	SS8 - Car charging (+)	Car charging points (No = 0, Yes = 1)		
	LU5 – Green & open space (+)	Public park (No = 0, Yes = 1) + Public walking trail (No = 0, Yes = 1) + Community garden (No = 0, Yes = 1)	**33**	**14**
	A1-2 – Hardscape & softscape features (+)	Do you observe pleasant hardscape features such as fountains, sculptures or art (public or private (No = 0, Yes = 1) + Do you observe softscape features such as gardens or landscaping (e.g., Public: bodies of water, designated viewpoints; Private: retaining walls, bark, ponds) (No = 0, Yes = 1)		
	A5 – Landscaping maintenance (+)	Is landscaping well maintained (0% = 0, 1-49% = 1, 50-99% = 2, 100% = 3)		
	SS8 - Benches (+)	Benches or other places to sit (No = 0 Yes = 1)		
	P23-25 – Trees (+)	How many trees exist within 5ft of either side of the pavement/pathway (No pavement/NA = 0, 0-1 trees = 0, 2-10 trees = 1, >11 trees = 2) + How are the trees generally spaced (Irregular or no sidewalk/NA= 0, Evenly = 1) + What percentage of the length of the pavement/walkway is covered by trees, awnings or other overhead coverage (No coverage or no sidewalk/NA and ≤25% = 0, 26%-75% = 1, >75% = 2)		
Inclusivity	**LU2 -** Mix of residential and non-residential (+)	If answered Yes to any of LU2a-f plus any of LU5 a-ae or LU6 a-c No = 0, Yes = 1)		
	LU2 - Residential houses (+)	Single family homes (No = 0 Yes = 1) + Multi-unit homes (No = 0 Yes = 1) + Apartments or flats (No = 0, Yes = 1) + Apartments/flats above street retail (No = 0, Yes = 1) + Retirement/senior living facility (No = 0, Yes = 1) + Other (No = 0, Yes = 1)	**11**	**11**

	LU5 - Places of work/commercial (+)	If answered 1 or 2+ to any of LU5 or LU6 (No = 0, Yes = 1) (excluding LU5v,w,y,ae)		
	LU5 - Education (+)	School (No = 0, Yes = 1)		
	LU5 - Place of worship (+)	Place of worship (No = 0, Yes = 1)		
	LU5 – Senior Centre (+)	Senior Centre (No = 0, Yes = 1)		
Places	**LU5 and LU6 -** Shops (+)	Grocery/supermarket (No = 0, Yes = 1) + Convenience store (No = 0, Yes = 1) + Big box store (No = 0, Yes = 1) + Specialty food store (No = 0, Yes = 1) + Other retail (No = 0, Yes = 1) + Shopping centre (No = 0, Yes = 1) + Strip mall (No = 0, Yes = 1) + Shopping arcade (No = 0, Yes = 1)		
	LU5 - Restaurants (+)	Fast food restaurant (No = 0, Yes = 1) + Sit-down restaurant (No = 0, Yes = 1) + Café or coffee shop (No = 0, Yes = 1)		
	LU5/A3 - Culture (+)	Library/Museums (No = 0, Yes = 1) + Are there observable historic or cultural features along the route (statues, murals etc.) (No = 0, Yes = 1)		
	LU5 - Post office (+)	Post office (No = 0, Yes = 1)		
	LU1 - Car parks (+/-)	On-street, parallel (No = 0, Yes = 1) – Small lot or garage (<30 spaces) (No = 0, Yes = 1) – Medium to large lot or garage (No = 0, Yes = 1)		
	LU5 - Bank (+)	Bank or credit union (No = 0, Yes = 1)		
	LU5 – Other land use (-)	Warehouse/factory/industrial (No = 1, Yes = 0) + Abandoned building (No = 1, Yes = 0) + Unmaintained lot/field (No = 1, Yes = 0)		
	LU5 - Entertainment (+)	Entertainment (No = 0, Yes = 1) + Casino (No = 0, Yes = 1)	**40**	**33**
	LU5 – Green & open space (+)	Public park (No = 0, Yes = 1) + Public walking trail (No = 0, Yes = 1) + Community garden (No = 0, Yes = 1)		
	LU5 - Leisure facilities (+)	Private indoor (No = 0, Yes = 1) + Public indoor (No = 0, Yes = 1) + Private outdoor (No = 0, Yes = 1) + Public outdoor pay (No = 0, Yes = 1)		
	LU5 – Other services (+)	Other service (No = 0, Yes = 1)		
	A4 – Building maintenance (+)	Are the buildings well maintained (0% = 0, 1-49% = 1, 50-99% = 2, 100% = 3)		
	P20-22 Aesthetics (+)	How many different predominant building façade colours exist on the route (No building/NA or 1 color = 0, 2-3 colors = 1, >4 colors = 2) + How many different building accent colours exist on the route (No building/NA or 1 color = 0, 2-3 colors = 1, >4 colors = 2) + How many different predominant building materials exist along the route (No building/NA or 1 color = 0, 2-3 colors = 1, >4 colors = 2)		
Education	**LU5 -** Schools (+)	School (No = 0, Yes = 1)	**2**	**0**
	LU5 – Library/Museums (+)	Library/Museums (No = 0, Yes = 1)		
Traffic/transport	**SS1 -** Public transport (+)	If answered 1 or more to **SS1a-c** (No = 0, Yes = 1 (**SS1a or SS1b or SS1c),** Yes = 2 **(two from SS1a-c**) or Yes = 3 (**each of SS1a-c)**		
	SS3-4 - Speed signs (+)	Posted speed limit signs (No = 0, Yes = 1) + 20mph speed limit signs (No = 0, Yes = 1) + special zone speed limit signs (No = 0, Yes = 1)		
	SS5 - Speed calming measures (+)	Traffic calming signs (No = 0, Yes = 1) + Traffic calming circles (No = 0, Yes = 1) + Traffic calming speed tables (No = 0, Yes = 1) + Traffic calming speed humps (No = 0, Yes = 1) + Traffic calming curb extension (No = 0, Yes = 1) + Instructional signs for pedestrian's (No = 0, Yes = 1) + Crosswalk signage or other pedestrian signage (for drivers) (No = 0, Yes = 1)	**15**	**12**

	P10-11 – Traffic lanes (-)	Number traffic lanes (1- 4 = 1, >5 = 0) + Is the street predominantly one-way to two-way (One-way = 0, Two-way = 1)		
Pavements	**SS8 -** Street amenities (+)	Building overhangs that provide shelter from inclement weather in public space (No = 0, Yes = 1) + Rubbish bins (public) (No = 0, Yes = 1) + Benches or other places to sit (No = 0, Yes = 1) + Bicycle racks (No = 0, Yes = 1), Working drinking fountain (No = 0, Yes = 1) + Working public telephones (No = 0, Yes = 1) + Kiosks or information booths (No = 0, Yes = 1) + Car charging points (No = 0, Yes = 1)		
	A6 – Litter in street/pavements (-)	Noticeable/excessive litter in street/pavement (No = 1, Yes = 0)		
	A8 – Obstructions to walking (-)	Railroad tracks (No = 1, Yes = 0) + Highway nearby (No = 1, Yes = 0) + Other (No = 1, Yes = 0)		
	SS6 - Street lights (+)	Are street lights installed (No = 0, Some = 1 (e.g., overhead street lights on utility poles with wide spacing) or Ample = 2 (e.g., regularly spaced pedestrian lampposts)		
	SS9 - Crossings (+)	Mid-segment street crossing where an individual could safely cross (marked by a sign or crosswalk) (No = 0, Yes = 1)		
	P1-2,4, 12 – Pavements (+)	Pavement present (No = 0, Yes = 1) + pavement over 50% of the route (No = 0, Yes = 1) + width of pavement (<3ft =1, 3-5ft = 2, >5ft = 3, no pavement = 0) + continuous pavement (No = 0, No pavement = 0, Yes = 1) + pavement over 50% of the route (No = 0, Yes = 1) + If no pavement is there any other place to walk that is safe from traffic (Yes = 1, No = 0, N/A pavement present = 1)	**42**	**30**
	P3 – Buffers (+)	Buffer present (No = 0, Yes = 1) + buffer over 50% of the route (No = 0, Yes = 1) + how wide is the majority of the buffer (<3ft =1, 3-5ft = 2, >5ft = 3, N/A = 0)		
	P5 – Pavement quality (-)	Poorly maintained sections of pavement that constitute trip hazards (e.g., heaves, misalignment, cracks, overgrowth): minor – moderate (none = 4, One = 3, A few = 2, A lot = 1, No pavement = 0) + major (none = 4, One = 3, A few = 2, A lot = 1, No pavement = 0)		
	P8-9 – Pavement obstructions (-)	Permanent obstructions (None = 3, Some = 2, Many = 1, No pavement = 0) + temporary obstructions (None = 3, Some = 2, Many = 1, No pavement = 0)		
Roads	**SS9, C1, 3-7, 10, 11 -** Crossings (+/-)	Mid-segment street crossing where an individual could safely cross (marked by a sign or crosswalk) (No = 0, Yes = 1) + Intersection control (Yield sign = 1 + Stop signs = 1 + Traffic signal = 1 + Traffic circle = 1) + Signalization (Green arrows for dedicated vehicle turn = 1 + Pedestrian walk signals = 1 + Push buttons = 1) + Pre-crossing curb (Ramp lines up w/xing = 1, Ramp doesn't line up = 0, No ramp = 0) + Post-crossing curb (Ramp lines up w/xing = 1, Ramp doesn't line up = 0, No ramp = 0) + Gutters present in crossing (No = 1, Yes = 0) + Other characteristics (Steep slope No = 1, Yes = 0) + Temporary obstructions (No = 1, Yes = 0) + Crossing aids (No = 0, Yes = 1) + Crosswalk treatment (Marked crosswalk No = 0, Yes = 1) + High-visibility striping (No = 0, Yes = 1) + Stop lines on road or additional crosswalk warnings (No = 0, Yes = 1) + Raised crosswalk (No = 0, Yes = 1) + Different material than road (No = 0, Yes = 1) +	**41**	**26**

		Features (Specifically identified lanes turning into crossing No = 0, Yes = 1) + Protected refuge islands (No = 0, Yes = 1) + One-way streets through crossing (No = 0, Yes = 1) + Curb extension (No = 0, Yes = 1) + Miscellaneous problems (Lack of lampposts or overhead street lamps No =1, Yes = 0) + Poor condition of crossing surface (No = 1, Yes = 0) + Poor visibility at corners (No = 1, Yes = 0) + Faded or worn crosswalk markings (No = 1, Yes = 0)		
	A8 – Obstructions to walking (-)	Railroad tracks (No = 1, Yes = 0) + Highway nearby (No = 1, Yes = 0) + Other (No = 1, Yes = 0)		
	P14, 15 – Bicycle lane/use (+)	Is there a marked bicycle lane marked with a lane (No = 0, Yes = 1) + Does the marked bicycle lane run for the entire route (100% = 4; 75-99% = 3; 51-75% = 2; 25-50% = 1; 1-25% = 0) + Is there a marked bicycle track separated from traffic and pedestrians (No = 0, Yes = 1) + Does the marked bicycle track run for the entire route (100% = 4; 75-99% = 3; 51-75% = 2; 25-50% = 1; 1-25% = 0) + Are there any signs indicating bicycle use (No = 0, Yes = 1)		
Overall score	A summed score can be produced for liveability	Safety + Health + Sustainability + Inclusivity + Places + Education + Traffic/Transport + Pavements + Roads (with the exception of those variables that are doubled scored in attributes (only counted once)) (highlighted in grey)	**N/A**	**178**

Items not used in scoring protocol but can be dependent on the study aims and objectives: **LU3** (How many non-residential buildings are adjacent to the pedestrian walkway or sidewalk and/or street? 0% = 1 1-33% = 2 34-66% = 3 67-99% = 4 100% = 5 N/A (all residential) = 6 N/A (no walkway) = 7); LU**4** (How many of the non-residential buildings have parking lots or drives between the pedestrian walkway or sidewalk along the street and their entrances? 0% = 1 1-33% = 2 34-66% = 3 67-99% = 4 100% = 5 N/A (all residential) = 6 N/A (no walkway) = 7); **SS5f-g** (What other street characteristics are present? Roll-over curbs, drainage ditches; **SS7** (How many driveways or alleys are there? None, 1-2, 3-5 or 6+; **P6a** (How steep is the pavement at the steepest point in the route (__degrees, no pavement)); **P6b** (How much of the route is at or near this level of steepness? Little 1-25%, some 26-75%, most or all 76-100%, no pavement); **P6c** (If answer to 6(b) is "little" provide a steepness measure that represents the majority of the route ___degrees, no pavement or N/A); **P7** (What is the steepest unavoidable cross-slope that affects walkers?__ degrees, no pavement); **P13** (If no pavement, what is the width of the place on which one could safely walk? (not in possible path of traffic) None, <4ft, >4ft, N/A); **P16 (**Are there any signs or structures discouraging skateboard usage Yes, No); **P17** (Is there an informal path (shortcut), not on a cul-de-sac, which connects to something else Yes, No); **P18a/18b** – (is this a dead-end street Yes, No) Is there a paved or informal path at the end of the cul-de-sac or dead end street that connects to something else (Yes, No, N/A); **P26-28** (What is the smallest building setback from the pavement/What is the largest building setback from the pavement (no building, <10 feet, 10-20 feet, 21-50 feet, 51-100 feet, > 100 feet), What is the average height of buildilngs, No building, 1-2 stories, 3-5 stories, 6-10 stories, > 10 stories); **C2** (Number of legs at intersection, T-intersection, 4-way intersection, > 4-ways, N/A); **C8** (Bike lane crosses the crossing Yes, No); **C9** (Distance of crossing leg, including all potential parking and turn lanes____ lanes wide); **C11** (Unanticipated mid-segment crossing, Other___), **SS2 –** Public transport facilities (+).

Appendix F. MAPS-Full Subscales

MAPS-Full section	MAPS-Full existing subscales
Destination and Land use	Residential density subscale
	Shops subscale
	Restaurant and entertainment subscale
	Institutional/services subscale
	Government services subscale
	Worship land uses
	School land uses
	Public recreation subscale
	Private recreation subscale
	Parking land uses (positive)
	Positive parking subscale
	Warehouse/factory/industrial uses
	Abandoned buildings
	Unmaintained lots and fields
	Casinos
	Parking land uses (negative)
	Positive destinations and land use
	Negative destinations and land use subscale
	Overall destinations and land use
Streetscape	Positive streetscapes
	Positive streetscape subscales (transit tally, posted speed limits, traffic calming, instructional signs, street lights, street amenities, (overhangs, trash bins, benches, bike racks, drinking fountains, public telephones, kiosks, mid-segment crossings)
	Negative streetscapes
	Negative streetscape subscale
	Overall streetscape scale
Aesthetics and social	Positive aesthetics and social elements (hardscape, softscape, landscaping, neighbourhood watch signs, other signage for destinations)
	Negative aesthetics and social elements
	Negative aesthetics and social subscale (Negative Aesthetics and Social Subscale: Buildings not maintained, graffiti, abandoned cars, broken/boarded windows, drug paraphernalia, broken glass, litter in yards, extent physical and social disorder, obstructions to walking)
	Overall aesthetics and social subscale
	Overall route scale
Pavements	Positive setback and building height
	Positive pavements
	Positive pavement subscale
	Positive buffer
	Buffer positive subscale
	Positive bike infrastructure
	Positive bike infrastructure subscale
	Positive building aesthetics and design
	Building aesthetics and design positive subscale
	Trees positive subscale
	Informal path or shortcut positive
	Building height to road width ratio subscale
	Pavements negative
	Pavements negative subscale
	Pavement slope negative
	Pavement slope negative subscale
	Negative street design subscale
	Negative street design subscale
	Positive segments subscale
	Negative segments subscale – senior

	Negative segments subscale – child/adult
	Overall segment subscale – senior
	Overall – segment subscale - child
Crossings	Crosswalk amenities positive subscale
	Curb quality/presence
	Curb quality/presence positive subscale
	Intersection control and signage positive subscale
	Road width sum
	Road width negative subscale
	Crossing impediments negative
	Crossing impediments negative subscale
	Positive crossing subscale
	Negative crossing subscale
	Overall crossing
Cul-de-sac	Overall cul-de-sac

Appendix G. MAPS-Full scoring protocol adjusted for MAPS-Liveability

Part 1: Route

A. Route: Destinations and Land Use

Item	Item Content	Scoring
Residential Density Subscale		
ResMix	Residential Mix	Apartment over retail only =1 Apts or multi-family only =2 Mixed or other = 3 Single family only = 4 None=0
Res_Density_Mix_recode	Residential density mix recoded (points)	0=commercial 1=single family 2=multi-family only and any other mix 3=apts over retail
Shops subscale		
Shops	Shops subscale score	**LU5c + LU5d + LU56f + LU5g + LU5h + LU5i + LU65n +LU6a + LU6b + LU6c**
Restaurant and Entertainment Subscale		
Restaur_ Ent	Restaurants and Entertainment subscale	**LU5a + LU5b + LU5e + LU5l**
Institutional/Services Subscale		
Institu_Svc	Institutional/Services subscale	**LU5j + LU6k + LU6m**
Government Services Subscale		
Govt_Svcs	Government Services subscale	**LU5o + LU5p + LU5q+ LU5r**
Worship Land Uses		
LU5s	Government or community land use: Place of worship	0=0 1=1 2+ =2
School Land Uses		
LU5t	Government or community land use: School	0=0 1=1 2+ =2
Public Recreation Subscale		
Public_Rec	Public Rec facilities subscale (Community garden, public indoor, public outdoor pay and public park)	**LU5y + LU5aa + LU5ac + LU5ad + LU5ae**
Private Recreation Subscale		
Private_Rec	Private Rec facilities subscale (private indoor & outdoor)	**LU5z + LU5ab**
Parking Land Uses (positive)		
LU1b_recode	What parking facilities are present? On-street, parallel, or angled Recoded	No = 0 Yes = 2
Positive Parking Subscale		
Pos_Parking	Positive Parking influences subscale	**LU1a** + LU1b_rec
Warehouse/Factory/Industrial Uses		
LU5u	Other land use: Warehouse, factory, industrial	0=0 1=1 2+ =2
Abandoned Buildings		
LU5v	Other land use: Abandoned buildings	0=0 1=1 2+ =2
Unmaintained lots and fields		
LU5w	Other land use: unmaintained lots or fields	0=0 1=1 2+ =2
Casinos		

LU5x	Other land use: Casinos	0=0 1=1 2+ =2
Parking Land Uses (negative)		
LU1c	What parking facilities are present? Small lot or garage (< 30 spaces)	No = 0 Yes = 1
Parking Land Uses (negative)		
LU1d_rec	What parking facilities are present? Medium to large lot or garage Recoded.	No = 0 Yes = 2
Positive Destinations and Land Use		
DLU_pos	Destinations and Land Use: Positive subscale	ResMix_recode + Shops + Restaur_Ent + Institu_Svc + Govt_Svc + **LU5s** + **LU5t** + Public_Rec + Private_Rec + Pos_Parking
Negative Destinations and Land Use Subscale		
DLU_neg	Negative Destinations and Land Use subscale Casino, abandoned building, unmaintained lot/field, med-large parking lot	**LU5u**+ **LU5v** + **LU5w** + **LU5x** + LU1c + **LU1d**_rec
Overall Destinations and Land Use		
DLU_Overall	Overall Destinations and Land Use Scale	DLU_pos – DLU_neg

Items from DLU section not used in positive or negative subscales: ~~LU1 (How is audit information collected? Foot (walked route) = 1 Auto (drove route) = 2 Both = 3);~~ **LU3** (How many non-residential buildings are adjacent to the pedestrian walkway or sidewalk and/or street? 0% = 1 1-33% = 2 34-66% = 3 67-99% = 4 100% = 5 N/A (all residential) = 6 N/A (no walkway) = 7); and LU**4** (How many of the non-residential buildings have parking lots or drives between the pedestrian walkway or sidewalk along the street and their entrances?
0% = 1 1-33% = 2 34-66% = 3 67-99% = 4 100% = 5 N/A (all residential) = 6 N/A (no walkway) = 7).

B. Route: Streetscape

Item	Item Content	Scoring
Positive Streetscape		
Transit_tally	Transit stop tally that includes amenities (bench, shelter, and timetable)	SS1a + **SS1b +** SS2_1b + SS2_1c + SS2_1d + SS2_2b + SS2_2c + SS2_2d + SS2_3b + SS2_3c + SS2_3d + SS2_4b + SS2_4c + SS2_4d
Transit _tally_trichot	Transit stop tally. Trichotomized (points: 0, 1, or 2 thru highest)	0 1 2
SS3a_ sign	Is there a posted speed limit along the route? Is there a sign or not? No vs. yes	No = 0 Yes = 1
SS3a_ pos	Is there a posted speed limit along the route? Regular zone: Speed limit 25 mph or below.	No = 0 Yes, speed limit 25mph or less= 1
SS3b_20mph_painted	**How many 20mph speed limit signs are along the route? Painted on the ground**	**Continuous variable**
SS3b_20mph_sign	**How many 20mph speed limit signs are along the route? Sign on a pole**	**Continuous variable**
SS3b_20mph_other	**How many 20mph speed limit signs are along the route? Other**	**Continuous variable**
SS3b_20mph_other_qual	**How many 20mph speed limit signs are along the route? If other, please state**	**Qualitative**
SS**4**_pos	Is there a posted speed limit along the route? Special zone: Speed limit 25 mph or below.	No = 0 Yes, speed limit 25mph or less= 1
SS**5**a_ dichot	What other street characteristics are present? Traffic calming (signs, circles, speed tables, speed humps, curb). Dichotomized	None = 0 Any = 1

SS**5**d_ dichot	Instructional signs for pedestrians Dichotomized	None = 0 Any = 1
SS**5**e_ dichot	Crosswalk signage or other pedestrian signage (for drivers). Dichotomized	None = 0 Any = 1
SS**6**_dichot	Are street lights installed? Dichotomized	None = 0 Any = 1
Positive Streetscape Subscales		
Pos_Streetscape	Positive Streetscape subscale: Transit tally, posted speed limits, traffic calming, instructional signs, street lights, street amenities (overhangs, **rubbish** bins, benches, bike racks, drinking fountains, public telephones, **car charging points,** kiosks, mid-segment crossings)	Transit_tally_trichot + SS3a_sign + SS3a_pos + **SS3b_20mph_painted + SS3b_20mph_sign + SS3b_20mph_other + SS3b_20mph_other_qual +** SS**5**a_dichot + **SS5**d_dichot + **SS5**e_dichot + **SS6**_dichot + **SS8a** + **SS8b** + **SS8c** + **SS8d** + **SS8e** + **SS8f** + **SS8g** + **SS8h** + SS**9**
Negative Streetscape		
SS1a_ dichot	Number of public transit stops: Bus stops. Dichotomized none=neg)	None = 1 Any = 0
SS1b_dichot	**Number of rapid transit stops: Bus stops. Dichotomized none=neg)**	**None = 1 Any = 0**
SS3a_ dichot	Is there a posted speed limit along the route? Regular zone: Speed limit greater than 25 mph. Dichotomized	Lowest through 25= 0 > 25mph = 1
SS**5**b_ dichot	Roll-over curbs (if whole segment = 1) Dichotomized	None = 0 Any (>=1) = 1
SS**6**_dichot _neg	Are street lights installed? Dichotomized	None = 1 Any (some and ample)= 0
SS**7**_dichot	How many driveways or alleys are there? Dichotomized	0-5 driveways = 0 6+ driveways = 1
Negative Streetscape Subscale		
Neg_Streetscape	Negative Streetscape subscale	SS1a_dichot + **SS1b_dichot** + SS3a_dichot + **SS5**b_dichot + **SS6**_dichot_neg + SS**7**_dichot
Overall Streetscape Scale		
Streetscape_Overall	Overall Streetscape Scale	Pos_Streetscape - Neg_Streetscape

Items from the Streetscape section not used in positive or negative subscales: SS1b (Number of public transit stops: senior transit/paratransit #); SS2_1a (Transit stop (#1): Route # text); SS2_2a (Transit stop (#2) Route # text); SS2_3a (Transit stop (#3) Route# text); SS2_4a Transit stop (#4) Route# text); **SS5**c (Drainage ditches (count one side of street, #); **SS8i (smoking areas).**

C. Route: Aesthetics and Social

Item	Item Content	Scoring
Positive Aesthetics and Social Elements		
A5_dichot	Is the landscape well maintained? Dichotomized	0-99% = 0 100% = 1
Positive Aesthetics and Social Subscale		
Pos_AesthSoc	Positive Aesthetics and Social Subscale: Hardscape, softscape, landscaping, neighborhood watch signs, other signage for destinations, **safety button connecting to police**	A1 + A2 + A5_dichot + A6i + A6j + **A6k**
A9_walking	**Presence of anyone walking**	**No = 0 Yes = 1**
A10_running	**Presence of anyone running**	**No = 0 Yes = 1**
A11_cycling	**Presence of anyone cycling**	**No = 0 Yes = 1**
A12_PA_exercise	**Presence of anyone performing other physical activity or exercising (not walking or cycling)**	**No = 0 Yes = 1**
Negative Aesthetics and Social Elements		
A4_dichot_neg	Are the buildings well maintained? Dichotomized	0-99% = 1 100% = 0
A7_ dichot	Rate the extent of physical disorder. Dichotomized	None = 0 A little, some or a lot = 1
~~A8_ dichot~~	~~Rate the extent of social disorder. Dichotomized~~	~~None = 0 A little, some or a lot = 1~~

Negative Aesthetics and Social Subscale		
Neg_AesthSoc	Negative Aesthetics and Social Subscale: Buildings not maintained, graffiti, abandoned cars, broken/boarded windows, drug paraphernalia, broken glass, litter in yards, extent physical ~~and social~~ disorder, obstructions to walking.	A4_dichot_neg + A6a + A6b + A6c + A6d + A6e + A6g + A7_dichot + ~~A8_dichot~~ + **A8a** + A**8**b
Overall Aesthetics and Social Subscale		
AesthSoc_Overall Overall	Overall Aesthetics and Social Subscale	Pos_AesthSoc - Neg_AesthSoc
Overall Route Scale		
Route_Overall	Overall Route Scale	DLU_Overall + Streetscape_Overall + AesthSoc_Overall

Items from the Aesthetics and Social section not used in positive or negative subscales: A3 (Are there observable historic or cultural features along the route? No = 0 Yes = 1); A4_dichot (Is the building well maintained? Dichotomized 0-99% = 0 100% = 1); A9c (Other obstructions to walking: Other No = 0 Yes = 1); A6f (Beer/liquor bottles/cans No = 0 Yes = 1); A6h (Noticeable/excessive litter in street/sidewalk No = 0 Yes = 1).

Part 2: Segments

(Note: ~~There are multiple segments possible per route; S1 indicates the first segment, for which the variables and subscales are listed below. For subsequent segments, use S2, S3, etc. for naming variables and subscales.~~ **There is only one route per segment – S1**)

A. Positive Subscales Item

Item	Item Content	Scoring
Positive Setback and Building Height		
S1_26	What is the smallest building setback from the sidewalk?	No building = 1 <10 feet = 2 10-20 feet = 3 21-50 feet = 4 51-100 feet = 5 >100 feet = 6
S1_27	What is the largest building setback from the sidewalk/walkway?	No building = 1 <10 feet = 2 10-20 feet = 3 21-50 feet = 4 51-100 feet = 5 >100 feet = 6
S1_26_27_0pts	Either setback (S1_26, S1_27) >50 ft and no building.	No = 0 Yes = 0
S1_26_27_1point	All other combinations of S1_26 and S1_27	No = 0 Yes = 1
S1_26_27_2points	Both setbacks (S1_26 and S1_27) 10-20 ft. or one setback <10 ft and one setback 10-20 ft.	No = 0 Yes = 2
S1_26_27_3points	Both setbacks (S1_26 and S1_27) <10 ft.	No = 0 Yes = 3
S1_26_27_points	Smallest and largest setback scores combined	S1_26_27_0pts + S1_26_27_1point + S1_26_27_2points + S1_26_27_3points
S1_28_trichot	What is the average height of buildings? Trichotomized.	No building and 0-2 stories = 0 3-5 stories = 1 6-10 stories = 2 10+stories = 3
Positive Building Height and Setbacks Subscale		
PosBldgHtSetbks_S1	Positive Setbacks/Bldg. Height: Positive subscale	S1_26_27_points + S1_28_trichot
Positive Sidewalk		
S1_2_recode	What is the width of the majority of the sidewalk? Recoded	<3 feet = 2 3-5 feet = 2 >5 feet = 3 No sidewalk= 0
S1_12a_recode	If no sidewalk, is there any other place to walk that is safe from traffic? Unpaved pathway (goat path); Recoded	Recoded No = 0 Yes = 1 NA/Sidewalk=0
S1_12b_recode	If no sidewalk, is there any other place to walk that is safe from traffic? Street shoulder; Recoded	No = 0 Yes = 1 NA/Sidewalk=0
S1_12c_recode	If no sidewalk, is there any other place to walk that is safe from traffic? Buffer; Recoded	No = 0 Yes = 1 NA/Sidewalk=0
S1_12_sum	Combination of 12a; 12b; 12c	No/ NA to 12a, 12b & 12c (no alternative walking path)= 0 Yes to 12a or 12b or 12c (alternative walking path) = 1

Positive Sidewalk Subscale		
Sidewalk_ Pos_S1	Sidewalk and sidewalk alternative (combined) presence and width (#s 1, 2, 12): S1_2_recode+s1_12_sum	No sidewalk = 0 Any path = 1 Narrow sidewalk(<5 ft) = 2 Wide sidewalk (>5) = 3
Positive Buffer		
S1_3a_recode	Is there a buffer present? Recoded	No sidewalk = 0 No = 0 Yes = 1
S1_3b_dichot	How wide is the majority of the buffer? Dichotomized.	No sidewalk = 0 0-3 feet = 0 >3 feet = 1
Buffer Positive Subscale		
Buffers_Pos_S1	Buffers: Positive subscale	S1_3a_recode + S1_3b_dichot
Positive Bike Infrastructure		
S1_14a_recode	Is there a marked bicycle lane marked with a line or a raised curb? Recoded	No = 0 Yes = 2
S1_14ai_bicycle_lane	**Does the marked bicycle lane run for the entire route?**	**100% = 4; 75-99% = 3; 51-75% = 2; 25-50% = 1; 1-25% = 0**
S1_14b_recode	**Is there a marked bicycle lane marked with a line or a raised curb? Recoded**	**No = 0 Yes = 2**
S1_14bi_bicycle_track	**Does the marked bicycle track run for the entire route?**	**100% = 4; 75-99% = 3; 51-75% = 2; 25-50% = 1; 1-25% = 0**
Bike Infrastructure Positive Subscale		
Bike_ Infra_S1	Bike Infrastructure: Positive subscale	S1_14a_recode + **S_14ai_bicycle_lane + S1_14b_recode + S1_14bi_bicycle_track** + S1_15
Positive Building Aesthetics and Design		
S1_19_trichot	Proportion of street segment w/windows within 40 feet of sidewalk/walkway (or street): Trichotomized	No windows – 25% = 0 26%-75% = 1 >76% = 2
S1_20_trichot	How many different predominant building façade colors exist? Trichotomized	No building/NA or 1 color=0 2-3 colors=1 >4 colors=2
S1_21_trichot	How many different building accent colors? Trichotomized	No building/NA or 1 color=0 2-3 colors=1 >4 colors=2
S1_22_dichot	How many different predominant building materials? Dichotomized	No building/NA or 1 material=0 >2=1
Building Aesthetics & Design Positive Subscale		
BldAesthDes_S1	Building Aesthetics & Design: Positive subscale	S1_19_trichot + S1_20_trichot + S1_21_trichot + S1_22_dichot
Trees Positive		
S1_23_trichot	How many trees exist within 5 feet of either side of the sidewalk/pathway? Trichotomized	No sidewalk/NA = 0 0-1 trees = 0; 2-10 trees = 1 >11 trees = 2
S1_24_recode	How are the trees generally spaced? Recoded	Irregular or no sidewalk/NA= 0 Evenly = 1
S1_25_trichot	What percentage of sidewalk/walkway is covered by trees/other overhead coverage? Trichotomized	No coverage or no sidewalk/NA and ≤25% = 0 26%-75% = 1 >75% = 2
Trees Positive Subscale		
Trees_S1	Trees: Positive subscale	S1_23_trichot + S1_24_recode + S1_25_trichot
Informal Path or Shortcut Positive (single item, not a subscale)		
S1_17	Is there an informal path (shortcut), not on a cul-desac which connects to something else?	No = 0 Yes = 1
Building Height to Road Width Ratio Subscale		
BldgHt_RdWdthSetbk_R atio_S1	Building Height: Road Width+ Setback Avgs. Ratio	S1_28_feet/RdWdth_plus _Setbk_avg_S1
BldgHt_RdWdthSetbk_R atio_Scores_S1	Scores for the above ratio.	Lowest - .499 = 0 .50 - .999 = 1 1.0 - 1.999 = 3 2.0 - 2.999 = 2 3.0 – Highest = 1
RdWdth_plus_Setbk_avg_ S1	Road width (in feet) plus setback averages	S1_10_feet + S1_26_27_feetmid_avg

S1_28_feet	Average building height –recalculated in feet (using midpoint of response option ranges). (Top of the ratio.)	No building = 0 1-2 stories = 18 3-5 stories 48 6-10 stories = 96 >10 stories = 144
S1_10_feet	How many traffic lanes are present? Recalculated in feet.	1 = 12 2 = 24 3 = 36 4 = 48 5 = 60 6 = 72 7+ = 84
S1_26_feetmid	Smallest building setback from the sidewalk, calculated using the midpoint of response option ranges.	No building = 0 <10 feet = 5 10-20 feet = 15 21-50 feet = 35 51-100 feet = 75 >100 feet = 100
S1_27_feetmid	Largest building setback from the sidewalk, calculated, using the midpoint of response option ranges.	No building = 0 <10 feet = 5 10-20 feet = 15 21-50 feet = 35 51-100 feet = 75 >100 feet = 100
S1_26_27_feetmid_avg	Average smallest and largest setback midpoints (S1_26 and 27). (Part of the bottom of the ratio.)	Calculated numeric range

Part B. Segments: Negative Subscales

Sidewalk Negative		
S1_4_recode	Is the sidewalk continuous within the segment? Recoded	No = 1 Yes = 0
S1_5a_dichot	Are there poorly maintained sections of the sidewalk that constitute trip hazards? Minor- moderate; Dichotomized	0-1 = 0 A few or a lot = 1
S1_5b_dichot	Are there poorly maintained sections of the sidewalk that constitute trip hazards? Major; Dichotomized	0-1 = 0 A few or a lot = 1
S1_8_dichot	Are there permanent obstructions in the sidewalk? Dichotomized	None = 0 Some or many = 1
S1_9_dichot	Are the temporary obstructions in the sidewalk? Dichotomized	None = 0 Some or Many = 1
Sidewalk Negative Subscale		
Sidewalk_Neg_S1	Sidewalk : Negative subscale	S1_4recode + S1_5a_dichot + S1_5b_dichot + S1_8_dichot + S1_9_dichot
Sidewalk Slope Negative		
S1_6a_dichot_S	How steep is the sidewalk at the steepest point in the segment? Dichotomized. [For seniors]	0-6.88 = 0 6.89-highest = 1
S1_6a_dichot_C		
	How steep is the sidewalk at the steepest point in the segment? Dichotomized. [For children/adults]	0-6.88 = 0 6.89-highest = 1
S1_6b	How much of the segment is at or near this level of steepness (follow-up question to S1_6a)?	Little (1-25%) = 1 Some (26-75%) = 2 Most or all (76-100%) = 3 No sidewalk = -777
S1_6c	If answer to 6(b) is “Little,” provide a steepness measure that represents the majority of the segment	#
S1_6c_recode_S	If answer to 6(b) is “Little,” steepness measure majority of the segment: Recoded. [For seniors] If answer to 6(b) is not “Little” there is not a separate measure of the steepness of the majority of the segment, steepness measure from s1_6a_dichot_S is recoded here.	0-3.43 = 0 3.44 - 6.88 = 1 6.89 - 8.99 = 2 8.99 – Highest = 3
S1_6c_recode_C	If answer to 6(b) is “Little,” steepness measuremajority of the segment: Recoded. [For children/adults] If answer to 6(b) is not “Little” there is not a separate measure of the steepness of the majority of the segment, steepness measure from s1_6a_dichot_S is recoded here.	0-6.88 = 0 6.89 - 8.99 = 1 8.99 – Highest = 2

S1_7_recode_S	What is the steepest unavoidable cross-slope that affects walkers? Recoded. [For seniors]	0 - 1.14 = 0 1.15 - 2.28 = 1 2.29 - 3.43 = 2 3.44 – Highest = 3
S1_7_recode_C	What is the steepest unavoidable cross-slope that affects walkers? Recoded. [For children/adults]	0 - 2.28 = 0 2.29 - 3.43 = 1 3.44 – Highest = 2
Sidewalk Slope Negative Subscale		
Sidewalk_Neg_Slope_S	Seniors Slope: Negative subscale	S1_6a_dichot_S + S1_6c_recode_S + S1_7_recode_S Sidewalk
Sidewalk_Neg_Slope_C	Children Slope: Negative subscale	S1_6a_dichot_C + S1_6c_recode_C + S1_7_recode_C
Negative Street Design Subscale		
S1_10_dichot	How many traffic lanes are present? Dichotomized	1-4 lanes = 1 >5 lanes = 2
S1_11_recode	Is the street predominantly one-way or two-way? Recoded	One-way = 1 Two-way = 0
Negative Street Design Subscale (Note: this subscale is not included in the overall negative sum; it can be calculated and used separately if desired.)		
Neg_Street_Des_S1	Street Design: Negative subscale	S1_10_dichot + S1_11_dichot
Positive Segments Subscale		
Segments_Pos_S1	Sum of positive segment subscales	PosBldgHtSetbks_S1 + Sidewalk_Pos_S1 + Buffers_Pos_S1 + Bike_Infra_S1 + BldgAesthDes_S1 + Trees_S1 + S1_17 + BldgHt_RdWdthSetbk_ Ratio_Scores_S1
Negative Segments Subscale - Senior		
Segments_Neg_Senior	Sum of negative segment subscales, for seniors	Sidewalk_Neg_ S1 + Sidewalk_Neg_Slope_S_ S1
Negative Segments Subscale – Child/Adult		
Segments_Neg_Child	Sum of negative segment subscales, for youth/adults	Sidewalk_Neg_ S1 + Sidewalk_Neg_Slope_C_ S1
Overall Segments Subscale - Senior		
Overall_Segment_Senior	Overall segment score for seniors	Segments_Pos_S1Segments_Neg_Senior_S 1
Overall Segments Subscale - Child		
Overall_Segment_Child	Overall segment score for youth/adults	Segments_Pos_S1Segments_Neg_Child_S1

Items from Segments section not used in positive or negative subscales: S1_6b (How much of the segment is at or near this level of steepness (follow-up question to S1_6a)? Little (1-25%) = 1 Some (26-75%) = 2 Most or all (76-100%) = 3 No sidewalk = -777); S1_13 (If no sidewalk, what is the width of the place on which one could safely walk? None = 1 <4 feet = 2 ≥4 feet = 3 N/A = -777); S1_16 (Are there any signs or structures discouraging skateboard usage? No = 0 Yes = 1); S1_18a (Is this a dead-end street? No = 0 Yes = 1); S1_18b (Is there a paved or informal path at the end of the cul-de-sac or dead-end street which connects to something else (follow-up question to S1_18a)? No = 0 Yes = 1 N/A = -777).

Part 3: Crossings

(Note: ~~There are multiple crossings possible per route; C1 indicates the first crossing, for which the variables and subscales are listed below. For subsequent crossings, use C2, C3, etc. for naming~~ **There may be multiple crossings on a route however questions should be answered for the overall route**.)

A. Positive Subscales Item

Item	Item Content	Scoring
Crosswalk Amenities Positive Subscale		
CrosswalkAmenities_C1	Crosswalk amenities: Positive subscale (Crossing aids, marked crosswalk, high visibility striping, stop lines or crosswalk warnings, raised crosswalk, different material than road, protected refuge islands, curb extensions).	C1_7c + C1_8a + C1_8b + C1_8c + C1_8d + C1_8e + C1_11c + C1_11e
Curb Quality/Presence		
C1_5a_positive	Pre-crossing curb - option 1: Ramp lines up with crossing. Recoded	Ramp lines up w/xing = 1 Ramp doesn't line up = 0 No ramp = 0
C1_5b_positive	Post-crossing curb - option 1: Ramp lines up with crossing. Recoded	Ramp lines up w/xing = 1 Ramp doesn't line up = 0 No ramp = 0
Curb Quality/Presence Positive Subscale		

Curb_Qual_C1	Curb Quality and Presence Subscale	C1_5a_positive + C1_5b_positive
Intersection Control and Signage Positive Subscale		
IntsectCtrlSign_C1	Intersection Control/Signage: Positive subscale (Yield signs, stop signs, traffic signal, traffic circle, green arrows for turn lane, pedestrian walk signals, push buttons, countdown signal, audible walk signal, lanes turning into right crossing, lanes turning into left crossing, one way streets through crossing)	C1_1a + C1_1b + C1_1c + C1_1d + C1_3a + C1_3b + C1_3c + C1_3d + C1_3e + C1_11a + C1_11b + C1_11d

Part b: Crossings: Negative Subscales

Road Width Sum		
C1_10_trichot	Distance of crossing leg, including all potential parking and turn lanes. Trichotomized	1 – 2 = 0 3 – 4 = 1 5 – Highest = 2
Road Width Negative Subscale		
Road_Width_C1	Same as trichotomized road (crossing) width	C1_10_trichot
Crossing Impediments Negative		
C1_5a_negative	Pre-crossing curb-option 3: No ramp. Recoded	Ramp lines up w/xing = 1 Ramp doesn't line up = 0 No ramp = 0
C1_5b_negative	Post-crossing curb-option 3: No ramp. Recoded	Ramp lines up w/xing = 1 Ramp doesn't line up = 0 No ramp = 0
Crossing Impediments Negative Subscale		
Cross_Imped_C1	Crossing impediments: Negative subscale (no ramp pre- and post-crossing curb, gutters, steep slope or cross-slope, temporary obstructions, poor visibility at corners, faded or worn crosswalk markings)	C1_5a_negative + C1_5b_negative + C1_6 + C1_7a + C1_7b + C1_12c + C1_12d
Positive Crossing Subscale		
PosCrossChars_C1	Positive Crossing	CrosswalkAmenities_C1 + CurbQual_C1 + IntsectCtrlSign_C1
Negative Crossing Subscale		
NegCrossChars_C1	Negative Crossing	Road_Width_C1 + Cross_Imped_C1
Overall Crossing		
OverallCrossScore_C1	Overall Crossing Scale	PosCrossChars_C1 – NegCrossChars_C1

Items from Crossings section not used in positive or negative subscales: C1_2 (Number of legs at intersection T-intersection = 1 4-way = 2 >4-way = 3); C1_4 (Crosswalk timing # of seconds No crosswalk = -777 No signal = -778); C1_5a_opt2 (Pre-crossing curb-option 2: Ramp doesn't line up with crossing Ramp does not line up = 1); C1_5b_opt2 (Post-crossing curb-option 2: Ramp doesn't line up with crossing Ramp does not line up = 1); C1_9 (Bike lane crosses the crossing? No = 0 Yes = 1); C1_12a (Misc problems: Lack of lampposts or street lamps No = 0 Yes = 1); C1_12b (Misc problems: Poor condition of crossing surface No = 0 Yes = 1); C1_12e (Misc problems: Unanticipated mid-segment crossing No = 0 Yes = 1); C1_12f (Misc problems: Other No = 0 Yes = 1); C1_12f1 ("other" reason (if above is applicable)).

Part 4: Cul-De-Sacs

(Note: There may be multiple cul-de-sacs (CdS) per route; D1 indicates the first cul-de-sac, for which the variables and subscale are listed below. For subsequent cul-de-sacs, use D2, D3, etc., for naming.)

Item	**Item Content**	**Scoring**
~~D1_1_dichot~~	~~How close is cul-de-sac or dead-end to participant's home? Dichotomized.~~	~~On the CdS = 1 Adjacent = 1 <200 feet away = 0 >200 feet away = 0~~
D1_**1**_dichot	How big is cul-de-sac at its largest diameter? Dichotomized.	<50 feet = 0 51-100 feet = 1 101-200 feet =1 >200 feet = 1
D1_**2**a_dichot	What is incline/grade of cul-de-sac at its steepest point? Dichotomized.	0 thru 6.88 = 1 6.89 thru highest = 0

D1_2b_dichot	What is incline/grade of street at opening to cul-desac? Dichotomized.	0 thru 6.88 = 1 6.89 thru highest = 0
D1_4_dichot	For paved part, how smooth is pavement? Dichotomized.	Not smooth = 0 Somewhat smooth = 0 Mostly smooth = 0 Very smooth = 1
D1_5_sum	Total amenities: basketball hoops + skateboard features + streetlights + pedestrian or safety signage	#
D1_5_sum_trichot	Total amenities: sum: Trichotomized	0 = 0 1 = 2 >1 = 2
D1_7_recode	Is parking allowed in the area? Recoded.	No = 1 Yes = 0
Overall CulDeSac		
OverallCdSScore_D1	Sum of following items ~~all items except 4, 9, 10, 12~~ (~~closeness to participant's home~~, largest cul-de-sac diameter, incline/grade at steepest point, smooth pavement, total amenities, ~~visibility of cul-de-sac area from participant's home, visibility of cul-de-sac area from other homes,~~ parking allowed)	~~D1_1_dichot~~ + D1_1_dichot + D1_2a_dichot + D1_2b_dichot + D1_4_dichot + D1_5_sum_trichot + D1_7 + ~~D1_8 + D1_11_recode~~

Items not used in cul-de-sac score: D1_3 (What %age of cul-de-sac is paved? <25% = 1 25-50% = 2 51-75% = 3 >75% = 4); D1_5e1 (What amenities exist at opening to or in cul-de-sac? Other #); D1_5e2 (What amenities exist at opening to or in cul-de-sac? Other (describe) Text); D1_6 (Number of driveways that enter into the cul-de-sac ~~#); D1_10 (Is there an island in the cul-de-sac? No = 0 Yes = 1);~~ D1_8a (Is there access through the end of the cul-de-sac to another public street or area? No = 0 Yes = 1); D1_9b1 (If yes: what type of access? Formal path No = 0 Yes = 1); D1_9b2 (If yes: what type of access? Informal path No = 0 Yes = 1); D1_9b3 (If yes: what type of access? Informal, no path No = 0 Yes = 1); D1_10c1 (If yes: what is on the other side? Another street No = 0 Yes = 1); D1_10c2 (If yes: what is on the other side? A recreation or play area No = 0 Yes = 1); D1_10c3 (If yes: what is on the other side? Open space No = 0 Yes = 1); D1_10c4 (If yes: what is on the other side? Commercial or retail area No = 0 Yes = 1); D1_10c5 (If yes: what is on the other side? Other No = 0 Yes = 1).

*Highlighted text shows changes that were made to the tool.

Appendix H. MAPS-Liveability

Date of audit	
Auditor	
Street name	
Start time	
End time	
Google maps date	

Section: Land use/destinations

Count both sides of the street

1. What parking facilities are present?
Check all that apply
- ☐ None
- ☐ On-street, parallel or angled parking
- ☐ Small lot or garage (< 30 spaces)
- ☐ Medium to large lot or garage

2. What types of residential uses?
Check all that apply
Single family houses
- ☐ Multi-unit homes (duplex, 4-plex, terrace)
- ☐ Apartments or flats
- ☐ Apartments/flats above street retail
- ☐ Retirement/senior living facility
- ☐ Other (mobile home, dormitory, students)
- ☐ None

3. How many of the non-residential buildings are adjacent to the pedestrian pavement and/or street? *(Adjacent to pavement and street means that there is not a yard, parking lot or other space blocking entrances between the sidewalk and the building)*
- ☐ 0%
- ☐ 1-33%
- ☐ 34-66%
- ☐ 67-99%
- ☐ 100%
- ☐ N/A (all residential buildings)
- ☐ N/A (no pedestrian walkway/pavement)

4. How many of the non-residential buildings have parking lots or drives between the pedestrian walkway or pavements along the street and their entrances?
- ☐ 0%
- ☐ 1-33%
- ☐ 34-66%
- ☐ 67-99%
- ☐ 100%
- ☐ N/A (all residential buildings)
- ☐ N/A (no pedestrian walkway/pavements)

5. How many of the following types of non-residential destinations are present? (Do not double count.)

Food-related land uses

a. Fast food restaurant *(national or local chain, primarily sells burgers, fried chicken, pizza, or "Americanized" Mexican, Chinese, etc.)*
☐ 0 ☐ 1 ☐ 2+

b. Sit-down restaurant
☐ 0 ☐ 1 ☐ 2+

c. Grocery/supermarket
☐ 0 ☐ 1 ☐ 2

d. Convenience store *(may also be a petrol station)*
☐ 0 ☐ 1 ☐ 2+

e. Café or coffee shop
☐ 0 ☐ 1 ☐ 2+

f. Liquor/alcohol store *(primarily sells alcohol, wine bar, pub)*
☐ 0 ☐ 1 ☐ 2+

g. Big box store *(e.g.,, Asda, Tesco, Sainsburys, B&Q)*
☐ 0 ☐ 1 ☐ 2+

h. Specialty Food Store (*e.g.,, ice cream, sweets, bakery)*
☐ 0 ☐ 1 ☐ 2+

Retail and service oriented land uses

i. Pharmacy or drug store
☐ 0 ☐ 1 ☐ 2+

j. Bank or credit union
☐ 0 ☐ 1 ☐ 2+

k. Health-related professional *(e.g.,, chiropractor, Dr. office)*
☐ 0 ☐ 1 ☐ 2+

l. Entertainment *(e.g.,, movie theatre, arcade)*
☐ 0 ☐ 1 ☐ 2+

m. Other service *(e.g.,, salon, lawyer, accountant, estate agent, laundry/dry cleaner, commercial mailing service)*
☐ 0 ☐ 1 ☐ 2+

n. Other retail *(e.g.,, books, clothing, hardware, video rental)*
☐ 0 ☐ 1 ☐ 2+

Government or community land use

o. Health or social services *(e.g.,, hospital, health department, community action agency, police/fire stations, city hall, etc.)*
☐ 0 ☐ 1 ☐ 2+

p. Library/Museums
☐ 0 ☐ 1 ☐ 2+

q. Post office
☐ 0 ☐ 1 ☐ 2+

r. Senior center
☐ 0 ☐ 1 ☐ 2+

s. Place of worship *(e.g.,, church, synagogue, convent, mosque, etc.)*
☐ 0 ☐ 1 ☐ 2+

t. School (including pre-, college and university)
☐ 0 ☐ 1 ☐ 2+

Other land use

u. Warehouse/factory/industrial

☐ 0 ☐ 1 ☐ 2+

v. Abandoned building

☐ 0 ☐ 1 ☐ 2+

w. Unmaintained lot/field

☐ 0 ☐ 1 ☐ 2+

x. Casino

☐ 0 ☐ 1 ☐ 2+

Recreational land use

y. Community garden

☐ 0 ☐ 1 ☐ 2+

z. Private indoor *(e.g.,, commercial gyms, dance clubs)*

☐ 0 ☐ 1 ☐ 2+

aa. Public indoor *(community centers)*

☐ 0 ☐ 1 ☐ 2+

ab. Private outdoor *(e.g.,, private golf course, commercial outdoor recreation)*

☐ 0 ☐ 1 ☐ 2+

ac. Public outdoor pay *(e.g.,, pool)*

☐ 0 ☐ 1 ☐ 2+

ad. Public park

☐ 0 ☐ 1 ☐ 2+

ae. Public walking trail

☐ 0 ☐ 1 ☐ 2+

6. Shopping Centers

Check all that apply

- ☐ Shopping centre
- ☐ Strip mall (strip of shops with parking in front)
- ☐ Shopping Arcade
- ☐ None of the above

Section: Streetscape

Count both sides of the street

1. Number of public transport stops

If NO stops, skip to 3.

(a) Bus stops _____

(b) Rapid transport stops_____

(c) Senior transit/paratransit _____

2. What is available at each transit stop?

Only count benches that users could be easily identified by bus drivers as waiting to ride the bus.

Route # _____

☐ Bench ☐ Covered Shelter ☐ Timetable

Route # _____

☐ Bench ☐ Covered Shelter ☐ Timetable

Route # _____

☐ Bench ☐ Covered Shelter ☐ Timetable

Route # _____

☐ Bench ☐ Covered Shelter ☐ Timetable

3. Is there a posted speed limit along the route?

If multiple, select the highest

Regular

☐ Yes 3a) {0, No}..._____ mph ☐ No

3b. How many 20mph speed limit signs are along the route?

_____painted on ground _____sign on a pole

_____Other

If other, please state_____

4. Special zone speed limits *(school, construction)*

☐ Yes _____ mph ☐ No

Please state_____

5. What other street characteristics are present? (specify # of each type)

Check all that apply

- ☐ Traffic calming signs_____
- ☐ Traffic calming circles_____
- ☐ Traffic calming speed tables_____
- ☐ Traffic calming speed humps____
- ☐ Traffic calming curb extension_____
- ☐ Roll-over curbs _____ (if whole segment = 1)
- ☐ Drainage ditches
- ☐ Instructional signs for pedestrian's _____
- ☐ Crosswalk signage or other pedestrian signage (for drivers) _____
- ☐ None of the Above

6. Are street lights installed?

- ☐ None
- ☐ Some *(e.g.,, overhead street lights on utility poles with wide spacing)*
- ☐ Ample *(e.g.,, regularly spaced pedestrian lampposts)*

7. How many driveways or alleys are there? Count only one side of the street.

(Count only alleys that are wide enough to be used by cars or other vehicles that could impede pedestrian traffic.)

☐ None ☐ 1-2 ☐ 3-5 ☐ 6+

8. Presence of street amenities

Check all that apply

- ☐ Building overhangs that provide shelter from inclement weather in public space (i.e. pavements)
- ☐ Rubbish bins (public)
- ☐ Benches or other places to sit
- ☐ Bicycle racks
- ☐ Working drinking fountain
- ☐ Working public telephones
- ☐ Kiosks or information booths
- ☐ Car charging points

☐ Smoking areas
☐ None of the Above

9. Presence of any mid-segment street crossing, where an individual could safely cross (marked by sign or crosswalk)?
☐ Yes ☐ No

Section: Aesthetics and Social

Count both sides of the street

1. Do you observe pleasant hardscape features, such as fountains, sculptures, or art (public or private)?
☐ Yes ☐ No

2. Do you observe softscape features such as gardens or landscaping (*e.g.,, Public: bodies of water, designated viewpoints; Private: retaining walls, bark, ponds)?*
☐ Yes ☐ No

3. Are there observable historic or cultural features along the route (statues, murals etc.?
☐ Yes ☐ No
Please state_____

4. Are the buildings well maintained?
☐ 0% ☐ 1-49% ☐ 50-99% ☐ 100%

5. Is landscaping well maintained?
☐ 0% ☐ 1-49% ☐ 50-99% ☐ 100%

6. Which of the following physical disorders are present?
Check all that apply
☐ Graffiti/tagging (not murals or street art)
☐ Abandoned cars
☐ Buildings with broken/boarded windows
☐ Drug paraphernalia
☐ Broken glass
☐ Beer/liquor bottles/cans
☐ Litter in yards
☐ Noticeable/excessive litter in street/sidewalk
☐ Neighborhood watch signs
☐ Signage for commercial destinations or parks
☐ Safety button connecting to police
☐ None of these

7. Rate the extent of physical disorder *(question 6) (e.g.,, litter, graffiti, broken glass, abandoned cars)*
☐ None
☐ A little (physical/social disorder is present)
☐ Some (disorder is very noticeable)
☐ A lot (disorder is overwhelming)

8. Other obstructions to walking
Check all that apply
☐ Railroad tracks (must obstruct walkway)
☐ Highway nearby (within one segment from walkway)
☐ Other: _____
☐ None

9. Presence of anyone walking?
☐ Yes ☐ No

10. Presence of anyone running?
☐ Yes ☐ No

11. Presence of anyone cycling?
☐ Yes ☐ No

12. Presence of anyone performing other physical activity or exercising? (not walking or cycling)
☐ Yes ☐ No

Section: Pavements / Roads

Type: Residential / Commercial (circle)

1. Is a pavement present?
☐ Yes ☐ No ☐ Over 50% of the route

2. What is the width of the majority of the pavement?
☐ < 3 ft. ☐ 3-5 ft. ☐ > 5 ft. ☐ No pavement

3. (a) Is there a buffer present?
☐ Yes ☐ No ☐ Over 50% of the route
(b) How wide is the majority of the buffer?
☐ < 3 ft. ☐ 3-5 ft. ☐ > 5 ft. ☐ N/A

4. Is the pavement *continuous* within the route?
☐ Yes ☐ No ☐ No sidewalk ☐ Over 50% of the route

5. Are there poorly maintained sections of the pavement that constitute trip hazards? *(e.g.,, heaves, misalignment, cracks, overgrowth)*
a. Minor - moderate
☐ None ☐ One ☐ A few ☐ A lot ☐ No pavement

b. Major
☐ None ☐ One ☐ A few ☐ A lot ☐ No pavement

6. (a) How steep is the pavement at the steepest point in the route? *(Excluding heaves)*
_____ degrees ☐ No pavement

(b) How much of the route is at or near this level of steepness?
☐ Little (1-25%) ☐ Some (26-75%)

□ Most or All (76-100%) □ No pavement

(c) If answer to 6(b) is "Little," provide a steepness measure that represents the majority of the route _____ degrees □ No pavement □ N/A

7. What is the steepest unavoidable cross-slope that affects walkers? _____ degrees □ No pavement

8. Are there permanent obstructions in the pavement?
(e.g.,, telephone poles, trees, café tables, shrubs, basketball hoops)
□ None □ Some □ Many □ No pavement

9. Are there temporary obstructions in the pavement?
(e.g.,, parked cars, sandwich boards, rubbish bins)
□ None □ Some □ Many □ No pavement

10. How many traffic lanes are present (include all lanes that traffic can use; choose most predominant)?
□ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7+

11. Is the street predominantly one-way or two-way?
□ 1-way □ 2-way

12. If no pavement, is there any other place to walk that is safe from traffic?
□ Yes
□ Unpaved pathway (goat path)
□ Street shoulder
□ Buffer
□ No
□ N/A pavement present

13. If no pavement, what is the width of the place on which one could safely walk? *(Not in possible path of traffic)*
□ None □ < 4 ft. 0 □ ≥ 4 ft. □ N/A

14a. Is there a marked bicycle lane marked with a line?
□ Yes □ No

14ai. Does the marked bicycle lane run for the entire route?
□ 100% □ 75-99% □ 51-75%
□ 25-50% □ 1-25%

14b. Is there a marked bicycle track separated from traffic and pedestrians?
□ Yes □ No

14bi. Does the marked bicycle track run for the entire route?
□ 100% □ 75-99% □ 51-75%
□ 25-50% □ 1-25%

15. Are there any signs indicating bicycle use (share the road, etc.)?
□ Yes □ No

16. Are there any signs or structures discouraging skateboard usage?
□ Yes □ No

17. Is there an informal path (shortcut), not on a cul-de-sac, which connects to something else?
□ Yes □ No

18a. Is this a dead-end street?
□ Yes □ No

18b. Is there a paved or informal path at the end of the cul-de-sac or dead end street that connects to something else?
□ Yes □ No □ N/A

19. Estimate the proportion of street segment that has ground floor or street-level windows within 40 feet of pavement/walkway (or street if no pavement/walkway)
□ 1-25% □ 26-50% □ No windows
□ 51-75% □ 76-100%

20. How many different predominant building façade colors exist on the route? *(Count both sides of the street)*
□ 1 □ 2-3 □ 4-6 □ >6 □ N/A

21. How many different building accent colors exist on the route? *(Count both sides of the street)*
□ 1 □ 2-3 □ 4-6 □ >6 □ N/A

22. How many different predominant building materials (e.g.,, brick, concrete, steel, wood) exist along the route? *(Count both sides of the street)*
□ 1 □ 2-3 □ 4-6 □ >6 □ N/A

23. How many trees exist within 5 feet of either side of the pavement/pathway (can be in buffer or setback; also count trees that are more than 5 feet away if they provide shade for the pavement/pathway)?
□ 0 or 1 □ 2-5 □ 6-10 □ 11-20 □ 21+ □ N/A

24. How are the trees generally spaced?
□ Evenly spaced □ Irregularly spaced □ N/A

25. What percentage of the length of the pavement/walkway is covered by trees, awnings or other overhead coverage?

☐ 1-25% ☐ 25-50% ☐ No coverage
☐ 51-75% ☐ 76-100% ☐ N/A

26. What is the smallest building setback from the pavement?

☐ No building ☐ <10 feet ☐ 10-20 feet
☐ 21-50 feet ☐ 51-100 feet ☐ >100 feet

27. What is the largest building setback from the pavement/walkway?

☐ No building ☐ <10 feet ☐10-20 feet
☐ 21-50 feet ☐ 51-100 feet ☐ >100 feet

28. What is the average height of buildings? *(Count both sides of the street)*

☐ No building ☐ 1-2 stories ☐ 3-5 stories
☐ 6-10 stories ☐ >10 stories

Crossings

How many crossings on the route?_____

Answer for overall route

1. Intersection control

Check all that apply

- ☐ Yield signs
- ☐ Stop signs
- ☐ Traffic signal
- ☐ Traffic circle
- ☐ N/A – Unanticipated mid-segment crossing
- ☐ None of the Above

2. Number of legs at intersection

Check one

- ☐ T-intersection
- ☐ 4-way intersection
- ☐ > 4-ways
- ☐ N/A

3. Signalization

Check all that apply

- ☐ Green arrows for dedicated vehicle turn
- ☐ Pedestrian walk signals
- ☐ Push buttons
- ☐ None of the Above

4. (a) Pre-crossing curb *(Even if there is no marked crosswalk, there is still a crossing)*

Check one

- ☐ Ramp lines up with crossing
- ☐ Ramp does not line up with crossing
- ☐ No ramp

(b) Post-crossing curb

Check one

- ☐ Ramp lines up with crossing
- ☐ Ramp does not line up with crossing
- ☐ No ramp

5. Gutters present in crossing

Within possible path of crossing pedestrians

☐ Yes ☐ No

6. Other characteristics of crossing

Check all that apply

- ☐ Steep slope or steep cross-slope at intersection
- ☐ Temporary obstructions
- ☐ Crossing aids (e.g.,, flags)
- ☐ None of the Above

7. Crosswalk treatment

Check all that apply

- ☐ Marked crosswalk
- ☐ High-visibility striping
- ☐ Stop lines on road or additional crosswalk warnings
- ☐ Raised crosswalk
- ☐ Different material than road
- ☐ None of the Above

8. Bike lane crosses the crossing?

☐ Yes ☐ No

9. Distance of crossing leg, including all potential parking and turn lanes

_____ lanes wide

10. Features

Check all that apply

- ☐ Specifically identified lanes **turning into crossing**
  - ☐ Right turn ☐ Left turn
- ☐ Protected refuge islands
- ☐ One-way streets **through crossing**
- ☐ Curb extension
- ☐ None of the Above

11. Miscellaneous problems

Check all that apply

- ☐ Lack of lampposts or overhead street lamps
- ☐ Poor condition of crossing surface
- ☐ Poor visibility at corners
- ☐ Faded or worn crosswalk markings
- ☐ Unanticipated mid-segment crossing Reason: _____
- ☐ Other: _____
- ☐ None of the Above

Cul-de-sac

Complete only if street comes to a dead end – Cul-de-sac

In order for the cul-de-sac or street dead-end to be rated, it must open out, widen or bulbs out.

1. How big is the cul-de-sac or dead-end at its largest diameter?

Check one

- ☐ ≤ 50 feet
- ☐ 51 – 100 feet
- ☐ 101 – 200 feet
- ☐ > 200 feet

2. What is the incline/grade of the:

Cul-de-sac or dead-end at its steepest point:

__ degrees

Street at the opening to the cul-de-sac or dead-end: _____ degrees

3. What percentage of the cul-de-sac or dead-end is paved?

Check one

- ☐ <25%
- ☐ 25-50%
- ☐ 51-75%
- ☐ > 75%

4. For the paved part of the cul-de-sac or dead-end, how smooth is the pavement?

Check one

- ☐ Not smooth at all – a lot of bumps or cracks
- ☐ Somewhat smooth – a few major bumps or cracks
- ☐ Mostly smooth – minor bumps or cracks
- ☐ Very smooth – few or no bumps or cracks

5. What amenities exist at the opening to or along the cul-de-sac or dead-end portion of the street?

Check all that apply

- ☐ Basketball hoops _____ number
- ☐ Skateboard features (e.g.,, ramps) _____ number
- ☐ Streetlights _____ number
- ☐ Pedestrian or other safety signage (e.g.,, children at play)
- ☐ Other; describe _____
- ☐ None of the Above

6. _____ driveways enter into the cul-de-sac or dead-end area?

7. Is parking allowed (not prohibited) in the area?

☐ Yes ☐ No

8 (a). Is there access through the end of the cul-de-sac or dead-end street to another public street or area?

☐ Yes ☐ No If no, done with section.

9 (b). If yes, what type of access?

Check all that apply

- ☐ Formal: A planned formal path with a paved, marked or deliberate surface.
- ☐ Informal: An informal path that is unpaved, not marked and could be considered a shortcut.
- ☐ Informal, no path

10 (c). If yes, what is on the other side?

Check all that apply

- ☐ Another street
- ☐ A recreation or play area (can be part of a school)
- ☐ Open space
- ☐ Commercial or retail area
- ☐ Other _____

Qualitative open ended questions

1) Any other comments on the street regarding liveability: safety, health, sustainability, inclusivity, places, education, traffic, pavements or roads:

2) Please make a note of any temporary street furniture e.g., road works, traffic lights:

3) Please make a comment regarding the weather of the google street view at both time-point 1 and time-point 2:

Proxy indicators of behaviour including active transport

	Outcomes	Count	Total for the route
Cycling	Number of bicycle racks (as a whole unit)		
	Number of bicycle racks (how many bicycles can the rack hold)		
	Number of bicycles in each of the racks (total)		
	Number of cyclists		
Traffic	Number of moving cars		
	Number of parked cars		
	Total number of cars on the road (moving and/or parked)		
Exercise	Number of individuals exercising (not walking or cycling e.g., running, jogging rollerblading etc.)		
	Type of activities being performed (not walking or cycling e.g., running, jogging, rollerblading etc.)		
	Total number of activities being performed (not walking or cycling)		
Pedestrians	Number of pedestrians		
Groups	Presence of large groups of people (>4) congregating together (count as whole groups)		
Static people	Presence of people on their own or in small groups (2-3 people) waiting for the bus etc.		