This report describes methods and tools used in the Digital Mapping Toolkit that support inclusive advocacy for transport decarbonisation.

Digital Mapping Toolkit

Co-designed activities with marginalised groups to promote active and inclusive mobility

24.01.2024
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1. **Introduction to Digital Mapping**

**Introduction**

To ensure equitable mobility and speed up decarbonisation, it is essential for public transportation systems to prioritise inclusiveness. However, since centralised approaches to minimum service standards for urban mobility are absent, bottom-up approaches are crucial to incorporate the needs and aspirations of marginalised groups (including women, children, older adults, people with disabilities (PWD), and those from low-income communities). PWD often face challenges because of limited mobility, social exclusion, and financial insecurity. This digital mapping toolkit has been designed to promote equal rights for women and marginalised groups, including PWD. It provides effective strategies that enhance the capacity of vulnerable groups in providing inputs, encouraging improvement for active mobility, and raising awareness about gender and social inclusion in urban areas. This document serves as a reference for city governments and other relevant parties to address the needs and challenges of marginalised groups and promote the creation of a more inclusive transport policy and planning.

**What is the toolkit and who will benefit from this toolkit?**

A set of methods that support and build capacity of community groups, civil society, and non-government organisations (NGOs) representing women and other marginalised groups to undertake evidence-based advocacy for transport decarbonisation that meets their specific mobility needs, as well as supporting them.

This toolkit should assist governments, practitioners, and stakeholders in implementing suitable programmes to address gender and social inclusion issues at the city level and to improve accessibility to public facilities and infrastructure, enabling individuals from marginalised groups to take part fully in society.

**What does this digital mapping toolkit cover, and what are its benefits?**

This digital mapping toolkit includes various methods that can be tailored and applied in multiple contexts to achieve different objectives. It provides examples of its use in diverse contexts, data scopes, and participants' perspectives. In designing urban and active mobility, the toolkit’s features can help:

- Understand mobility characteristics, purposes, patterns, needs, and experiences, especially for disadvantaged groups.
- Incorporate inclusive perspectives in defining mobility services and infrastructures for comfortable, accessible, and stress-free daily commutes.
- Accommodate voices of women and marginalised groups to ensure their safety and security in the transport environment.

This toolkit is a living document that can be updated to adapt to changing contexts, needs, and resources.
Overview of methods

This toolkit summarises six individual methods linked to digital mapping:

1. **Participatory Mapping** – Where participants draw on paper maps information related to their mobility, which are digitised for further analysis,

2. **Photovoice** – Where participants capture spatially located images that describe their mobility experiences.

3. **Online Spatial Surveys** – Where participants undertake spatial surveys recording GPS locations and site attribute details on their smart phones or tablet PCs.

4. **On-street Rapid Appraisal Participatory-GIS** – On-street engagement using maps to capture spatially participants’ mobility experiences or preferences for improvement.

5. **Online Participatory Mapping (Spatial Questionnaires)** - Website questionnaires enabled with spatially enabled data collection features.

6. **Google Timeline** – Participants share their actual recorded journey data that has been captured through Google Maps.

We have grouped the methods for three key engagement purposes:

1. **Scoping Activity** – Used to collect rich spatial and qualitative data around mobility issues from a small sample of participants, usually selected to represent vulnerable groups or from a specific location.

2. **Specific Group or Location Targeted Activity** – Surveys that engage with a larger sample of the population in a specific place (often where scoping activities have revealed problems or where a change in mobility infrastructure or services is proposed) OR surveys that ask participants to collect new spatial data in a particular place or around a specific theme.

3. **City Wide Activity** – Surveys that generate data covering the whole city extent to validate scoping or targeted activities with a wider sample of the population.

Figure 1 presents a flowchart helping to select which of these different methods is most appropriate for specific activities. However, it should be highlighted that methods can be scaled up or down if required. For example, Participatory Mapping could be replicated across a city to mosaic knowledge across a wider area or Google Timeline data could be collected from participants from a specific location.
Figure 1 Choosing the right method: A flowchart for activity selection and scalability
2. Participatory Mapping

Background

Participatory Geographic Information Systems (PGIS) approaches have been championed as useful methods to enable greater inclusion of typically excluded communities. This facilitates people-centred urban and regional planning, which generates results relevant to planners. The repeatability of PGIS surveys to generate longitudinal (to assess changes over time) or temporal information (to assess the use of a space at different times of day), and the use of spatial visualisation of the resulting data, have been highlighted as key benefits.

Recent developments in transport studies include the collection of volunteered geographic information using Global Positioning Systems (GPS) recordings of travel routes. Using digital spatial data collection has been linked to the concepts of smart cities, urban laboratories, or city observatories, which incorporate the use of Information and Communication Technologies (ICT) to help cities make better use of their resources and monitor environments.

Participatory mapping is a map-making process that attempts to understand the views of local community members using a spatial framework. This method can be an effective tool for promoting idea generation and helping participants represent their ideas and potential plans visually. Participatory mapping traditionally has utilised paper maps to record participants’ knowledge, usually in a focus group setting. Participants can either work on individual maps to record their specific journeys and issues or shared group maps to collect a community perspective on the mobility issue of concern.

To become a digital process, the paper participatory map needs to be transformed into a digital format (digitised). This digital data can then be further analysed or interrogated using GIS software to provide visualised or statistical outputs for effective communication and to inform decision-making.

Method

1. Recruitment: Participants for mapping activities should be purposefully recruited either based on their knowledge of a specific location (typically their home or workplaces); primary mode of transport; specific demographic aspect (such as vulnerable stakeholders including PWD, youth or women); or interest in the topic (for example, cycle campaigners, public transport operators).

2. Mapping: Mapping can be undertaken either as individual maps or in groups. Individual maps enable participants to record their specific knowledge and information without being influenced by the wider group. This also results in data that can be attributed back to specific types of participants, e.g., women, PWDs, or youth. Group work enables participants to discuss topics and reach consensus on what the issues are and where they occur. This can
be useful if you would like the collective view on a mobility topic of concern, such as where congestion is worst or where should transport infrastructure be located.

Maps of sufficient size (physical dimensions), scale (resolution of the base map) and content (type of base map e.g., Google Streets, Open Street Map etc.) need to be produced for the participatory mapping activity. For group work large maps (A1 or A0) are preferable so that they are large enough for everyone to see. For individual mapping, smaller sizes may be easier to work with (A3 or A2).

Whichever, physical size is produced the critical element is that the base map participants work with contains sufficient landmarks and details for them to orientate themselves (locate where they live, and their journey routes) and accurately mark any information they want to communicate. For mobility studies, this means that key road names, landmarks and transport infrastructure (such as bus stops or taxi ranks) would be most useful to enable participants to effectively use the maps. If necessary two maps at different scales can be used – typically a zoom in on a particular area of interest (e.g., home location, city centre, transport interchange) and a smaller scale (larger area extent) that enables people to mark the entire route of their journey for long commutes. Base maps should be clear enough for participants to see – but also transparent enough that the information they add to the maps are clearly visible for the facilitators.

Participants should be provided with pens and clear legend of the colours or symbols they should use to mark specific types of features. For example, red sticker for location of problem infrastructure or blue pen for journeys undertaken on foot. Any annotations describing the issue for particular places (points) or routes (lines) can be recorded by the facilitator or participants either as additional notes directly onto the map or as numbered notes that connect the locations to the additional information (for example, location 10 on the map links to note 10 about the quality of that place).

For group mapping, active facilitation is often helpful to ensure all participants contribute – rather than dominant personalities undertaking all the mapping. This can particularly be the case with mixed gender or age groups. For individual mapping, participants can often undertake the mapping tasks independently without additional facilitation. However, for those PWD or older people, having a facilitator help locate and mapping features can be helpful. This individual facilitation can also enable visually impaired participants to contribute their experiences and knowledge in the mapping process.

3. **Digitisation and analysis:** Post mapping activity, the data collected needs to be digitised for further analysis and visualisation. Comment data can be compiled in spreadsheets for linking to the mapped locations or analysed in qualitative research software to identify key themes or codes.
Paper maps should be photographed, and these images imported and geo-rectified in the GIS to enable their accurate on-screen digitising (alternatively if only point data has been recorded that is easily located in the GIS it may be possible to digitise this directly on screen without this geo-rectification step). Once the image is in the GIS it should be converted into a digital point and vector data for visualisation and further spatial and statistical analysis.

Maps can be processed to highlight hotspots of routes, key locations or problem points. The data can also be stratified by the type of participants or the modes used to highlight issues for specific types of people or travel types (e.g., issues for walking, public transport or cycling).

Table 1 Participatory Mapping: advantages and disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Purposeful sample ensures key participants with specific knowledge are recruited for mapping (resulting in targeted information)</td>
<td>● Time consuming to digitise large numbers of paper maps into GIS</td>
</tr>
<tr>
<td>● Visual method encourages more equitable participation (less confident speakers can also contribute their knowledge, including children and youth)</td>
<td>● Relies on local spatial knowledge – if people struggle with the mapping the locations may be inaccurate</td>
</tr>
<tr>
<td>● Detailed spatial information can be collected, including themes that can be difficult to collect through other methods (e.g., knowledge of poor-quality pavements, or perceptions of crime locations)</td>
<td>● Excludes visually impaired participants (unless facilitated to record their information)</td>
</tr>
<tr>
<td>● Enrolling participants to directly pinpoint their experiences (issues or enabling comfortable travels) in a certain location encourages engagement.</td>
<td>● Shared mapping can lead to group think where divergent views are not recorded</td>
</tr>
<tr>
<td></td>
<td>● Typically, useful for scoping issues and locations as expensive to undertake a large sample of people (for statistical analysis)</td>
</tr>
</tbody>
</table>
An example of Participatory Mapping’ case study in Medan, Indonesia

Figures 2 and 3 capture the interaction between the participants in the mapping activity showing how the process can be collaborative and involves people from different backgrounds and experiences. By ensuring equitable participation, the journey mapping process in Greater Medan can enable a more comprehensive understanding of the community’s needs and lead to the identification of more inclusive urban mobility planning options.

From the journey mapping activities, the spatial location can be digitised which enables to identify areas and factors that make participants’ daily mobility more comfortable or obstacles that undermine their journeys (see Figures 5 and 6).
3. Photovoice

Background

Photovoice is a visual research method that asks participants to record images (using cameras or mobile phones) to document their knowledge and perceptions of concern. Photovoice can enhance community engagement, increase awareness of community resources, and develop community’s independent abilities to assess issues of concern. Meenar and Mandarano (2021) suggest that photovoice, as a research method, provides a more comprehensive understanding of the impact of the built environment on the community compared to traditional methods such as community discussions and field observations. Photovoice has the potential to inform urban design, development, and regeneration, and enhance the experience of place and quality of life for both current and future residents. The photovoice method provided a process and platform for empowerment, allowing participants to express their personal meanings, share their experiences, and contribute to influencing change (Macdonald et al., 2022). However, Labbé et al. (2022) noted that interpreting research data could vary when more participants with diverse demographics are involved. To address this, employing both inductive (starting with the data and observations and building findings from there) and deductive (having a theory on key issues and seeing if the data supports the hypothesis) approaches to evaluate interpretation is necessary.

Method

Photovoice studies involve four key steps:

1. **Sensitisation**: Recruited participants are briefed on the purpose of the study and the topic for their images. This includes instructions on how to upload images or how photographs will be collected. This stage should also include informed consent to ensure ethical compliance.

2. **Data collection**: Participants record relevant images; often these can be constrained to a limited number of images to avoid participant fatigue, analysis overload and data repetition.

3. **Narrative reflections**: Participants are asked to provide reflection narratives that further explain the content of their images to enable accurate analysis and synthesis. This can either be done online with written comments for each image, individual semi-structured interviews, or group discussions. These personal reflections are crucial to avoid facilitators mis-interpreting the content of images.

4. **Analysis and synthesis of findings**: The full library of collected images is assessed for key themes related to the issue under investigation. This can be disaggregated by gender, age or other relevant groupings (e.g., primary mobility mode). However, understanding voices can also lead to varying interpretations given the objects captured may encompass different meanings. Therefore, it is important to look at what the participants meant by the image to enable researchers to develop an informed view of the meaning.
Box 1: Example Photovoice Data Collection Instruction

Please try to capture photos that identify your mobility experiences linked to:

**Problems**

*Barriers or challenges that make your journeys difficult (or perhaps impossible).*

*These could be due to:*
  - Quality of infrastructure
  - Systems or services that don’t work for you
  - Behaviour of other people
  - Safety concerns

**Solutions**

*Factors that make your journey possible or more pleasant.*

*These could be due to:*
  - Quality of infrastructure
  - Systems or services that help you
  - Behaviour of other people
  - Factors that make you feel safe

Spatial dimensions of the Photovoice images can be assessed in two ways: Firstly, smart phone images often record the location (as a latitude, longitude coordinate) that enables the place to be identified. Secondly, participants and expert facilitators can identify locations manually in post processing steps (Step 3 above) by recording them on a paper or digital map.

**Table 2 Photovoice method: advantages and disadvantages**

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Qualitative method best using for scoping key issues of concern to participants</td>
<td>• Method can exclude participants with visual difficulties or lower income groups (who may not have access to cameras or smart phones). Note: Visually impaired participants can undertake this method with help from a sighted facilitator</td>
</tr>
<tr>
<td>• Suitable for a range of participants (across ages, gender etc.)</td>
<td></td>
</tr>
<tr>
<td>Images are objective (their contents catalogue real world conditions)</td>
<td>Qualitative method that may not reach saturation on the issue (for example, all the locations with a specific problem may not be identified)</td>
</tr>
<tr>
<td>Images enable efficient knowledge exchange and focussed discussions</td>
<td>Spatially locating images manually can be time consuming and may lead to inaccuracies</td>
</tr>
<tr>
<td>Method popular with participants</td>
<td></td>
</tr>
<tr>
<td>Collected images and supporting narratives useful for communication key issues to decision makers.</td>
<td></td>
</tr>
<tr>
<td>Images can be taken anytime during daily mobility, but multiple objects captured in a picture may invite multiple interpretations without narratives.</td>
<td></td>
</tr>
<tr>
<td>Potential identification of spatial locations can be obtained when participants turn on their image location.</td>
<td></td>
</tr>
</tbody>
</table>
An example of Photovoice’s case study in Medan, Indonesia

The case study conducted in the city of Medan to identify barriers and opportunities to enhance active mobility by using photovoice with marginalised communities. The following photos show how the Photovoice approach can provide valuable insights by combining photographs, participants’ voices, and tagged locations, revealing unique perspectives on community issues and potential solutions. For instance, participants complained about inadequate bus stop infrastructure and inadequate installation of guiding blocks. Also, this method encouraged participants to raise their voices in urban mobility planning by visualising their mobility experiences.

Figure 6 Inadequate installation of guiding blocks

Figure 7 Inadequate public transport facilities identified by photovoice participants.

Box 1 Voices from People with Disabilities

“During the Photovoice, we have provided some photos. For instance, the installation of guiding blocks from our friends with visual disabilities that are far from meeting our expectations. This is because individuals with disabilities were not involved in the planning and installation process. As a result, the workers did not set up the guiding blocks properly, rendering them useless.”
4. **Online Spatial Survey Tools**

**Background**

Several platforms and apps allow participants to collect spatial data from the field and upload them directly to a GIS database using a GPS enabled smartphone or tablet PC. These locations of specific points and ask participants to record the attributes, features, or quality of that location (for example, dangerous road crossing or PWD accessible transport infrastructure). This can include uploading images supporting their assessment. The survey tools typically require a limited amount of training to be successfully utilised, so are often best deployed with specific community participants who undertake the survey. Alternatively, it may be possible to provide online training videos to support a wider cross section of the participants to supply spatial survey data.

Nowak et al. (2020) identified several environmental field surveys that offer various features and functionality. These include seamless and easy integration with desktop and/or web GIS software, the capability to gather diverse data geometries such as points, polylines, and polygons, and the ability to accommodate multiple attributes. The surveys are compatible with commonly used data formats like Esri shapefile, KML, CSV, and geoTIFF. Examples of these tools include [QField](https://qgis.org) using QGIS, [KoboToolbox](https://kobotoolbox.org) and [ArcGIS 123](https://www.esri.com/en-us/arcgis/products/arcgis-for-mobile.html) spatial surveys. These tools can all be tailored to enable data collection on specific topics or questions relevant to mobility planning.

**Method**

1. **Survey preparation:** Whichever tool is adopted, the specific survey with relevant questions needs to be set up in the software. This will enable participants to record their current location and assess mobility questions for that location or record additional information, such as adding photographic evidence.

2. **Recruitment:** Participants can be recruited through specific engagement with relevant communities, social media campaigns, or via existing mailing lists. Participants are required to download the relevant app for that tool and link to the specific survey.

3. **Analysis:** Data is collected digitally from the outset in formats suitable for visualisation and analysis in common GIS software (e.g., QGIS or ArcGIS).
Table 3 Online Spatial Survey Tools: advantages and disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Digital data gathered from the outset reducing post-data collection processing times and costs.</td>
<td>• Recruitment can be difficult without access to existing e-mailing lists. Incentives and promotion may be required to reach specific demographics or target groups.</td>
</tr>
<tr>
<td>• Can be deployed to smartphones and tablets.</td>
<td>• Digital exclusion for those without access to online devices. This may exclude low-income communities, youth, or older people.</td>
</tr>
<tr>
<td>• Online engagement allows a wide cross-section of participation – and enables people to take part when they can rather than attending a meeting or specific event.</td>
<td>• Requires significant time commitment from participants to visit specific locations in person – and training in how to utilise the app to record data. Again, this can exclude significant numbers of participants.</td>
</tr>
<tr>
<td>• All data is independent – participants cannot be influenced by other people’s responses.</td>
<td></td>
</tr>
<tr>
<td>• Point spatial data is typically collected – but precise locations are recorded, linked to relevant survey questions completed by the participant, and supplemented by additional supporting evidence.</td>
<td></td>
</tr>
</tbody>
</table>
A QField Example

QField is a professional mobile app for QGIS, allowing users to deploy existing projects to the field. Its accessibility can be demonstrated through its ability to operate both online and offline in the field, allowing for the addition of new geographic features through GPS or manual input. As illustrated in the following pictures, when collecting data in the field, information such as map stations, structures, photos, and samples can be recorded as point data and synchronised in QGIS. Meanwhile, polygons and lines can be created by sketching them using a stylus or by manually adding vertices. Below is an example from https://qfield.org/.

Figure 8 Illustration of conducting field work

Figure 9 QField form

Figure 10 Map result from QField
5. **On-street Rapid Appraisal Participatory GIS (RAP-GIS)**

**Background**

To overcome the issues of vulnerable participants finding attending focus group discussions difficult, an alternative mapping approach has been developed that engages people on-street at specific locations. Engaging people as they undertake their daily activities enables a wider cross section of the population to take part without specific recruitment. This method can be useful in mobility studies, as participants can discuss issues around the location where the engagement occurs. The in situ, on-street, and multi-temporal nature of the approach allows researchers to obtain a first-hand impression of the issues participants communicate via mapping and to encourage participation from a broader section of society and is more cost-effective and efficient to implement than other engagement methods (Cinderby, 2010).

**Method**

1. **Recruitment**: RAP-GIS is undertaken on-street (or in specific public venues such as shopping centres or transport interchanges) at specific locations of interest. These can be based upon problematic places or locations where improvements are planned. Participants passing the mapping activity are encouraged by facilitators to engage. They are briefed on the purpose of the activity and asked for informed consent (typically verbally) and their demographic details recorded alongside a unique participant ID number (usually as paper sheets – but could also be digitally recorded on tablet PCs or smartphone forms).

2. **Mapping**: Participants are asked to map their knowledge on specific topics. Mapping can either be undertaken on individual maps (if journeys or travel routes are required) or, more typically, a shared group map where specific point locations can be identified (as points). Shared group maps should be physically large enough (ideally A0 Poster sized) to be clear for participants enabling them to locate specific places to accurately share their knowledge and views. Point locations can be identified with stickers or flag markers along with qualitative descriptions of why that location was selected (for example, what is the problem or positive aspect related to mobility at that place or what improvement would people like to see happen there to improve their journey experience). If these points or flags are numbered and connected to participant IDs the spatial locations can be linked to specific demographic groups (e.g., women, children, PWDs etc.).

3. **Digitisation and analysis**: Post engagement the paper maps and participant details need to be digitised into a GIS and database format to enable visualisation and further analysis.
Table 4 RAP-GIS method: advantages and disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Accesses high number of participants who would not attend a meeting –</td>
<td>● Activity must be quite brief as participants are recruited on the street–</td>
</tr>
<tr>
<td>for low costs. This can include targeting specific groups such as</td>
<td>so can lack depth.</td>
</tr>
<tr>
<td>women travellers, youth or elderly depending on the engagement purpose.</td>
<td>● Requires trained facilitators and knowledge of GIS to undertake effectively.</td>
</tr>
<tr>
<td>● Speaks to many participants in a brief space of time enabling replication</td>
<td>● Participants can only come from those using the space – for example, on-street</td>
</tr>
<tr>
<td>of data.</td>
<td>activities do not enable passing motorised transport users to take part.</td>
</tr>
<tr>
<td>● Records the spatial dimension of the issue.</td>
<td>● No discussion between participants – all individual answers. This means that</td>
</tr>
<tr>
<td>● Can repeat the process at different times or places to widen participation</td>
<td>the approach does not build consensus.</td>
</tr>
<tr>
<td>or look at the temporal dimensions (differences between daytime and</td>
<td>● Resulting data needs to be digitised, adding time and costs for analysis.</td>
</tr>
<tr>
<td>evening, for example).</td>
<td></td>
</tr>
<tr>
<td>● Analyses in GIS can add value to the data and help visualise the</td>
<td></td>
</tr>
<tr>
<td>findings for effective communication to decision makers, etc.</td>
<td></td>
</tr>
</tbody>
</table>
An example of RAP-GIS case study from York, UK

An on-street intercept survey was used to identify preferences for urban regeneration around key streets and public realm spaces (squares) in the city. Participants used flags to record the location and nature of the issue they were addressing in different themes (things to keep, things to change, barriers to mobility, and general views on the quality of spaces). These flags were coded to identify the participant to explore differences in views based upon demographics.

The themes of comments included provision and quality of parking provision for bicycles. The quality of spaces could also be visualised in the GIS identifying hotspots for potential improvement, but also capturing potential conflict locations where there were mixed views. Ideally, more work would be required to reach consensus on how to improve or maintain these locations with additional engagement activities.
Figure 12 Visualising Bike Parking Provision and Quality of Public Spaces: GIS Analysis

Source: (Cinderby, 2010).
6. **Online Participatory Mapping (Spatial questionnaires)**

**Background**

Online approaches to collecting spatial surveys can widen engagement and to collect all data digitally from the outset, reducing post-processing costs. One example of an online spatial questionnaire platform is Maptionnaire. A free alternative that provides similar functionality is the ATO survey tool. These platforms enable users to create, share, and analyse map-based questionnaires, giving planners the ability to develop their own Public Participation Geographic Information System (PPGIS) (Kahila-Tani, Kytta and Geertman, 2019).

The key steps for using these digital survey tools are similar to other online questionnaire systems but allow the inclusion of questions and answers linked to a map and specific place. The steps include creating an online spatially based questionnaire, recruitment of residents, interpretation of results, and incorporation of data into plans and designs. Compared to standard survey and focus groups, the Maptionnaire and ATO survey-links are sent to participants through emails. This eliminates the need for direct contact with respondents. Also, because data is stored and coded automatically in online depositories, management of large data sets is relatively simple.

The platforms enable participants to submit data as geographical-based features, making it possible to crowdsource mapping for different purposes. For example, respondents could be asked to draw the outline area of a neighbourhood they perceive as congested with traffic and then evaluate how they perceive this affects their quality of life or journey experiences. The platform also allows mapping lines (routes) and points in the city, which are relevant for transport-specific analysis such as accessibility and walkability. The results from the surveys can be visualised within the online tool directly or exported to GIS or databases for further coding and analysis.

**Method**

1. **Survey preparation:** Tools enable specific questions to be asked. These can include questions with a spatial component – so participants can be asked a where question alongside other types of survey questions, including rankings, lickert scales, text responses, etc.

2. **Recruitment:** Online surveys are distributed via email or can be promoted on a website. Email distribution requires a database of participants to be compiled or utilized. The survey should include an informed consent process and data protection information to ensure ethical compliance.

3. **Analysis:** The software enables initial rapid visualisation of data, including hot spot mapping and graphing of quantitative findings. However, additional processing in GIS, qualitative research software or statistical packages is usually required to generate final synthesised outputs.
### Table 5 Online Participatory Mapping: advantages and disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Digital data gathered from the outset reducing post-data collection processing times and costs.</td>
<td>• Recruitment can be difficult without access to existing e-mailing lists. Incentives and promotion may be required to reach specific demographics or target groups.</td>
</tr>
<tr>
<td>• Can be deployed to smartphones, tablets and computers.</td>
<td>• Digital exclusion for those without access to online devices. This may exclude low-income communities, youth, or older people.</td>
</tr>
<tr>
<td>• Online engagement allows a wide cross-section of participation – and enables people to take part when they can rather than attending a meeting or specific event.</td>
<td>• Software works best on a computer or tablet PC, limiting the quality of responses from smartphones.</td>
</tr>
<tr>
<td>• All data is independent – participants cannot be influenced by other people’s responses.</td>
<td>• Some functions require manual dexterity (for example, accurately drawing lines) making them difficult for the elderly or people with specific types of disability.</td>
</tr>
<tr>
<td>• Complex spatial data can be collected, including areas, lines, or points.</td>
<td>• License required to use the software, this can limit the availability of this platform where funds are not available.</td>
</tr>
</tbody>
</table>
The Maptionnaire Study in the Medan Metropolitan Area

A comprehensive Maptionnaire survey was conducted in the Medan Metropolitan Area, with participants marking their travel origins, destinations, and preferred routes as will be illustrated in the subsequent figure. The survey aimed to gather detailed insights into the daily commuting patterns, transportation difficulties, and infrastructure improvement needs of residents in the Medan Metropolitan Area. The survey was carried out over a period of two months from mid-June 2023 to mid-August 2023, capturing a wide range of demographic data, including information from women and marginalised communities. Participants were asked a series of questions about their transportation habits and were invited to mark their daily commutes and points of interest on a map within the Maptionnaire tool. The survey was circulated primarily online, at public fairs, and on buses connecting Medan with Binjai and Deli Serdang hubs.

A diverse cross-section of the population participated, including individuals of various ages, genders, and occupations. We incorporated marginalised groups by also identifying the extent of their difficulties in various aspects from hearing, remembering, seeing, walking, physical activities, and communication.
We gathered data from 521 online participants and 55 on-street participants, who shared their daily mobility patterns, commuting challenges, and suggested various improvements to promote the use of public transport, walking, and cycling.

**Demographics:**

Within the survey, we also ensured that the data are covering a wide range of communities to understand their diverse needs. The survey's coverage demonstrates that this type of map-based survey is publicly accessible, although some groups may face barriers to participation. The gender and social inclusion aspects were ensured through the way questions were structured, such as in asking the respondents' difficulties.

Moreover, the following figure illustrates the diverse group coverage ensured in the survey participation.

*Figure 14 Example in formulating questions associated with participant’s difficulties*
The chart displays the participation of marginalised groups in both Online Maptionnaire Surveys and On-street/Bus Surveys - Maptionnaire. It shows that the youth (under 19) and individuals on social benefits have the highest participation rates online alongside with the participation of pre-elderly individuals (aged 45-59). Moreover, the participation of Persons with Disabilities (PWD) is notably lower in on-street/bus surveys. The elderly (60 and above) have the least representation in both survey types, with slightly higher participation noted online.

The Maptionnaire survey attracted participation from both males and females, as shown in the subsequent figure.
The bar chart indicates that participation was relatively balanced between male and female respondents in the On-street/Bus Survey - Maptionnaire, whereas females were more prevalent in the Online Maptionnaire Survey, with a small number of participants opting not to disclose their gender.

**Travel Purpose, Frequency and Preference**

The survey explored the reasons for regular commutes, such as work, education, or personal errands, and how often these trips were made by various modes of transport. Participants also identified their main mode of transportation, ranging from bicycles to private cars and public transport options.

![Figure 17 Purpose of travel](image)

![Figure 18 Mode of transport and regularity](image)

The figure depicts the travel purposes of Maptionnaire respondents in the Medan Metropolitan Area, with 'Working' being the most common reason, followed by 'Education/school', and 'Taking the child', with 'Business' and 'Others' being the least cited reasons. The Maptionnaire survey conducted in the Medan Metropolitan Area also gathered data on the various modes of transport that respondents use for their regular mobility. The figure presents data on the frequency at which various modes of transportation are used. Personal motorcycles are the most commonly used mode of transport on a daily basis, followed by walking or wheeling, and bicycles. Trans Mebidang/Trans Metro Deli, pedicabs/rickshaw motors, trains, and taxis are the least used on a daily basis, with the majority of respondents never using the Trans Mebidang/Trans Metro Deli. Walking or wheeling shows a high daily usage, indicating a possible preference or need for short-distance travel. The data suggest a diversity in transport preferences, with personal vehicles predominantly used for daily travel, and public and non-motorized modes used less frequently.
Map-Based Feedback:

The Maptionnaire tool invited residents to mark their daily commutes, highlighting their travel origins, destinations, and favourite places. They also indicated areas where they desired improvements, including public bus services, cycling, and walking environments. The following figures demonstrate examples of the data that can be obtained.

![Figure 19 Map of the Spatial Mobility Survey Results](image)

The heat map, overlaid on a city map, displays the Maptionnaire survey results for transportation, with different coloured dots representing points of interest such as journey origins, destinations, and proposed areas for bus and cycling infrastructure improvements within the planned BRT corridor.
The above map provided a wealth of geolocated data on the current state of transport infrastructure and residents' preferences for improvements. The collected data could guide urban planners and decision-makers in enhancing the Medan Metropolitan Area's transportation network, ensuring that interventions are prioritised based on the community's needs.

The comprehensive Maptionnaire survey in the Medan Metropolitan Area has provided significant insights into the local population's transportation patterns, challenges, and needs. By deploying a digital approach for data collection, the survey benefited from reduced processing times and costs, thanks to the immediate gathering of digital data. The survey's compatibility with various devices, such as smartphones, tablets, and computers, enhanced its reach, allowing a wide spectrum of participants to engage conveniently online. This approach also ensured the independence of data, as participants' responses were not influenced by others.

While the digital format offers numerous advantages, it also presents certain drawbacks. The recruitment of participants was challenging without access to pre-existing email lists, necessitating incentives and promotions to reach specific demographics. Digital exclusion was a significant concern, especially for individuals without access to online devices, potentially side-lining low-income communities, and the elderly or those with sight difficulties. The software's optimal performance on computers and tablets limited the quality of responses from smartphones, and certain functions required manual dexterity, which posed difficulties for the elderly or those with certain disabilities. Furthermore, the need for a software license could limit the platform's availability in financially constrained settings.
Despite these challenges, the survey successfully engaged 521 online participants and 55 on-street participants, encompassing a wide demographic range, including women and marginalised communities. Participants provided valuable data on their daily mobility, the challenges faced in their commutes, and suggestions for improvements. These insights spanned various aspects of public transportation, walking, and cycling.

The survey’s map-based feedback was particularly enlightening, allowing residents to mark their daily commutes and highlight areas in need of improvement. This has provided a rich source of geolocated data, which is crucial for urban planners and decision-makers. With this data, they can make informed decisions to enhance the transportation network in the Medan Metropolitan Area, ensuring that interventions align closely with the community’s needs and preferences.

In summary, while the Maptionnaire survey faced certain limitations due to its digital nature, it successfully gathered valuable, in-depth insights into the transportation dynamics of the Medan Metropolitan Area. This information will be instrumental in guiding future urban planning and development efforts, aiming to create a more accessible, efficient, and inclusive transportation system for all residents.

ATO survey

This Automatic Travel Optimization (ATO) survey https://ato.cetler.se/ introduces a survey tool designed to collect data through both traditional and advanced methods, including randomisation of questions and integration of geographic features. Originally developed as an in-house project, it has since been expanded by researchers to offer a user-friendly interface for conducting online surveys suitable for both students and researchers. The manual serves as a step-by-step guide to utilising the various features of this application.
The figure shows a user interface for configuring and creating a new survey. The layout of the user interface suggests a structured approach to survey creation, offering multiple options for customization and respondent engagement while ensuring data collection can be managed effectively and ethically with options like anonymous submission.

The survey setting form can be illustrated in the following figure:
The process as outlined in the ATO survey flowchart indicates a comprehensive and methodical approach to collecting data. The survey design considers both qualitative and quantitative data collection methods, as well as the importance of spatial data through geolocation, which is particularly relevant for transportation studies. The inclusion of features like randomised answer choices helps to ensure the validity and reliability of the data collected by minimising potential biases. Overall, the ATO survey tool depicted seems to be a robust system for conducting detailed and structured surveys, particularly valuable in urban planning and mobility studies.

A case study on the use of an ATO tool for conducting a mobility survey. The ATO tool is being utilised in a collaborative project between Sweden and Norway to enhance sustainable mobility in the Sälen, Idre, Trysil, and Engerdal (SITE) regions. Further details of the case study project are available at https://sitedestination.eu/. By using the ATO tool, the primary goal is to examine and understand the travel behaviours of locals, second-home owners, and visitors within these destinations for both work and leisure purposes. The project identifies current travel patterns and pinpoints areas requiring transportation improvements, thereby informing and guiding future transport planning strategies.
7. **Google Timeline**

**Background**

Google Timeline, a web-based mapping tool, stands out for its ability to collect and analyse geospatial data, tracking the daily movement of people. This feature makes it a valuable asset in urban research, particularly as an alternative source for calculating emissions by monitoring shifts in travel patterns and behaviours. However, the use of Google Timeline and Location History raises significant privacy concerns, as it involves storing location data of Google account users, which could be misused if not handled securely and responsibly. Ensuring the data’s security and compliance with privacy laws is paramount, as well as using it solely for its intended purpose and making users aware of its potential applications. Several studies, including Lindquist and Galpern (2016); Galpern et al. (2018), utilised volunteered mobile phone GPS location and Google Timeline to identify walkability features and analyse participants’ movement behaviours. In Lindquist and Galpern's (2016) study, for example, the google timeline data enable to assess active travel locations and vehicular travel locations, also defining a speed of the movement.

The mobile phone data was used to determine the frequency of mobility engagement among the study participants. The challenges in data acquisition include public unawareness of the data’s potential uses and privacy implications. Overcoming these requires clear communication about the benefits of the data and stringent measures to protect user privacy. Ensuring data security and compliance is critical, along with providing transparent information to users on how their data will be utilised, to encourage voluntary sharing.

**Method**

1. **Recruitment**: An online survey distributed via identified and relevant channels can be used to enable people to volunteer as participants. The participants will also need to confirm they agree to share their data with an informed consent process and a General Data Protection Regulation (GDPR) statement. This can allow them to link to a shared drive space where they can voluntarily upload their historical data from their personal Google timeline. To enhance the analysis and enable assessments of inclusion impacts participants should also be asked a selection of demographic questions such as gender, age and disability affecting mobility to identify specific journey patterns.

2. **Data collection**: To understand travel patterns across a district or city, participants are asked to share their digital travel histories already recorded in their Google Timelines. In doing so, respondents are asked to activate their Google History tracking on their smartphone and submit their data through an online form.

3. **Analysis and synthesis**: Analysis is divided into descriptive statistical analysis and modelling using the spatial Keyhole Markup Language (KML) file from respondents’ journey. It is essential to identify attributes like age, gender, ethnicity, socio-economic status, or other
intended demographic elements of the population before using a clustering algorithm, such as k-means or hierarchical clustering, to create clusters of types of people based on these characteristics. The journey data can be analysed by modes to identify hotspots of routes. These can also be stratified by the types of user to identify gendered differences in journey patterns, modes or routes.

a. Spatial Distribution of Responses

To conduct a cluster analysis for sample distribution across the regencies of Medan, Binjai, Deli Serdang, and Karo, considering urban density proportions, it's crucial to first identify the population characteristics in these areas. These characteristics include age, gender, ethnicity, socio-economic status, and immigration status. After identifying these traits, a clustering algorithm, such as k-means or hierarchical clustering, is used to group the population into clusters based on these characteristics. Subsequently, a representative number of samples is selected from each cluster, ensuring they reflect the population distribution and urban density of the area.

b. Impact of Dissemination Strategy

In analysing the impact of Google Timeline’s journey mapping dissemination strategy, the time lag associated with various channels is a key factor. For instance, radio spots may have a longer time lag compared to a Zoom teleconference, while social media networks might have shorter lags than websites. It's essential to measure the dissemination strategy's effectiveness by evaluating its reach and impact. This involves quantifying the number of people reached, those who acted following the dissemination, and their engagement level with the journey mapping platform. Additionally, assessing the journey mapping platform's impact on the project's objectives is crucial to determine its overall effectiveness.
Digital Mapping Toolkit: Co-designed activities with marginalised groups to promote active and inclusive mobility

### Table 6 Google Timeline: advantages and disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Data recorded digitally from the outset – and coded with transport mode ensuring objective data on journey routes and modes</td>
<td>• Recruiting significant numbers of participants can be difficult to achieve without incentives</td>
</tr>
<tr>
<td>• Specific dates for recorded journeys can be requested to compare weekday vs. weekend journeys or look at the effect of specific events (e.g., heavy rainfall events that led to surface water flooding of specific routes or the impact of infrastructure changes)</td>
<td>• Uploading timeline data can be difficult for participants, leading to challenges in the data analysis (this drawback can be assisted with step-by-step video and written guidance – but not removed)</td>
</tr>
<tr>
<td>• Significant quantities of data can be collected, enabling statistical analysis of modal split assessments (by demographics), route popularity, hotspot mapping, etc.</td>
<td>• Digital exclusion can mean some marginalised groups (who do not use a smart phone) are not reliably included in the resulting dataset.</td>
</tr>
<tr>
<td>• Missing travel logs can be edited in the location history record.</td>
<td>• Sharing the trace of individual mobility patterns demands participants' trust.</td>
</tr>
<tr>
<td></td>
<td>• Processing large amounts of data ideally requires programming skills to make most efficient use of the timeline histories.</td>
</tr>
</tbody>
</table>
Case study of Google Timeline in Greater Medan

To offer initial understanding about the Google timeline, a pilot project was conducted as a form of travel survey in Greater Medan, Indonesia. This survey aimed to evaluate the feasibility of using Google Timeline for journey mapping in urban contexts. It assessed the tool's potential in collecting and analysing geospatial data for urban design projects, including its accuracy and effectiveness in journey mapping. The project aimed to understand the potential benefits and risks associated with Google Timeline’s use in urban planning and decision-making. The project's focus was on gathering data on current travel behaviour and attitudes towards different transportation modes. This can be used to assist in identifying strategies to reduce carbon emissions from urban mobility, such as enhancing public transport usage, promoting active travel, and encouraging electric vehicle adoption. However, the method presents limitations in reaching vulnerable groups like the elderly, children, and people with disabilities. Therefore, complementing the online survey with direct community engagement and assistance in data collection is essential to ensure inclusive planning outcomes.

From an initial pilot survey the following results were obtained. During the initial period, the online survey received 49 responses. Despite clear guidelines on data requirements and upload instructions, not all respondents submitted the correct file type. The breakdown of the collected files is as follows:

Table 7 Recap of Data Received: The example from the initial pilot survey.

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total respondents</td>
<td>49</td>
</tr>
<tr>
<td>Empty uploads</td>
<td>5</td>
</tr>
<tr>
<td>Non-KML file uploads</td>
<td>9</td>
</tr>
<tr>
<td>KML file uploads (less than 7 days)</td>
<td>3</td>
</tr>
<tr>
<td>Complete KML file uploads (7 days)</td>
<td>32</td>
</tr>
</tbody>
</table>

Table 8 Recap of KML file uploads

<table>
<thead>
<tr>
<th>Description</th>
<th>Count (49 Respondents)</th>
<th>Count (420 Respondents)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total KML files</td>
<td>227</td>
<td>2,940</td>
</tr>
<tr>
<td>Number of lines</td>
<td>9,421</td>
<td>9,918</td>
</tr>
<tr>
<td>Number of nodes</td>
<td>649</td>
<td>16,573</td>
</tr>
</tbody>
</table>
To overcome these difficulties additional guidance was produced for participants and facilitators were employed to assist people in their data uploads. This significantly improved on the volume and quality of the data uploads ensuring sufficient data was obtained for analysis. Respondents for the survey were regular commuters in the area, travelling between districts or cities for work or school. They had to possess a mobile device with Google Maps and an active Google email account to track their daily journeys. Participants had the option to download and upload KML files either independently or with surveyor assistance.

The example survey involved two forms:

- Form 1 gathered respondent profiles (gender, age, disability status, occupation, education, travel purpose, and transportation mode) and views on transportation services, particularly Bus Rapid Transit (BRT). It also outlined journey recording and data download procedures.
- Form 2 was used for travel data upload, requiring the same email address for consistency.

The main Google Timeline survey, carried out from 1st August to 30th October 2023, gathered responses from 420 individuals in the Greater area. The demographic breakdown of the respondents includes various categories such as gender, age, disability status, occupation, and education level. Notably, 46.2% of the participants were women, and 3.6% identified as having a disability. The majority of respondents (87.1%) were between the ages of 20 and 44. Detailed distributions of these categories are presented in Tables 9 and Figure 24.

Table 9 Respondents profile (n=420)

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Women</td>
<td>46.20%</td>
</tr>
<tr>
<td></td>
<td>Men</td>
<td>53.80%</td>
</tr>
<tr>
<td>Age</td>
<td>20-44 years</td>
<td>87.10%</td>
</tr>
<tr>
<td></td>
<td>45-59 years</td>
<td>7.40%</td>
</tr>
<tr>
<td></td>
<td>Under 19 years</td>
<td>5.20%</td>
</tr>
<tr>
<td></td>
<td>Over 60 years</td>
<td>0.20%</td>
</tr>
<tr>
<td>Disability</td>
<td>No disability</td>
<td>96.00%</td>
</tr>
<tr>
<td></td>
<td>With disability</td>
<td>3.60%</td>
</tr>
<tr>
<td>Occupation</td>
<td>Students</td>
<td>24.30%</td>
</tr>
<tr>
<td></td>
<td>Entrepreneurs</td>
<td>20.20%</td>
</tr>
<tr>
<td></td>
<td>Freelancers / Self Employed</td>
<td>17.90%</td>
</tr>
<tr>
<td></td>
<td>Employees</td>
<td>17.10%</td>
</tr>
<tr>
<td>Last Education</td>
<td>Graduates</td>
<td>50.50%</td>
</tr>
<tr>
<td></td>
<td>Bachelor Graduates</td>
<td>36.70%</td>
</tr>
<tr>
<td></td>
<td>Diploma Graduates</td>
<td>7.60%</td>
</tr>
</tbody>
</table>
The collected KML journey maps in Greater Medan provide a geographic overview for analysing urban mobility options like public transportation, cycling and walking routes, electric vehicle charging stations, and car-sharing locations. This data can be used to assess the environmental impact of urban mobility options, including carbon emissions, noise pollution, and air quality. Additionally, it offers insights into the economic implications of urban mobility and identifies areas requiring further investment or development.

**Trip Analysis**

Trip analysis plays a crucial role in transportation planning and forecasting. This process involves examining and forecasting the number of trips originating from or destined for specific areas. Notably, trip analysis offers valuable insights into travel patterns, aids in transportation planning, and supports decision-making processes.

**Table 10 Trips Based on Trip Purpose (n=420)**

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Number of Trips Per Day</th>
<th>Avg. Trips Per Day Per Person</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work</td>
<td>1016 (All Day)</td>
<td>4.26</td>
<td>Majority of trips are for work purposes.</td>
</tr>
<tr>
<td>Business</td>
<td>59 (All Day)</td>
<td>5.01</td>
<td>Business trips show higher per person rate on weekends.</td>
</tr>
<tr>
<td>Education</td>
<td>267 (All Day)</td>
<td>3.28</td>
<td>Education trips peak on weekdays.</td>
</tr>
<tr>
<td>Shopping</td>
<td>28 (All Day)</td>
<td>2.68</td>
<td>Slight increase in shopping trips during weekends.</td>
</tr>
<tr>
<td>Holiday/Social Activity</td>
<td>41 (All Day)</td>
<td>4</td>
<td>Social activities peak during weekends.</td>
</tr>
<tr>
<td>Others</td>
<td>5 (All Day)</td>
<td>2.64</td>
<td>Least common purpose.</td>
</tr>
<tr>
<td>Total</td>
<td>1416 (All Day)</td>
<td>3.64</td>
<td>Work and education are the primary trip purposes.</td>
</tr>
</tbody>
</table>
The data indicates that the majority of trips per day, totalling 1,416, are for work purposes, with an average of 4.26 trips per person. This is followed by education-related trips, which are more frequent on weekdays, with an average of 3.28 trips per person. Business trips, though fewer in number at 59 per day, show a higher per person rate on weekends. Shopping trips and holiday or social activities show a slight increase during weekends, highlighting a shift in purpose outside of the workweek. The least common trip purpose falls under the 'Others' category.

In terms of travel modes (Table 11), motorcycling is the most common, especially on weekdays, with 1,023 trips per day. Driving follows closely, more prevalent on weekends, with 364 daily trips. Other modes like bus, train, cycling, and walking have significantly lower usage, with cycling and walking showing more consistent use throughout the week. Overall, motorcycling and driving are the predominant modes of transport.

### Table 11 Trips Based on Trip Mode (n=420)

<table>
<thead>
<tr>
<th>Trip Mode</th>
<th>Number of Trips Per Day</th>
<th>Avg. Trips Per Day Per Person</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving</td>
<td>364 (All Day)</td>
<td>2.71</td>
<td>Driving is more prevalent on weekends.</td>
</tr>
<tr>
<td>Motorcycling</td>
<td>1023 (All Day)</td>
<td>3.37</td>
<td>Most common mode, especially on weekdays.</td>
</tr>
<tr>
<td>On a bus</td>
<td>10 (All Day)</td>
<td>1.3</td>
<td>Least popular mode.</td>
</tr>
<tr>
<td>On a train</td>
<td>1 (All Day)</td>
<td>1.11</td>
<td>Extremely low usage.</td>
</tr>
<tr>
<td>Cycling</td>
<td>6 (All Day)</td>
<td>1.41</td>
<td>Slightly more popular on weekends.</td>
</tr>
<tr>
<td>Walking</td>
<td>11 (All Day)</td>
<td>1.18</td>
<td>Stable usage throughout the week.</td>
</tr>
<tr>
<td>Total</td>
<td>1416 (All Day)</td>
<td>1.85</td>
<td>Motorcycling and driving are the predominant modes.</td>
</tr>
</tbody>
</table>

Analysis of trip distances (Table 12) reveals those short distances, specifically 0 km to 2.5km, account for the majority of trips, with 441 daily trips and an average of 2.07 trips per person. Medium distances (10km to 20km) and the 2.5km to 5km range show moderate frequencies. Longer distances over 20km are the least frequent. This pattern suggests that most travel occurs within shorter, more manageable distances.

### Table 12 Trips Based on Trip Distance (n=420)

<table>
<thead>
<tr>
<th>Trip Distance</th>
<th>Number of Trips Per Day</th>
<th>Avg. Trips Per Day Per Person</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0km - 2.5km</td>
<td>441 (All Day)</td>
<td>2.07</td>
<td>Most trips are short distances.</td>
</tr>
<tr>
<td>10km - 20km</td>
<td>219 (All Day)</td>
<td>1.62</td>
<td>Moderate frequency for medium distances.</td>
</tr>
<tr>
<td>2.5km - 5km</td>
<td>304 (All Day)</td>
<td>1.73</td>
<td>Second most common distance range.</td>
</tr>
<tr>
<td>5km - 10km</td>
<td>297 (All Day)</td>
<td>1.76</td>
<td>Similar frequency to 2.5km - 5km range.</td>
</tr>
<tr>
<td>&gt; 20km</td>
<td>155 (All Day)</td>
<td>1.61</td>
<td>Least frequent for long distances.</td>
</tr>
<tr>
<td>Total</td>
<td>1416 (All Day)</td>
<td>1.76</td>
<td>Short distances (0km - 5km) are predominant.</td>
</tr>
</tbody>
</table>
In summary, work and education emerge as the primary reasons for travel, with motorcycling and driving being the most used modes. Short distance travel dominates, reflecting a tendency for people to engage in localised activities. This data provides valuable insights into the commuting habits and preferences of the population, which can inform urban planning and transportation policy decisions.

**Presenting the data into the heatmap**

Further analysis of the collected KML journey maps in Mebidang (comprising Medan, Binjai, and Deli Serdang) could identify suitable areas for road safety, inclusion or emission reduction interventions (Figure 25). Direct extraction of data from Google Timeline captures various modes of transportation, including public transportation, driving, motorcycling, cycling, and walking.

**Figure 25 Heatmap of Mode Mobility**

**Relationship Between Google Timeline and Respondent’s Data**

In addition to direct data extraction from Google Timeline, some attributes can be compared with information from respondents. For instance, the modal choice stated in the Google Form questionnaire might differ from the actual mode used during daily travel.

The data indicates that respondents who stated the use of a private vehicle are more consistent with their actual daily modal choice than those who claimed walking as their main mode of mobility (Figure 26). In comparing the claimed mode of walking and actual mobility mode from Google Timeline, it appears that people who state walking often choose driving or motorcycling instead.
In addition to respondent profile attributes and Google Timeline data, community opinions have been gathered through a questionnaire. Issues and aspirations identified by the community are represented in a word cloud, where the size of each word reflects its prominence in the community feedback. For instance, in response to the question "What BRT Trans Mebidang services do you need that you haven't received yet?", the majority of participants highlighted 'shelter', 'priority', 'payment', and 'facility'. These terms are emphasised in the word cloud, suggesting they are key considerations for decision-makers to address (Figure 27).
**Discussion: Google Timeline**

Google Timeline emerges as an alternative and advanced platform for journey mapping, offering significant improvements over traditional methods. With the capability to visualise travel history across various locations and times, it provides a comprehensive view of individual travel patterns. The platform’s additional features, such as route suggestions, estimated travel times, and personalised recommendations, enhance the journey mapping experience. Furthermore, Google Timeline’s continuous learning and improvement ensure it delivers accurate and up-to-date data insights. Therefore, it is highly recommended for use in journey mapping for its enhanced capabilities.

In terms of dissemination strategies, social media networks are generally more effective than radio spots. This is due to their greater reach and the interactive engagement they facilitate between the audience and the campaign. Virtual dissemination sessions created through social media allow for more in-depth audience engagement, compared to the limited interaction achievable through radio spots, which are often only trackable through website hits. Consequently, social media networks are recommended for effective campaign dissemination.

Further work using a data science approach is advised to explore the findings. Building upon the current results of KML extraction with PowerBI, a dashboard could be developed to aid in data exploration and decision-making. This dashboard should feature interactive maps, data visualisations, and filters, as well as predictive analytics and machine learning algorithms. These tools will enable the identification of patterns and trends in the data, assisting in making informed decisions about low-carbon mobility and urban planning.

In conclusion, while Google Timeline offers numerous advantages for journey mapping, it is crucial to maintain ethical data practices, including voluntary data sharing with proper consent and robust data management. Raising public awareness about the benefits of participating in such initiatives can be a compelling motivator, often surpassing the need for incentives. Moreover, special attention should be given to engage vulnerable groups, such as the elderly, children, and people with disabilities, who may have limited access to or familiarity with smartphone technology. A balanced approach combining digital tools with traditional outreach methods is key for successful data collection and analysis in urban planning projects.
8. Conclusion

The digital mapping toolkit presents a comprehensive suite of methodologies designed to actively engage community members, including those from marginalised groups, in urban mobility planning. It is a resource for community groups, NGOs, and urban planners to collect a diverse range of qualitative and spatial data through adaptable methods such as participatory mapping, photovoice, RAP-GIS, online participatory mapping, and Google Timeline. These tools serve not only to involve individuals in data collection activities—whether online or in-person—but also to ensure their voices are central in shaping inclusive transport policies and urban development strategies.

Each method within the toolkit caters to specific engagement objectives, whether targeting a particular demographic within a city or spanning a broader population cross-section. For instance, participatory mapping is valuable for capturing detailed spatial information but necessitates consideration of the time required for digitisation and the participants' spatial knowledge. Conversely, photovoice excels in exploring key issues through personal narratives, though it may not be as accessible to those with visual impairments or without the technology.

While the toolkit is adaptable and can evolve with changing contexts and technological advances, it also highlights the importance of inclusivity and accessibility. It is crucial to weigh the advantages and disadvantages of each method to maximise participation. For example, RAP-GIS allows for the rapid collection of spatial data on the street but may lack depth without further engagement. Google Timeline offers extensive data analysis capabilities but requires careful consideration of privacy and data management practices.

In practice, the toolkit has demonstrated success in various case studies, such as in Greater Medan, Indonesia, where it has been instrumental in gathering insights into the transportation dynamics and contributing to future urban planning efforts. This underscores the toolkit’s role in fostering active mobility and contributing to the decarbonisation of public transportation by enabling vulnerable populations to contribute actively.

Ultimately, the toolkit champions a participatory approach in urban planning, advocating for a balanced blend of digital innovation and traditional methods to ensure all community members, regardless of their background or abilities, can contribute to creating more equitable, efficient, and sustainable mobility solutions. It represents a significant advance in participatory urban planning, offering an inclusive, adaptable approach to meet the complex mobility needs of diverse populations, thereby facilitating the development of digitally integrated, cleaner, and more inclusive cities.
9. Reference:


Front cover photo: Angelina Naibaho.
UK Partnering for Accelerated Climate Transitions (UK PACT) is a programme funded by the UK Government. UK PACT supports countries that strive to overcome barriers to clean growth and have high emissions reduction potential to accelerate their climate change mitigation efforts.

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