Walking and Cycling Tracking for Planning

Information and guidelines on using tracking data for mobility planning

(Deliverable 3.1)

Date: 30/03/2016 (pre-final version)

Author(s): João Bernardino (TIS), Mafalda Lopes (TIS), Giacomo Lozzi (Polis), Daniela Stoycheva (Polis), Predrag Živanović (FTTE), Stanko Bajčetić (FTTE)
<table>
<thead>
<tr>
<th>Deliverable No.</th>
<th>3.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workpackage No.</td>
<td>3</td>
</tr>
<tr>
<td>Workpackage Title</td>
<td>Tracking for planning: research towards tracking data analysis and planning</td>
</tr>
<tr>
<td>Task No.</td>
<td></td>
</tr>
<tr>
<td>Task Title</td>
<td>Guidelines on using tracking data for planning</td>
</tr>
</tbody>
</table>

**Date of preparation of this version:**

**Authors:** João Bernardino (TIS), Mafalda Lopes (TIS), Giacomo Lozzi (Polis), Daniela Stoycheva (Polis), Predrag Živanović (FTTE), Stanko Bajčetić (FTTE)

**Status (F: final; D: draft; RD: revised draft):** RD

**File Name:**

**Version:** 1

**Task start date and duration**

Start: June 2015 | Duration: 9 months

**Revision History**

<table>
<thead>
<tr>
<th>Version No.</th>
<th>Date</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>14/03/2016</td>
<td>1st draft version</td>
</tr>
<tr>
<td>1.1</td>
<td>30/03/2016</td>
<td>Pre-final version</td>
</tr>
</tbody>
</table>

**Reviewers List**

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patrick Van Egmond</td>
<td>Lux Mobility</td>
<td>30/03/2016</td>
</tr>
</tbody>
</table>
## TABLE OF CONTENT

ABOUT THE TRACE PROJECT ..................................................................................................................5

WHAT IS THIS DOCUMENT ABOUT? ....................................................................................................6

1. CURRENT PLANNING PRACTICES AND USE OF INFORMATION .......................................................7
   1.1 Review of planning and policy processes .....................................................................................7
   1.2 Current planning practices in surveyed sites ..............................................................................12
   1.3 Information and modelling processes .......................................................................................15
      1.3.1 Survey methods for monitoring travel behaviour .................................................................15
      1.3.2 Data collection technologies ...............................................................................................16
      1.3.3 Planning Support Systems (PSS) in mobility planning .........................................................18

2. POTENTIAL OF TRACKING FOR PLANNING AND POLICY ...........................................................20
   2.1 Recent experiences ....................................................................................................................20
      2.1.1 on the use of tracking data in other transport modes ...........................................................20
      2.1.2 on the use of cycling and walking tracking data for planning ............................................21
   2.2 Gaps in information that are addressed by tracking data ...........................................................23
   2.3 Comparison of costs of tracking based data and other sources .................................................26
   2.4 Potential of tracking ..................................................................................................................27

3. NEW PLANNING AND POLICY APPROACHES BASED ON TRACKING DATA ...............................28
   3.1 Functions of tracking data .........................................................................................................28
   3.2 From mobility vision to operations ............................................................................................29
   3.3 Stakeholders under influence of tracking ...................................................................................30
   3.4 What limitations? What challenges? ............................................................................................31
3.5  Context – how does the tracking data influence change according to context? .................................. 32

4.  APPLICATIONS OF TRACKING INFORMATION.................................................................................. 33

4.1  Indicators and visualizations made possible.................................................................................... 33

4.2  Quality of data..................................................................................................................................... 36

4.3  Data analysis tools ............................................................................................................................. 37

4.4  How it already happened: examples of application .......................................................................... 37

4.5  Issues to consider for obtaining and analysing walking or cycling tracking data......................... 40

FOR MORE INFORMATION: ................................................................................................................. 42

ANNEX I – LITERATURE REVIEW ON PLANNING AND POLICY PROCESSES, INFORMATION AND PLANNING SUPPORT SYSTEMS

ANNEX II – ASSESSMENT OF POTENTIAL OF TRACKING FOR PLANNING AND POLICY MAKING

ANNEX III – REPORT ON THE WORKSHOP ‘TRACKING DATA FOR PLANNING AND POLICY’
About the TRACE project

The mission of the TRACE project is to assess the potential of movement tracking services to better plan and promote walking and cycling in cities, and to develop tracking tools that will fuel the take up of walking and cycling measures. The project targets established measures to promote cycling and walking to the workplace, to school, for shopping purposes or simply for leisure.

More particularly, TRACE will assess the potential of ICT based tracking services to optimise the planning and implementation of such measures and enhance their attractiveness and potential impact. Issues such as data privacy, cost, interoperability, financial/tax incentives, infrastructure planning and service concepts will be addressed.

Dedicated TRACE tracking based tools to promote behaviour change and support mobility planning will be tested in eight pilot sites: Breda (NL), Agueda (PT), Southend-on-Sea Borough (UK), Bologna (IT), Esch (LU), Belgrade (RS), Plovdiv (BG) and Belgium, and evaluated in terms of impacts, success factors and benefits, while preparing for their full commercial exploitation. To that end, common, flexible and open access tools will be developed, which address related ICT challenges and enable the development of products based on tracking services tailored to the requirements of specific measures by market-oriented application developers.

Users, policy makers, and walking and cycling practitioners will be closely involved in all stages of the project.

In the end, TRACE aims to increase and optimise the use of ICT tracking services for the promotion and planning of cycling and walking in cities through:

- An open knowledge base on cycling and walking tracking possibilities, challenges, solutions and benefits
- Open access tools addressing fundamental ICT challenges to be used by market-oriented application developers
- Market-oriented tools to be used in the TRACE sites and elsewhere
- Direct involvement of commercial actors interested in developing top-notch tools for cycling and walking promotion
- 8 pilots that will become successful examples for other sites to follow
- Widespread promotion and take-up of TRACE’s tools and approaches by cities and related stakeholders, thanks to the project’s extensive dissemination and take-up activities
What is this document about?

This document aims to inform about the potential, state-of-the-art and policy and possible planning process transformations in the scope of the application of walking and cycling tracking data to the realization of analysis and communication for mobility planning and policy.

This document has been produced in the scope of the part of the work of project TRACE which aimed at:

- Characterizing current practices and information needs for cycling and walking planning and policy
- Assessing the potential of tracking for planning and policy making
- Proposing indicators and methodologies for data processing and analysis, producing specifications for the development of planning tools

As complementary to this document, the reader may consider TRACE’s Deliverable 3.2 - Specifications for the development of tracking tools – which defines technical specifications for future tools and the tracking data analysis tool to be developed until the end of 2016.

The sources of information that were applied in the elaboration of this document were the literature review on mobility planning practices and tracking applications, various stakeholder consultation initiatives (survey to planners and user representatives, interviews, the Workshop Tracking data for policy and planning) and the TRACE assessments realized on the basis of these inputs.

The document is structured in four parts:

1. Current planning practices and use of information
2. Potential of tracking for planning and policy
3. New planning and policy approaches
4. Applications of tracking information

In Annex, three additional elements can be found of use for the technical reader who is interested in going to the details of the reviews and analyses carried out in the work related to tracking data for planning in TRACE. They are:

- Annex I: Literature review on planning and policy processes, information and planning support systems
- Annex II: Assessment of potential of tracking for planning and policy making
- Annex III: Report on the Workshop 'Tracking data for planning and policy'
1. Current planning practices and use of data

In Europe and around the world, public authorities and other stakeholders are seeking for new ways to achieve sustainable urban mobility. Active travel policies, in particular on walking and cycling, have a large potential in this regard. At the same time, these two mobility modes strongly contribute to bust congestion. Although the importance of walking and cycling has been largely recognised at every institutional level, only few national and local authorities have already put in place robust and coherent strategies and measures in order to encourage their spread.

In the TRACE project, innovative and technological initiatives on how to foster walking and cycling will be explored. These tools are chosen because their application in planning processes holds huge potential to change mobility behaviour by fostering walking and cycling. The aim of TRACE is therefore to identify tools that on the one hand track walking and cycling and provide incentives for behaviour change, and on the other hand support tracking data analysis for planning purposes.

In order to foster the development of such tools, to assess their potential and the ways they are currently being applied, and to find out about their specific characteristics in different contexts, a broad in-depth knowledge of past and current projects in several scopes is needed. By creating this knowledge, challenges can be figured out when it comes to their technical implementation. By identifying these challenges, advice on how to overcome certain difficulties could be developed. Current needs and practices on planning and policy making regarding walking and cycling, with a focus on the design of tracking based tools that have the potential to contribute to planning processes, have been identified in this chapter.

1.1 Review of planning and policy processes

This literature review focuses on current practices for cycling and walking planning and policy. The research ranks all the identified projects according to their level of significance with respect to the mission and the activities of TRACE. A numerical scale from 1 (very low significance) to 5 (very high significance) has been adopted, regardless the specific topic at stake (see Annex II).

This section identifies EU projects related to planning processes and elements of data collection and analysis, investigating whether specific provisions and indications are considered for data collection. In particular, the general Sustainable Urban Mobility Plans process is analysed, together with two finished projects, BYPAD (now a platform) and PRESTO.

SUMP (Sustainable Urban Mobility Plans): the European policy making process and the role of data collection

In addition to the general planning aspects, the SUMP guidelines have been analysed regarding the way data should be incorporated in planning processes. Special attention has been paid on how data influences decision making processes regarding to the SUMP guidelines.

According to the SUMP Planning Cycle (see below), data collection is mainly addressed in:

- Step 3 - Analyse the mobility situation and develop scenarios (preparation)
- Step 5 - Set priorities and measurable targets (goal setting)
- Step 8 - Build monitoring and assessment into the plan (elaboration)
- Step 11 - Learn the lessons (implementation).
Data plays an important role during all the planning phases of a SUMP:

A. **Preparation of measures**: data is used to analyse the current mobility situation and develop alternative scenarios that might result from different policies and measures.

B. **Setting of the objectives**: the level of accuracy of the previously collected data should be assessed, in order to develop SMART (measurable and quantifiable) targets.

C. **Elaboration of the plan**: monitoring and evaluation process should be defined, and the impact of a particular measure will be assessed on the basis of the type of data selected and its ex-ante/ex-post quantification.

D. **Monitoring processes** which, again, leads to new action: more general impact assessment will be implemented in order to understand success and failure: this process will consider the actual achievement of the target previously identified.
**PRESTO project**

There is no one-size-fits-all model for making cities cycle-friendly. This project proposes, as a first step of the planning process, to distinguish cities according to their level of cycling development as Starter, Climber, and Champion cities, and suggests approaches and packages of measures that are likely to be most effective at each stage. The level of cycling development of a given city depends on two indicators:

- cycling conditions
- cycling rate.

As regards data collection indications, the projects recommends that monitoring and research should become increasingly important to foster knowledge and innovation as cycling progresses. It is recommended to involve cyclists into the process of gathering data. Bicycle counters are recommended to monitor the use of the network, and provide valuable input. User surveys should shed lights on the needs of cyclists and potential cyclists.

Gathering data is a process that should not end at some point, but is rather ongoing. The kind of gathered data varies depending on the specific context and condition of a city, and is likely to change over time. The decisions taken during a decision making process should be based on those data.

**BYPAD project and platform**

BYPAD regards cycling policy and planning as a dynamic process, where different components need to fit together to be successful. BYPAD provides a broad picture, determining whether the planning process is embedded in the political strategy.

BYPAD distinguishes nine modules, for which a quality level (from 1 to 4) is assigned on the ladder of development. The results of all nine modules altogether determine the overall quality level of the cycling policy. The dynamic planning process envisaged by BYPAD, although with some differences, presents the same approach of the Planning Cycle for a sustainable Mobility Plan described above.
The process of evaluation and quality improvement is carried out by a **local evaluation group**. The **quality plan** documents the objectives, main fields of action and measures the evaluation group has agreed on. This represents the basis for the resulting **action plan**, which will ensure the deployment of a coherent and effective package of measures to improve the local cycling policy. Also the BYPAD project suggest the implementation of **tailored cycling policies** according to the **city typology** (Starter, Climber and Champion).

**PRESTO and BYPAD project: similar approach**

Therefore, the **Promotion** or **Infrastructure** effort that a local authority should undertake in its planning process depends on the city typology. This categorisation is the same used both in the PRESTO and BYPAD projects (see figure below): in BYPAD, this distinction is used to define the proper mix of hard (infrastructure) and soft (promotion) measures. In PRESTO, the diagram suggests a sequence of cycling development efforts, regarding the same types of measures, across the three cycling stages.
Bottom-up planning

Digital platforms accelerate social innovation and public participation. A particular area within the social innovation in mobility is the tendency of creation of small local, temporary, experiments, often triggered by citizen movements with the acceptance and support of public authorities. This type of movement creates new opportunities and even disruptions to the common top-down planning processes. Initiatives like Living Streets or Better Block (US), which intervene on public spaces to improve the liveability of streets while occupying car space, are such examples. A new policy governance approach practiced in Gent is transition management, which relies on several stages of public participation leading to transition experiments.

Data plays a significant role in these bottom-up planning processes since it allows to evaluate the outcomes of experiments, including the mobility and traffic behaviour in the experiment sites.

Open questions

The literature review on the current planning and policy processes has left some open questions to be answered by the TRACE project, in particular about:

- The supportive role of data for decision making process: how data (and specifically tracking) should be collected and used to effectively support the planning (cycle) process?
- The relevance of the contexts in terms of local needs (City typology): how the local situations really affects and changes the planning approach?
1.2 Current planning practices in surveyed sites

Activities related to cycling and walking are parts of transportation planning, although often neglected in practice due to lack of quality data. Recent trends of sustainable development imply increasing of walking and cycling modal share. To address these trends traditional transportation planning process must be changed towards more priority and better quality cycling and walking planning and decision making. Growing importance of promoting and improving conditions for cycling and walking is approved by the result of the TRACE Public Authorities (PA) Survey and TRACE Users Survey.

In fact, the largest number of respondents declares that it is very important (66.2%) or important (28.5%) to promote and improve conditions for cycling.

Priorities of elements in the planning and operational activities

For both cycling and walking, respondents from Local authorities gave the greatest importance to the security and safety of cycling, followed by the maintenance, improvement and construction of infrastructure elements. In particular for walking, this is accompanied by the improvement of the accessibility for persons with reduced mobility and increasing pedestrian facilities. The lowest priority for cycling was given to the element - "Providing services for cyclists (e.g. self-service bike repair stations, discounts, etc.)" and to the element related to the regulation of cycling flows, while for walking it was removing bottlenecks and providing information to users.

The TRACE User Survey revealed that the users have slightly different priorities in the planning and operational activities: for both walking and cycling, users find the maintenance, improvement and construction of infrastructure elements (making roads compatible for these modes, new paths, tracks, parking, etc.) to be the most important.
Barriers in planning process
Implementing the planning and operational activities is subject to specific constraints. In spite of the public and political support, for local authorities the main barrier for achieving existing priorities is the lack of resources. Respondents also considered most relevant the lack of data, more so for walking (32.8%) than for cycling (25.5%).

From the users’ point of view, lack of data is the least important constrain for achieving the existing priorities. They found the lack of resources (in 25.5%) and the lack of political support (in 23.5%) to be main barriers.

Assessment of gaps in data relevant for transport planning

Type of information considered for cycling and walking
Good quality and reliable input data are crucial for an efficient transport planning process. Types of information considered for cycling and walking planning can be classified as qualitative and quantitative data. Qualitative data are much wider in use in planning practice and this fact is supported also in TRACE Public Authorities Survey. Climber and champion cities always use this data, while in every forth small starter city this data is not considered. Compared to the qualitative data, quantitative data is much less prevalent in planning practice.

Question: Which type of information is commonly considered in your municipality/region?

Counts of pedestrian and/or cycling volumes on transport network links and/or nodes are the most widely used quantitative data, in almost two-thirds of the cities according to the survey results. Walking and cycling planning in half of the surveyed cities is based also on OD (Origin-Destination) matrices.

Figure 7 - Type of information considered for cycling and walking (PA Survey)
Consideration of tracking data

Tracking of individual routes is taken into consideration in around 40% of analysed cities and almost exclusively just for cycling. Penetration level of cycling tracking data usage in transport planning is recorded to be slightly less than for public transport (Figure 10 and Figure 11). On the other hand, pedestrian tracking data are used in only 15% of the cities. From the users’ perspective, usage of tracking data in transport planning is observed to be on similar level as for the public authority representatives.

Cycling tracking data usage is related both to city size and cycling modal share. Bigger cities consider more often this data in their planning practice. With the increase of cycling modal share, the level of tracking data usage is higher. For smaller cities, potential of these data is insufficiently used.

Question: Is your municipality/region using tracking data (i.e. data on the routes of individuals)?

![Figure 8 - Tracking data usage – cycling (PA Survey)](image)

Tracking technologies

Traditional data collection methods seem no longer adequate to satisfy all data needs of transport planners and policy makers, who demand more detailed information. With the advancement of data collection techniques, such as GPS, public transport smart cards, and mobile phones, various types of travel trajectory data are increasingly complementing or replacing conventional travel diaries and stated preference data. Out of all these methods, Global Positioning System (GPS)-based data collection methods have shown the biggest potential. TRACE Public Authorities Survey is in the alignment with this statement: the highest percentage of respondents declared that GPS is used for tracking (in 62.5% of cases).
1.3 Information and modelling processes

1.3.1 SURVEY METHODS FOR MONITORING TRAVEL BEHAVIOUR

Different survey methods can be used for monitoring travel behaviour. A short presentation of the multimodal surveying, pedestrian and cyclist travel survey, stated preference survey and the intercept survey is provided below. For more information on each of these methods, please refer to Annex I.

Regardless of the model chosen, good quality and reliable input data is crucial for efficient transport planning. Data can be classified as qualitative and quantitative. Qualitative data is much more widely used in the planning practice, a fact also supported by TRACE Public Authorities Survey (see Annex II). Counts of pedestrian and/or cycling volumes on transport network links and/or nodes is the most widely used quantitative data, in almost two-thirds of the cities, according to the survey results. In half of the surveyed cities, walking and cycling planning is based also on OD (Origin-Destination) matrices. Tracking of individual routes is taken into consideration in around 40% of the analysed cities and almost exclusively just for cycling. Pedestrian tracking data is used in only 15% of the cities. This undoubtedly shows how tracking data usage decreases with the increase of the level of individuality in travel patterns.

The reasons for such a relatively modest use of tracking data in planning can be found in data collection methods. A mainstream data collection method is travel diaries (paper or phone call surveys) giving the transport planner detailed information about each trip and providing him with socio-economic background data. This data collection method has a number of drawbacks, however: large burden placed on respondents,
high costs, decrease in the quality of the recorded data, missing trips especially if the diary is made over several consecutive days, etc. Stopher et al. (2012) highlight ‘non-response’ as the most pressing problem in all surveys (response rates around 20-30 percent from a mail-back survey, 40-60 percent from a telephone survey, and 60-75 percent from a face-to-face interview).

One of the most common methods is direct interview of cyclists and pedestrians, i.e. capturing them while using a specific route during an intercept survey. Indirect survey methods exist, however, as well.

A problem faced in many travel surveys is that they assume trips are taken by only one mode. Clifton and Muhs (2012) therefore developed a survey method for multimodal surveying that captures the information of multimodal trips. “Last-mile” connections to and from public transport trips are the best-known example of missing multimodal information, such as walking to a bus stop, or carpooling to a park-and-ride station. This issue was addressed by recommending walking trips over 50 m to be included in multimodal surveys. Several recommendations are offered to improve computer-assisted telephone interviews and suggestions are made on the use of GPS to obtain observed, rather than reported, travel data (see Annex II).

The Pedestrian and Bicyclist Travel Survey method aims to address the national surveys’ shortcomings in depth of questions and sample size. This method fills a gap in the survey methods provided at the national level and those that are corridor-specific. The questions were tested for statistical reliability, and should provide comparable results if used by multiple jurisdictions.

The previous survey methods have focused on reporting travel behaviour regarding travel in the past, whereas stated preference in surveying methods allows predictive modelling for facilities and routes that may not yet exist. Sener and others’ work on the route preferences of cyclists in Texas is one example, finding that a given route’s travel time (for commuters) and motorized traffic volume were the most important factors in route choice (Sener et al, 2009).

Regardless of their forms, traditional data collection methods seem no longer adequate to satisfy all data needs of transport planners and policy makers, who demand more detailed information. As a result, different data collection approaches have come into being.

1.3.2 DATA COLLECTION TECHNOLOGIES

Relatively new applications of technology to monitor active transportation travel can cross the boundaries of whether a method is focused on understanding traffic counts or behaviour. Smartphone technology and other systems can integrate an online survey instrument or other methods with screenline counting or route data storage. Though many of these techniques were pioneered for automobile applications, researchers and practitioners are using new tools to make active transportation data collection more efficient (Transportation Research Board, 2014b).

With the advancements of different location-based technologies (e.g., GPS, Wi-Fi positioning system, etc.), it is now feasible and affordable to collect large volumes of tracking data at the individual level. GPS logs usually consist of longitude, latitude, altitude, direction, time, and speed. However, other information could be present depending on specific cases. Pure GPS tracking offers detailed data on geolocation and temporal aspects of all trips, and possibility to reveal trip mode and purpose combining GPS tracks and other GIS data. This allows quantitative analysis of daily activity patterns, both on individual or collective level (e.g. transport zones). GPS-based data collection methods are potentially more accurate, incur fewer monetary costs and less of a burden on respondents compared to paper diary methods, while exact location coordinates of trip destinations, travel times and even routes can be recorded. In this way, GPS data can be used for estimating...
volumes of travel on a specific route and understanding behavioural aspects through route choice (Transportation Research Board, 2014). Moreover, the need for time-consuming data entry is avoided since data are available immediately in digital format. However, this method has some deficiencies and the main is lack of socio-economic background data necessary for transport planning. Travel mode information is also an issue, although there are some methods which derive travel modes by combining latitude, longitude and timestamps in the GPS logs without respondent involvement. Another drawback is lack of trip purpose data, which is not possible to extract from GPS logs. Overcoming this deficiency usually requires some initial data (i.e. the addresses of each person’s workplace or school, and the address of the two most frequently used grocery stores, etc.). Aside these, It is also important to specify the level of detail desired in trip purpose categorisation.

To address all these deficiencies various solutions emerged combining different data collection methods.

Another different approach combines GPS logs with Geographic Information System (GIS) data to get missing data. The quality of GIS maps and data has great influence on reliability and precision of travel mode and trip purpose data. While the success of this method in determining travel mode is well documented, literature examples for deriving trip purpose are few and usually only focused on car trips.

Different possibilities exist for asking respondents for additional information and data validation (face-to-face interviews, Internet recall survey, etc). Bohte and Maat (2008) present an innovative method that combines GPS logs, GIS technology and an interactive web-based validation application. The method was tested in large-scale fieldwork with a sample of more than 1000 residents of Amersfoort (137000 inhabitants), Veenendaal (61000 inhabitants) and Zeewolde (19000 inhabitants), three municipalities in the centre of the Netherlands. Their approach concentrates on the issue of deriving and validating trip purposes and travel modes, as well as allowing for reliable multi-day data collection. There are two main processes in this method. During the interpretation process, three different data sources (GPS logs, GIS data and individual characteristics of the respondents collected by a survey) are combined to derive travel patterns. When trip characteristics are reconstructed as much as possible, they are forwarded to the validation process. The main part of the validation process consists of a web application that gets its data from the spatial database. The derived data are presented to the respondents in maps and tables and they are asked to use this validation application to correct and add to the derived trip characteristics. Feedback from validation process is used to update individual characteristics which are reused in the interpretation process. The success of the interpretation process is done by determining what percentage of all travel modes and trip purposes had to be provided or changed by the respondents in the validation application. Bohte and Maat show that in almost three quarters of all cases, the travel mode proves to have been estimated correctly during the interpretation process. Car use is deduced correctly most often (75% of all trips), followed by cycling (72%) and walking (68%), respectively. Reasons for not accomplishing higher percentage are found in the fact that the assignment of a mode is almost exclusively based on average and maximum speeds of trips, and quite a lot of trips were missed by the GPS data logger. Deriving trip purpose was correct only in 43% of all cases, with trips that end at home are most often given the correct trip purpose because the home location is already known. The results from evaluation survey have shown that the participants did not consider carrying and charging the GPS device as a nuisance, and were enthusiastic about viewing their trips in the maps of the validation application. Moreover, the majority of respondents were able to go through the validation application within a reasonably short period of time. Bohte and Maat conclude that, at present, both GPS and GIS are starting to make a significant contribution to collecting data on travel behaviour of individuals.
1.3.3 Planning Support Systems (PSS) in mobility planning

Experience with Planning Support Systems and barriers to their wider use

The urban planning and policy practice has been increasingly applying information and analysis tools which provide support by identifying problems and testing solutions. Such tools are commonly referred to in the academic literature as Planning Support Systems.

Planning Support Systems (PSS) may be defined as “an information framework that integrates the full range of current (and future) information technologies useful for planning”.

PSS exhibit certain advantages in providing analytical and communicative support, even though the usefulness for specific planning tasks differs. From an analytical perspective, the PSS can provide valuable feedback on the necessary iterations that are part of a negotiation task. From a communication perspective, the PSS may spark an active and content-based dialogue between the involved participants and improve the collaboration and communication among different disciplines. However, PSS can also have a negative effect on conducting a task, if GIS becomes performative, and hereby starts steering rather than supporting the process.

In the past years, there has been a significant evolution, powered by new technologies for disseminating information. This, coupled with the development of intrinsically visual tools such as GoogleMaps, has led to the common media of communication becoming predominantly visual. As such, PSS have evolved to graphic and related media in contrast to its origins in numerical data processing. The interactivity of these systems has also developed considerably.

An assessment of spatial planning practice at the end of the 20th century however suggested that the adoption and use of geo-information tools (geographic information and spatial modelling systems) are far from widespread and far from being effectively integrated into the planning process. Different factors can explain why the usage of Planning Support Systems has not become widespread. Some barriers refer to institutional/procedural discrepancies (i.e. separate planning institutions, formal processes, financial arrangements, etc.) and substantive differences (i.e. different planning objects, information etc.). A survey among people involved in planning practices from all around the world identified as main obstacles the little awareness among planners of the existence of PSS and the purposes for which PSS can be used, lack of experience with PSS, and low intention to start using a PSS among possible users. A complete list of barriers presented in the literature is available in Annex I.

In order to reduce these bottlenecks, it is suggested that marketing actions accompanying the launching of the PSS are essential in order to give PSS a good chance to prove their value as a means for improving spatial planning practice. It is also considered that the early planning phases are crucial for effective integration of PSS and political decisions since there is still a diversity of options and agents to be considered, even if this significantly increases the complexity of the process. Some authors consider it advisable for the development of the PSS to be intertwined with the planning process itself in order to reduce the existing implementation gap between the PSS and the actual planning decisions. Vonk & Geertman (2008) have created a figure which presents succinctly how PSS can be made better and wider use of (see figure below).
The literature review detailed in Annex I helps identifying the main concerns that should be taken into account in order to ensure that the tools developed within the project TRACE are successfully applied by planners and decision-makers:

- These actors should be involved in the development process from an early stage, in order to fully identify their needs and difficulties. This involvement should be present at every stage of the development process.
- Similar projects and tools should be analysed in order to learn from their successes or failures. The potential of these tools as complementary to the TRACE tools should also be taken into account.
- The collected data should be stored in a format that allows the data to be easily accessed, exchanged and processed.
- The tools should provide a way to visualize the data that is pleasant and intuitive.
- The development of the tools should be accompanied by a divulgation campaign that shows their value and potential as communication and planning tools.
- The tools should be as clear and transparent as possible.
- The tools should not steer but rather support the process of planning and policy making, especially when they provide information which, as is normal in models, is partial.
2. Potential of tracking for planning and policy

2.1 Recent experiences

2.1.1 ON THE USE OF TRACKING DATA IN OTHER TRANSPORT MODES

At this moment, individual vehicle tracking has a significant application in traffic management, through collecting and processing the large amount of non-personalized data of user movements and their further use in traffic management process. Considering that the amount of data collected in transportation is increasing exponentially, it is becoming clear that real potentials of tracking and collecting data will never be realized without collaboration. A good example of such cooperation is the TM2.0 ERTICO Platform\(^1\) launched in 2011 by TomTom and Swarco-Mizar. Today it consists of more than 20 members from all ITS sectors focusing on new solutions for advanced active traffic management. It aims to agree on common interfaces to facilitate the exchange of data and information from the road vehicles and the Traffic Management and Control Centers (TMC), and back, improving the total value chain for consistent management and traffic services as well as avoiding conflicting guidance information on the road and in the vehicles.

The recent emphasis on utilising advanced technologies has created an environment in which traffic simulation models have the potential to provide a cost-effective, objective, and flexible approach for assessing design and management alternatives. Using these models in real systems requires of these models to be adequately calibrated for local conditions. Tracking (trajectory) data is seen as one of the main inputs in processes of verification, validation and calibration in traffic simulation models. Applicability of this data varies based on the output parameter from the model. Several studies showed that measurement based on trajectories (link or a path) can give representative speed estimates with sample size of just 1% vehicles in heavy traffic.

Besides traffic management, vehicle tracking is significantly presented in car sharing and taxi service. For example, MOMO (EU) Car-Sharing\(^2\) is an Intelligent Energy Europe (IEE) project intended to promote a sustainable mobility culture supporting various transport options aside from car ownership. GPS taxi tracking data is another well documented data source to study mobility patterns and travel behaviour (Wang et al., 2011). Liu et al. (2012) established a random walk model to interpret the distance and direction distribution patterns observed from the taxi trajectories in Shanghai (1.5 million anonymous trips during 7 consecutive days). Many other similar projects use individual vehicle tracking for improving traffic conditions and mobility.

Significant usage of tracking data is also present in public transport planning. Nowadays, almost every city in the world has a smart card based fare collection system in public transport. Various information is stored within smart cards, including trip data (trip mode, start and/or end time, start and/or end stop, route, etc.) and personal identification data. Thus, smart card data can be used either in travel demand modelling (Chu

\(^1\) http://tm20.org/

and Chapleau, 2008) and demand forecasting (Mariko et al., 2006) or individual travel patterns detecting (Pelletier et al., 2011) and OD matrix extracting. But complete trip information is only available in distance base tariffs, when check in/check out fare collection system is in use. Majority of fare collection systems only require validation on trip start, thus, a major challenge in using smart card data is how to identify or estimate a complete trip trajectory (Hofmann et al., 2009) and multimodal transfers (Seaborn et al., 2009). Nevertheless, smart card data is considered to be feasible in travel behaviour and transport planning studies, but with a common concern about privacy issues when linking trip data with personal information.

While individual tracking of persons in public transport using smart card data is still evolving, vehicle (collective) tracking in public transport is a well-known and approved technology. Vehicle tracking data is widely use in real-time management process, as well as the input in off-line transport planning and design. In 2012 vehicle management and fare collection system was implemented in urban public transport system in Belgrade3.

2.1.2 ON THE USE OF CYCLING AND WALKING TRACKING DATA FOR PLANNING

Few systematic cases of cycling or walking tracking data analysis have been conducted. The RouteCoach initiative in Belgium, the Bikeprint tool and the Fietstelweek4 in the Netherlands are cases of data collection which was used on systematic analyses focused on mobility planning. In the scope of walking, we are not aware of specific tools developed to analyze walking data for the purpose of planning, even though there have been several research initiatives focused on walking data.

Routecoach is a behaviour change focused initiative (based on a tracking app giving coaching on the user’s mobility lifestyle) which delivered cycle tracking data from the city of Leuven. All the data collected was meant to be used as input for the city of Leuven and the province of Flemish Brabant so that policy makers could learn more about actual travel times, actual routes used, transportation choices and satisfaction. Some lessons learned were be used by policy makers to design information policies for users (see examples below).

Bikeprint is a tool to analyse bicycle tracking data which has applied various sources of data in the province of Noord-Brabant. Bikeprint already delivers the following policy-relevant information per area:

- Real bicycle speeds: section speeds including waiting times, and relative speed (bottlenecks).
- A picture of bicycle traffic movements at various moments of the week and during the day.
- The various routes of all cyclists that make use of a specific stretch of road (selected link).
- The detour factor between the actual route compared with straight-line distance and compared with the shortest route.
- Isochrones for travel time, the actual distance to be covered from a certain area within a certain period of time.
- Travel times, traffic volumes and choice of travel modes over a day (hour), over a week (per week day) and per distance category.
- Potential bicycle accessibility between residential areas and working areas.
- Number of potential new cyclists as a result of changes in bicycle infrastructure.

---


Another interesting case coming from North America is the CycleTracks\(^5\) application developed in 2010 by the San Francisco County Transportation Authority with the objective of better understanding the needs of cyclists. The application monitors cyclist paths to collect data about actual route choice. At the end of each trip, personal data, trip data and GPS logs are sent to server and stored in three database tables: Person table (containing personal information), Trip table (for trip data) and GPS coordinates table (storing raw GPS logs). After several months of data collection, there was a sufficient amount of data to develop a bike route choice model. Output data can be incorporate into the SF-CHAMP, the official travel model for San Francisco. The list of cities collecting data with CycleTracks includes 10 cities in USA and Canada, as well as 8 more cities that have rebranded and improved this app prior its use.

There are several other cases of simpler application of tracking data, although with limited analytical procedures. This is the case for example of the European Cycling Challenge (ECC)\(^6\), a European initiative involving tracking through a mobile application which provides the collected data to cities.

Some technical aspects of existing tools are presented in the following table:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>The European Cycling Challenge - ECC</th>
<th>RouteCoach</th>
<th>Bikeprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>System development</td>
<td>Startup 2012 in Bologna; In 2013 ECC was upscaled at European level; Cycling365 app lunched on April 1st 2015 and used during the ECC 2015 edition (May 2015)</td>
<td>Developed by the University of Ghent as part of NISTO project</td>
<td>Developed by the University of Applied Sciences of Breda.</td>
</tr>
<tr>
<td>Main objectives</td>
<td>Reducing car trips; Encouraging people to change their lifestyle in favour of a more active mobility; Collecting data that is useful to urban planning.</td>
<td>Collection, organization, processing, analysis and re-use of the travel data</td>
<td>Production of various indicators, visualizations and analyses</td>
</tr>
<tr>
<td>Basic architecture</td>
<td>Not applicable</td>
<td>MOVE mobility intelligence platform; RouteCoach app.</td>
<td>A map-matching software coupled with a GIS service.</td>
</tr>
<tr>
<td>Data Collection</td>
<td>Through the App (via GPS) or manually (uploading a gpx file or drawing manually the trip on the map); App works online and offline.</td>
<td>Through the RouteCoach app; App works online and offline.</td>
<td>Data collection by different sources GPS tracking sources such as B-Riders, Positive Drive and the Fietselweek.</td>
</tr>
<tr>
<td>Specific tracking for planning indicators (KPI's)</td>
<td>Heatmaps; Raw GPS logs are given to Local Authorities for use.</td>
<td>Tracking activity in kilometres registered: Travelled distance by mode (walking, cycling, PT, car, etc...) and number of trips by mode (walking, cycling, PT, car, etc...).</td>
<td>Absolute and relative speed Traffic volumes Travel times Isochrones Choice of travel modes Bike accessibility Potential demand from infrastructure changes</td>
</tr>
</tbody>
</table>

---


\(^6\) [http://cyclingchallenge.eu/](http://cyclingchallenge.eu/)
Experience with walking tracking data is far less present in current practice. However, still there are some examples. Walk Score is a web-based tool launched in 2007 which aims to promote car-independent lifestyles. The Washington, DC Office of Planning is one of the governmental entities to take advantage of Walk Score data in its transport planning process.

2.2 Gaps in information that are addressed by tracking data

Good quality and reliable input data are crucial for efficient transport planning process. Types of information considered for transport planning can be classified as qualitative and quantitative data. Qualitative data is much widely used in planning practice and this fact is supported also by TRACE Public Authorities Survey (for more information please refer to Annex II). Transport planning models need to be as flexible as possible, especially regarding the possibility to efficiently handle a wide set of input data (quantitative and qualitative): socioeconomic data (demographics, land-use data), network data (transport infrastructure), etc. Moreover, these models have to be adjustable to the specific needs of each mode. One of the major issues for not putting walking and cycling on an equal footing with motorised transport modes is the lack of input data.

---

7 https://www.walkscore.com/
Table 2 reviews gaps in data relevant for transport planning for traditional data collection methods. It is clear that surveying as data collection method lacks network and travel data. On the other hand, counting only gives network data, while socioeconomic and travel information are absent. These deficiencies can be mitigated by combining traditional methods with state-of-art technologies. Thus, this table gives also the potential of advanced data collection methods based on tracking to fulfil those gaps which will be discussed later.
Table 2 - Identification of gaps in data relevant for transport planning and potential of tracking data to fulfil those gaps

<table>
<thead>
<tr>
<th>Input data for transport planning</th>
<th>Traditional data collection methods</th>
<th>Advanced data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surveying</td>
<td>Counting</td>
</tr>
<tr>
<td>Socioeconomic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Age</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Household data</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Occupation</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Home address</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Work school address</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Travel data - individual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Origin</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Destination</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Journey start time</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Journey end time</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Exact routes</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Transport mode(s)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Travel purpose</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Transfer nodes</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Transfer time</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Network data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road data (type and condition)</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Nodes data (Volumes, Bottlenecks, Delays, etc.)</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Links data (Link Speeds, Volumes, Bottlenecks, Delays)</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>PT data (stops, lines, routes, etc.)</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Parking data (location, quantity)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Zones data</td>
<td>✓</td>
<td>✗</td>
</tr>
</tbody>
</table>
2.3 Comparison of costs of tracking based data and other sources

As shown by Table 2, the various data collection methods provide very distinct types of information and have different temporal scopes, so a direct comparison of their costs is not feasible. Still, for reference, indicative costs of the three main different types of data collection methods is provided here. Table 3 shows indicative unitary costs for obtaining data per each registered trip, considering the data obtained for a whole week.

Table 3 - Cost comparison of data collection methods

<table>
<thead>
<tr>
<th>Input data for transport planning</th>
<th>Traditional data collection methods</th>
<th>Advanced data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surveying</td>
<td>Counting</td>
</tr>
<tr>
<td>Costs</td>
<td>Per trip (during one week)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.00€*</td>
<td>0.13€**</td>
</tr>
</tbody>
</table>

* Assuming a cost of 15€ per survey and 15 trips per week per individual

** Assuming a cost of 1200€ per sensor and an average pedestrian and cyclist traffic of 9000 trips per week

*** According to Fiets Telweek in the Netherlands: a budget of 350000€ and 377321 recorded trips in a week

A good reference of the costs of a tracking based data collection was the recent Fiets Telweek, which happened in September 2015 in the Netherlands. During this week-long event, participants were asked to download a tracking app that registered their cycling trips during that week. The initiative had a budget of 350000€ and 50964 people participated, registering 377321 trips and 1.2 million km. The cost per monitored participant was around 7€, of which 3.8€ were spent in promotion and recruiting of participants. This initiative is due to be repeated in September 2016 and it is foreseeable that the number of participants will be higher and the costs per participant will be lower.

While this and other campaigns such as the European Cycling Challenge have a limited time horizon, other tracking data collection initiatives may be extended indefinitely. For example, the Moves and the Humans applications constantly register travel data. Continuous measurement initiatives have the significant advantage of being able to measure the effects of infrastructure interventions, experimental actions, or any other events. The fact that users continuously used the application would dramatically lower the average cost per registered trip. On the other hand, it is expectable that the number of users being tracked diminished over time, thus requiring new recruitment efforts to maintain a significant sample.

---

\[8\] According to an average of the options presented in “Effectiveness of a Commercially Available Automated Pedestrian Counting Device in Urban Environments”, Greene-Roesel et al., TRB 2008
A survey campaign can provide very thorough data, but this information is static. To evaluate changes over time or the effects of new measures, a new campaign is required. In order to have a significant sample, a considerable economical effort is required: reaching the same number of people than the Fiets Telweek would cost around 610000€. Unlike when collecting tracking data, the cost per registered trip in a survey does not reduce significantly when increasing the size or duration of the survey campaign.

There are several automated counting methods (motion, infra-red, computer vision…), with varying degrees of accuracy. Implementing one sensor has relatively low costs and will provide data for extended periods of time, requiring only minimum energy and occasional maintenance. However, in order to have a clear picture of the movement within the city, a high number of counters is be required, which quickly becomes quite costly.

Since the various methods have different advantages and provide distinct types of information, they work best when combined, so that they can complement each other’s gaps.

### 2.4 Potential of tracking

Growing importance of promoting and improving conditions for cycling and walking is evident in today planning practice. The TRACE surveys’ results (see Annex II) have shown that both public authorities and users have high awareness of the potential of tracking data, although this data is rarely used in everyday planning process, especially for walking. This is confirmed in the review of recent experiences on the use of tracking data for planning. This review has included not only cycling and walking tracking, but motorised transport modes as well.

With the advance of ICT, GPS-based surveys are expected to eventually replace traditional travel diary surveys. Although the feasibility of using GPS log data to replace traditional travel diaries has been affirmed in literature, some authors still argue that passively collected GPS-based surveys may never entirely replace surveys that require active interaction with study participants.

In the TRACE Surveys, public authorities’ representatives and users’ representatives also gave their opinion on the information they would like to get from tracking devices. Apart from standard GPS-based information, i.e. modal choice, trip length, trip duration, chosen route, transport planners are eager for Origin-Destination (OD) data (trip volume, speed/time, link volumes, etc.) and current road/pavement conditions. The collected data should be stored in a format that allows the data to be easily accessed, exchanged and processed. They would like to obtain these data in ready-to-use format, tabular or graphic, but even raw GPS logs are acceptable for many of these transport planners.

Although tracking offers large data sets, the main constrain limiting the potential of its usage in transport planning practice is the quality of tracking data. No study has yet systematically examined the implications of using low-quality big data for traditional modes of analyses. A review of elements contributing to data quality is provided below (section 4.2).
3. New planning and policy approaches based on tracking data

As we have seen, tracking can open a new window of information. Information over where, when, how, why, how far, how fast and from and to where people walk or cycle. This information will be available cheaply and quickly. It is our hypothesis that this new window of information will cause a change in planning and decision making processes. How will this happen? Through what actors? With what kind of information? For what types of action? Who will want it and why? Will it all have a positive outcome? What can be done to make it possible and that the outcomes are most desirable ones? These are the questions that we approach in this section.

The views which are expressed here are the result of the analysis of the opinion of numerous stakeholders contacted by the TRACE project and the social and institutional analysis which was done based on these stakeholder opinions, on the analysis of the current planning practices and the analysis of information gaps and potential of tracking for planning described in the former sections.

3.1 Functions of tracking data

Question: Do you believe tracking-based information could be useful for:

![Survey to planners and decision makers: applications of tracking information](image)

Figure 11 – Survey to planners and decision makers: applications of tracking information
Tracking data may have multiple functions which interfere in different ways in the policy and planning process:

**Linking the interests of users and stakeholders.** This will enable stakeholders to reward walkers and cyclists for their behaviour, being it a shopper who wants to give discounts to arriving cyclists, an employer who wishes to subsidize active commuters, a health insurance company providing better premia to healthy people or a municipality wishing to reward people who choose sustainable transport. Tracking data creates multiple opportunities to incentivize active mobility.

**Data analysis.** The location and time data provided by tracking allows for a variety of analysis fields and approaches, be them about the level of service of the infrastructure or knowledge about the demand and its preferences, at a micro or macro level, per type of user, schedule, weather or location. Below some possibilities of indicators and visualizations based on TRACE’s stakeholder consultation are presented.

**Monitoring of measures.** Tracking data allows to see in much detail what has changed with users whenever a measure is introduced in the local mobility system. Be it a new link, simply a new sign or construction work, or temporary experiment, maybe based on behaviour change tracking applications, it is possible to see how users are reacting to it.

**A simple tool for Communication.** A potential of tracking data that is worth highlighting is its apparently powerful communication ability. Because it makes cyclists or walkers visible to the decision maker or to the general public, using tracking visualizations truly seems to have the ability to influence opinions and decisions, at least in the short term.

Like other policy and planning tools, it may be that tracking data and related tools will become intrinsically connected within the process of planning and decision making. We could say that it will have become a building block of the process. At that point, its influence will be structural and part of the paradigm of urban mobility. It is relevant that such influence of a tool is positive and not biased towards certain objectives opposed to others, or that it is not only illusionary contributing to some objective. This was the case in the past of traffic models, which ignored other modes of transport and which ignored that addressing congestion through more space for cars was feeding a never ending feedback loop. In its own ways (and probably with much smaller consequences), tracking data has it risks of creating biases.

### 3.2 From mobility vision to operations

The TRACE stakeholder consultation, particularly through the Workshop *Tracking data for planning and policy*, explored how tracking data could influence planning and policy from mobility *vision* to *operations*.

A starting point is that changing the mobility paradigm away from car use is a difficult task that can only be achieved through collaboration. To that end, there has to be a strong dialogue that promotes the sharing of information, ideas and issues. In this process, tracking will help redefining the mobility policy vision by providing evidence and helping quantifying goals: *vision is not a technical matter, but it needs technical support.*

* This has been the subject of another part of the work of TRACE. See TRACE Deliverable 3.2 Specifications for the development of tracking tools.
Tracking will give visibility to ideas and groups of users commonly disregarded by traditional planning and data collection methods, and may help increase the community engagement and participation. The vision goal is to influence the change based on user demand, on what people actually want, rather than planners just deciding what people need, and the visibility that tracking gives to people may help in this process. By profiling its users, tracking will help reinforce the idea that users are persons, not numbers, thus enabling setting goals and approaches more suited to the target groups: if you want to build a city for people, you have to have data on people.

Tracking will be standard in ten years, which, coupled with the use of big data, will have significant impacts on the planning process. Tracking data provides continuous and current information, richer detail, user segmentation, and can complement other types of data. Tracking allows knowing instead of imagining and contributes to make diagnoses, test ideas, monitor and evaluate actions, develop multimodal policies and improve the network design.

By providing data continuously, tracking will shorten the temporal horizon of activities and programs: with tracking we don’t need to wait for the elephant paths (name given in the Netherlands to the destruction of grass made by people choosing the shortest path across a park).

However, when using tracking for planning it is important to keep in mind that it should not be seen as a goal in itself or as the sole basis for establishing goals and visions. Tracking reinforces the idea that mobility is an engineering question, and it is not. It is a mean, not a goal in itself, and it relates to personal choices, lifestyle and citizens’ well-being.

### 3.3 Stakeholders under influence of tracking

Stakeholders may use or be influenced by tracking information in several ways. We will describe the potential role of tracking in the system of interrelations between different actors in the planning and decision making process.

The systems is constituted by planners in the field of walking and cycling, planners from other fields (sometimes with opposing objectives), decision makers (including politicians) and the public, which may include the general public but also user activists.

First of all walking and cycling planners may use tracking information to develop better analysis and properly defining priorities for action. But they can also use tracking information to communicate and sometimes influence other actors. That might be the case in the communication with other technicians within the organization who might have different objectives or

---

*Figure 12 - Roles of tracking data in the planning process*
distinct languages, where the visual and quantitative power of tracking data to show that people exist, have movement needs or that for example lose time in traffic lights, might serve as the decisive evidence to advocate for certain priorities.

The same goes for the planners’ relation with decision makers. Here, the influence might happen not only on operational decisions but also at a higher level of vision definition. Showing the evidence on the entropy of walking, or the choices of cyclists towards safer or quicker paths, may trigger the decision maker’s appetite for giving priority to improving the conditions for walkers or cyclists.

Tracking information will also give decision makers an additional assurance. The assurance that they will have a tool to communicate with the public, through which they will be able to describe with numbers what is the problem, and what will be the effects of the solution. This ability to argue based on empirical evidence provides decision makers the comfort that they will have powerful arguments and face public with a lower risk over negative public opinion.

The communication between decision makers and public also occurs in the opposite direction. Activism towards walking or cycling can in the same way find in tracking data a powerful tool to argue for the improvement of their conditions, showing that there are users and describing their problems through data, makes it more inevitable for the interlocutor politician to act. Another form of communication involving citizens which may be enhanced by tracking data may refer to the latest planning processes based on co-creation, co-production and experimental and ‘slow designs’.

The following Chapter presents some examples of applications of tracking information in some of the contexts above.

### 3.4 What limitations? What challenges?

The first challenge is obviously to **obtain tracking data**. To do this, the local authority or actor needs that users engage in some form of tracking initiative. This may be done by asking users to share data for altruistic and self-interested reasons of helping their local planners to understand their needs or through some mechanism that incentivizes the users to use a data collection application, for example by giving rewards to users or involving them in gaming. If the application in question is also promoting sustainable mobility, then the local authority is achieving a double objective of sustainable mobility promotion and data collection.

A common barrier to obtaining data is the **privacy issue**. Besides technically dealing with the issue by reducing the scope as much as possible for privacy problems\(^{10}\) – the ability for such depends on the type of information required - , a solution includes the creation of a clear user agreement and convincing users on the importance and rightful use of their data, which in turn may also help keeping users engaged.

One of the major challenges in terms of tracking data use is **how to go from raw data to meaningful knowledge**. Information must be translated into a set of indicators and visualization methods that planners will actually use. Before developing the tool and choosing indicators, it is necessary to understand what is needed, and to ask the right questions. This is a core part of the work in TRACE and the Workshop **Tracking data for policy and planning** had as one of the most important outputs the definition of indicators and visualizations useful for planners and other actors (see the following chapter for results).

---

\(^{10}\) TRACE Work Package 4 will be working on dealing privacy issues at a technical level in the scope of walking and cycling tracking applications. Open access modules will be provided dealing with this issue.
Another limitation is the **quality of the data**, in particular its accuracy and representativeness (see Chapter 4). The limitations of tracking data in terms of representativeness and reliability may be mitigated by merging tracking data with other sources and interpreting the results, paying special attention to what the data might not be showing. For this, it is necessary that the data is applicable in different analysis tools and/or that it is collected in a format that can be used in these tools.

The issues of quality, transparency and interoperability may be improved by developing common **standards** and creating an open data platform.

Overall, the use of tracking data faces several challenges in its relation with **planners**, who need to be aware of its potential and how to appropriately apply the knowledge made possible. Identifying their needs and ensuring they accept and know how to use new methods to interpret the tracking data is crucial, which may be achieved by giving planners specific training and developing good data analysis tools.

### 3.5 Context – how does the tracking data influence change according to context?

The needs that are primarily met by tracking information depend greatly on context, with a significant difference found between sites where cycling and walking mobility promotion and use is well developed (**Champions**) and sites where it is not yet well developed (**Starters**). The main difference is in the main function of tracking data for each of these contexts:

**Champion sites tend to give more importance to data analysis for the understanding level of service related indicators.** They want to identify congestion, bottlenecks, points of low level of service, and they want to test and monitor possible solutions. They are also more comfortable in dealing with raw data.

**Starter sites tend to give importance to the ability to understand intervention priorities based on the knowledge of basic origin-destination information and network conditions.** They also see the communication function of tracking data as an opportunity for planners or lobbyists to make users visible in the dialogue with other actors. For this reason there is a tendency to prefer ready to use analysis and visualisations.

![Figure 13 - Indicators stakeholders would like to obtain from tracking data, according to the city profile](image-url)
4. Applications of tracking information

4.1 Indicators and visualizations made possible

The Workshop Tracking data for planning and policy and the surveys sent to stakeholders (planners, decision makers and user representatives) allowed to identify indicators and visualizations that would meet their needs and to prioritize them by order of importance. Also, the survey directed to planners and user representatives provided an indication of their preferences.

Question: The tracking device will identify modal choice, trip length, trip duration, chosen route. Which additional information would you like to obtain from tracking services?

![Figure 14 – Preferences of planners and decision makers on indicators and visualizations](image)

The indicators can be grouped in broad types:

- **Origins and destinations** – sites of origin and destination of trips and their relative importance by volumes. At a micro scale, identification of preferred parking spot locations.
- **Flows and volumes** – volumes of flows per link, node, in area or between areas.
- **Level of service** – information on speeds, travel times, delays which allows to identify problems and priorities for intervention.
- **Surface quality** – information on the quality of the surface of paths realized by users, particularly cyclists.
- **Comparisons with other indicators** – the overlapping of user activity data collected by tracking with other available data, like accidents, pollution or orography.
The following tables outline the full list of indicators and visualizations identified in the consultation process and the level of importance and priority attributed to it (1 being the most important and 3 the least). These will be applied in terms of development priority for the TRACE tracking data analysis tool:

Table 4 – Tracking data Indicators

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Space dimension</th>
<th>Unit</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of users</td>
<td>Link</td>
<td>users/time</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Node</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Number of trips originated per zone (origin)</td>
<td>Area</td>
<td>users/time</td>
<td>1</td>
</tr>
<tr>
<td>Number of trips ended per zone (destination)</td>
<td>Area</td>
<td>users/time</td>
<td>1</td>
</tr>
<tr>
<td>Volume of users per origin-destination</td>
<td>Area-Area</td>
<td>users/time</td>
<td>1</td>
</tr>
<tr>
<td>Speed average</td>
<td>Link</td>
<td>km/h</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Speed standard deviation</td>
<td>Link</td>
<td>km/h</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Level of service (average speed / free flow average speed)</td>
<td>Link</td>
<td>%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Path</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Node</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Area-Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance average</td>
<td>Area-Area</td>
<td>meters</td>
<td>1</td>
</tr>
<tr>
<td>Trip time average</td>
<td>Area-Area</td>
<td>minutes</td>
<td>1</td>
</tr>
<tr>
<td>Congestion</td>
<td>Link</td>
<td>%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Path</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Area-Area</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Waiting time</td>
<td>Link</td>
<td>hours</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Node</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Path</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Area-Area</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Waiting time average per user</td>
<td>Link</td>
<td>minutes /user</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Node</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Path</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Area-Area</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Quality of surface</td>
<td>Link</td>
<td>rugosity index</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 5 – Tracking data Visualizations

<table>
<thead>
<tr>
<th>Visualization</th>
<th>Variable /description</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicator related visualizations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volumes</td>
<td>Volume of users per link <em>(heat map)</em></td>
<td>1</td>
</tr>
<tr>
<td>Routes finder</td>
<td>Volume of users per link</td>
<td>1</td>
</tr>
<tr>
<td>Origins</td>
<td>Number of trips originated per zone</td>
<td>1</td>
</tr>
<tr>
<td>Destinations</td>
<td>Volume of trips ended per zone</td>
<td>1</td>
</tr>
<tr>
<td>Speed</td>
<td>Speed per link</td>
<td>1</td>
</tr>
<tr>
<td><strong>ALL OTHER TRACKING BASED INDICATORS</strong></td>
<td>All tracking based indicators defined above may be visualized</td>
<td>3</td>
</tr>
<tr>
<td>Parking spots</td>
<td>Heat map of locations where trip ends</td>
<td>2</td>
</tr>
<tr>
<td>Isochrones</td>
<td>For a given location (point), representation of lines which define the set of locations which take 5 / 10 / 15 / 20... minutes to reach that location</td>
<td>2</td>
</tr>
<tr>
<td><strong>Imported variable VS tracking variable</strong></td>
<td>Visualize at the same time external (data link, location or based) and a tracking based visualization</td>
<td>2</td>
</tr>
<tr>
<td>Examples</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident data (vs volume, speed...)</td>
<td>Heat map with accident locations, visualized together with other variables (volumes, speed...)</td>
<td></td>
</tr>
<tr>
<td>Steepness (vs speed, volume)</td>
<td>Slope (%), visualized together with other variables (volumes, speed...)</td>
<td></td>
</tr>
<tr>
<td>Exposure to pollution (vs use);</td>
<td>Pollution indicator, visualized together with other variables (volumes)</td>
<td></td>
</tr>
</tbody>
</table>
4.2 Quality of data

There are two main elements related to quality of data for the purpose of realizing analysis meaningful for mobility planning. The first one is the accuracy of the location data, which depends on the instruments and methods of measurement used by the application. This is essentially a technical issue which is dealt with by TRACE in the part of the work related to ICT challenges\(^\text{11}\). It impacts on the ability to generate accurate indicators.

The other issue is the representativeness of sample. The representativeness is not only defined by the size of the sample, but also by whether the groups inside the sample are representative of the universe targeted by the analyst. Three typical problems of representativeness are presented:

- **Leisure vs utilitarian cyclists**: the most developed segment of tracking applications is related to the promotion of sports or physical activity in general. For example, the STRAVA\(^\text{12}\) heat map is available for any user and site. In starter countries with a low level of cycling, even applications primarily targeted at utilitarian trips, like the *European Cycling Challenge*, do attract individuals who cycle for leisure. Leisure minded cyclists have different preferences in terms of destinations and path choice to utilitarian cyclists and are generally not suitable as a sample for the purpose mobility planning. In ECC application in Bologna, currently the tool attempts to distinguish utilitarian from sports users by filtering the trips by some areas of the city or schedule.

- **Experienced cyclists vs starters**: this distinction is particularly relevant in the context of starter or climber cities, where the cycling network is not fully developed and there are very significant differences between users in terms of their ability and willingness to use the car network for cycling. Initiatives that collect data about existing cyclists tend to attract experienced cyclists, who are the more willing to participate in these kind of initiatives. However, the stronger is their identity as a cyclist, the more likely are they to be far away from the average in terms of choice preferences. When the target of the planner is to take into account the preferences of users who are not very experienced or have a strong cyclist identity, this effect should be considered. A possible way to isolate the differences among different groups is to ask the application users how they identify themselves in terms of their experience and cycling identity.

- **Info excluded users**: walkers with specific needs like elder people and children are also the ones who tend to be excluded from the use of smart mobile phones, which are the devices that make it viable to track the movements of users. This biasing factor is difficult to overcome and the planner may have to assume that the data is not representative for these types of users. If data from these users is particularly important, the planner may require different data collection methods and a specific campaign targeted at these users.

Overall, it is important that the analyst is critical about the type of sample represented by the data and the implications that that may have for the validity of the analysis that are realized. The application of samples from different sources may minimize the problem or, at least, consist of an opportunity to compare data from different segments. Obtaining specific information about the user characteristics also provides the chance to perform analyses and compare results for different user groups.

\(^{11}\) Work Package 4

\(^{12}\) https://www.strava.com/
4.3 Data analysis tools

Most relevant analysis from tracking data may be done in a GIS format, therefore any entity with competencies on GIS can expect to be able to perform relevant analyses. The creation of specific dedicated tools are supposed to facilitate the life of analysts, easing the analytical process and potentially enabling it for GIS laypeople. There are few tools giving the first footsteps in this. Bikeprint is a tool developed and tested by NHTV for the Dutch Noord Brabant region within the NISTO project (Interreg). The same project originated Routecoach, a tool tested in the Flanders region in Belgium with analyses conducted by the University of Ghent (see section 2.1.2). These tools are focused on walking. But so far there are no easy-to-use and commercially available tools prepared for a widespread application and reading data from multiple sources. TRACE is trying to develop such a tool and developing basic tools for other applications to provide the same service.

4.4 How it already happened: examples of application

This section presents some examples of application of tracking information in real policy and planning processes. The following cases are presented from Lisbon, Leuven, Bologna and Eindhoven.

1. Selecting the ideal path in Lisbon

Type of case: Internal dialogue in municipality for space allocation

Source: STRAVA heat map

In Lisbon there was an internal discussion by the municipality staff about the reconfiguration of the Eixo Central, the most important north-south urban path in the city. In a given section, the issue was whether a cycling path should be developed in the main link of the path (A) or, alternatively, in parallel paths with a longer distance but arguably with better slope and traffic conditions for cyclists (B, C). The observation of the local heat map of cyclist paths led to clearly conclude that users preferred the central link, as opposed to the argument that they preferred other connections. This led to the decision to build the cycle path in the main link, even if this implied complications in the allocation of space between different modes in the link.

Figure 15 – Path development choice in Lisbon
2. “Cycling is faster” area definition in Leuven

Type of case: communication with citizens to promote cycling
Source: Routecoach, Univ. Ghent

In Leuven, the cycling and car tracking data allowed to map the areas of the city from which each of the modes of transport is faster in trips towards the train station.

This information was then used to communicate to citizens with the objective to promote more cycling in relation to car use. The communication campaign was based on outdoor posters spread in the frontier line where cycling became the fastest mode as one approached the city centre. The outdoors stated something like “From here, it is faster to arrive by bicycle”.

3. Defining position for new bike racks in Bologna

Type of case: Internal dialogue in municipality for new bike facilities
Source: European Cycling Challenge using Endomondo, SRM

At the end of 2015, the Municipality of Bologna decided to install 1,000 new bike racks in the city centre of Bologna. The issue was to determine the places and the number of racks per place in order to maximize their efficacy. The Local Mobility Agency and the Municipality decided to study the origins/destinations coming from GPS data collected during the European Cycling Challenge 2015 (around 17,000 bike trips, for a total amount of 80,000 km, tracked during the whole month of May in the city). The result was a set of locations and a number of racks per location based on real needs of cyclists, an "evidence-based" approach that gave strength and concreteness to the decision.
4. **How would a new cycle highway improve travel times in Eindhoven?**

Type of case: data analysis on effects of possible infrastructure intervention  
Source: Bikeprint, University of Applied Sciences Breda

![Image](image1)

**Figure 18 – Analysis of travel time reduction by implementation of a high speed cycling lane in Eindhoven**

In Eindhoven, existing cycle tracking data allowed to closely characterize the speeds practised in each link, as well as the travel times from each zone to the city centre. Based on that information made possible by tracking data, a test was made to check what would be the time benefits per zone, as shown by the figure.

5. **Identification of user sub-optimal choices and improve communication to users in Leuven**

Type of case: data analysis on user preferences  
Source: Routecoach, University of Ghent

![Image](image2)

**Figure 19 – Bicycle user route choices between a high speed route and an old route in Leuven**

A new high speed cycling route was develop at the north side of the rail line in Leuven. However, the tracking data revealed about half of the users coming from the south side of the line were still using an old route when they would be able to ride faster if they followed a certain link towards the north route. Following from this information, the municipality inserted better information at the relevant intersection so as to inform the users that they could proceed to the high speed cycle route.
4.5 Issues to consider for obtaining and analysing walking or cycling tracking data

A number of issues and decisions need to be considered when one intends to obtain and analyse tracking data. The following lines describe four main issues and related decisions.

What are the objectives?

Depending on the specific objectives of the actor intending to obtain and analyse tracking data, there will be different types of decisions to take regarding the approaches to take. A significant aspect is of course the target group of users of the analysis. Does it refer to the whole population of users or to a specific target group like trips to school? This will affect the type of campaign to develop both in terms of communication and tracking technology\(^\text{13}\). Another relevant aspect is whether the analyst intends only to get a static overview of the travel patterns in the area or if dynamic information (i.e. measurements throughout longer

\(^{13}\text{See TRACE Deliverable 2.2 on Campaign Guidelines}\)
Information and Guideline

s on tracking data for planning

(like for example the case of the Fiets Telweek initiative in the Netherlands). In the latter case, a more continuous collection will be needed.

Is a behaviour change campaign also intended?

As the collection of tracking data provides an opportunity to set up campaign directed at the promotion of active modes through dedicated applications, it might be an opportunity to do both things. An example is the European Cycling Challenge which is both a behaviour change and a data collection initiative. The communication to users will of course be distinct since the behaviour change approach has multiple options to attract users while the simple data collection campaign will mostly rely on asking the users to contribute with data for a better planning. Regarding behaviour change campaigns, it is recommended to consider possible self-selection effects from different types of users.

For a detailed guidance on tracking based behaviour change design, see TRACE Deliverable 2.2 on “Guidelines for campaign design using tracking services”.

Is there data already available?

If a new behaviour change campaign is not a prerequisite, a campaign wouldn’t be necessary if there is already data available. It might be that there are already data sources available locally which can be used, allowing to do without a whole new campaign. Depending on the objectives of the analysis, the requirements on the data quality and representativeness might differ. For example, in the Lisbon example above a publicly available Strava map (which includes mostly leisure and sports users) was sufficient for the data interpretation in question. Even if it is still rare to find local data by commuters, the future tendency will be that more initiatives producing relevant and quality data are ongoing. Furthermore, in some areas like the Netherlands (Fiets Telweek) or European Cycling Challenge participants, there have already been initiatives which produced relevant data.

What tools to perform analyses?

Two types of tools may be considered: simple GIS tool and tracking data analysis tool performing map matching. In general terms, the more complex and detailed are the analyses intended, the more a map matching based tool is needed as it allows to compute detailed indicators per link and node. In a broad sense, the more advanced a city is in walking or cycling use and provision, the more will map matching tools be needed to perform relevant analysis for improvements which in such scenario deal more at the level of the details. In terms of resources for conducting analysis, for the GIS tool application a technician with basic knowledge on such instrument is required. For other tools, it is still difficult to say how the future will be, but the currently existing tools still require specialized expertise on GIS like applications.

To our knowledge, the only European tool currently explicitly on the market in the scope of cycling since recently is Bikeprint, although more applications should appear in very few years. No such tool is yet available in the scope of walking.
For more information:

- Project coordinator at INESC ID: Paulo Ferreira: paulo.ferreira@inesc-id.pt
- Project communication manager at Polis: Giacomo Lozzi: glozzi@polisnetwork.eu
- About this deliverable (Leader of Work Package 3 – Tracking data for planning and policy): João Bernardino, TIS: joao.bernardino@tis.pt

Project website: www.h2020-trace.eu
Twitter: @TRACE_project
TRACE LinkedIn Group: TRACE Project
ANNEX I (Deliverable 3.1)

Literature review on planning and policy processes, information and planning support systems

Date: 08/01/2016

Author(s): Giacomo Lozzi (Polis), Mafalda Lopes (TIS), Predrag Živanović (FTTE)
## Contents

1. Aim of TRACE and of this literature review ..........................................................5
2. Methods and materials .........................................................................................6
3. Results and findings ..............................................................................................8
4. Overview of guidelines and projects on planning for walking and cycling ..........9
   4.1 SUMP (Sustainable Urban Mobility Plans): the European policy making process and the role of data collection ..........................................................9
     4.1.1 The general planning approach ....................................................................9
     4.1.2 The use of data in the SUMP process ...........................................................11
     4.1.2.1 Analyse the mobility situation and develop scenarios (Step 3) ....................12
     4.1.2.2 Set priorities and measurable targets (Step 5) ............................................13
     4.1.2.3 Build monitoring and assessment into the plan (Step 8) ............................13
     4.1.2.4 Learn the lessons (Step 11) ......................................................................13
     4.1.2.5 Final summary .........................................................................................13
   4.2 BYPAD project and platform ............................................................................13
     4.2.1 The policy making process as intended in the BYPAD project ....................14
     4.2.2 Tailored cycling policies for different city typologies .................................18
     4.2.3 Data sources: which data are used? How data have influenced the decision making process? ..........................................................18
     4.2.4 Final remarks ............................................................................................19
   4.3 PRESTO project ...............................................................................................20
     4.3.1 The policy making process as intended in the PRESTO project ...................20
     4.3.2 Tailored cycling policies for different city typologies .................................23
     4.3.2.1 Infrastructure ..........................................................................................23
     4.3.2.2 Promotion ...............................................................................................24
     4.3.3 Data sources: which data are used? How data have influenced the decision making process? ..........................................................24
     4.3.4 Final remarks ............................................................................................25
5. Overview of ongoing relevant projects on walking and cycling .........................26
   5.1 B-TRACK-B .....................................................................................................26
   5.2 EMPOWER .....................................................................................................26
   5.3 FLOW ............................................................................................................27
   5.4 SMASH ..........................................................................................................27
   5.5 ENDURANCE .................................................................................................27
6. The importance of synergies with other projects and how synergies are being detected ..........................................................29
7. List of identified projects ......................................................................................30
List of figures

Figure 1 - Planning Cycle for a sustainable Mobility Plan ................................................................. 12
Figure 2 - BYPAD modules .................................................................................................................. 16
Figure 3 - BYPAD ladder of development ......................................................................................... 17
Figure 4 - Balance of infrastructure measures and promotion measures ............................................ 18
Figure 5 - Scheme of Starter, Climber and Champion Cities .............................................................. 21
Figure 6 - Sequence of cycling strategy efforts .................................................................................... 21

List of tables

Table 1 - Categories of identified projects .......................................................................................... 8
Table 2 - Overview of five selected projects ....................................................................................... 26
Table 3 - List of ongoing projects ..................................................................................................... 30
Table 4 - List of finished projects ...................................................................................................... 35
1 Aim of TRACE and of this literature review

In Europe and around the world, public authorities and other stakeholders are seeking for new ways to achieve sustainable urban mobility. Active travel policies, in particular on walking and cycling, have a large potential in this regard. At the same time, these two mobility modes strongly contribute to bust congestion. Although the importance of walking and cycling has been largely recognised at every institutional level, only few national and local authorities have already put in place robust and coherent strategies and measures in order to encourage their spread.

In addition to urban mobility planning initiatives addressing walking and cycling, in recent years behaviour change initiatives have gained momentum. They consist of introducing small incentives and increasing awareness to guide the behaviour of citizens, engaging users by relying only on small prizes, social incentives and motivational nudges, without enforcement actions.

The TRACE project will provide new tracking services for walking and cycling, which will address both behaviour change and mobility planning.

In this project, innovative and technological initiatives on how to foster walking and cycling will be explored. Therefore, particular attention is being paid on new technologies which are emerging for mobile computing as well as on new affordable and accessible ways to facilitate walking and cycling. These tools are chosen because their application in planning processes holds huge potential to change mobility behaviour by fostering walking and cycling. The aim of TRACE is therefore to identify tools that on the one hand track walking and cycling data and provide incentives for behaviour change, and on the other hand support tracking data analysis for planning purposes.

In order to foster the development of such tools, to assess their potential and the ways they are currently being applied, and to find out about their specific characteristics in different contexts, a broad in-depth knowledge of past and current projects in several scopes is needed. By creating this knowledge, challenges can be figured out when it comes to their technical implementation. By identifying these challenges, advice on how to overcome certain difficulties could be developed. Current needs and practices on planning and policy making regarding walking and cycling, with a focus on the design of tracking based tools that have the potential to contribute to planning processes, must be selected. This literature review, carried out in the framework of WP3 “Tracking for planning: research towards tracking data analysis and planning”, will mainly focus on the tracking for planning aspect. Behaviour change initiatives will be specifically investigated in WP2.

The objectives of the TRACE project are being supported by the European Commission which acknowledges the fact that the unbridled use of cars for individual journeys is no longer compatible with a sustainable mobility system in cities. The approach to encourage walking and cycling, and consequently to bust congestion, is therefore in line with the European Union’s commitments regarding the reduction of greenhouse gas emissions and European legislation on air quality.
2 Methods and materials

As a start off, this research identifies projects related to walking and cycling tracking activities, their application in planning processes and successful undertakings, as well as strategies on how to overcome or avoid shortcomings, over the last ten years. In order to select significant projects to be further analysed, the following sectors have been considered:

1. Walking and Cycling
2. Planning aspects and policy making processes
3. Tracking and ICT

The analysis have considered interesting results as well as promising approaches regarding the aims of TRACE as described above.

Further attention has been paid on potential synergies and exchanges between the projects, in order to circulate and reinforce information and results identified in the TRACE project to relevant target groups. The cooperation with other projects increases the synergies concerning the understanding and unlocking of the potential of tracking services to promote walking and cycling. By organising joint events, an exchange and a spread of knowledge will be triggered and the results of TRACE will be presented to a national and international audience. Special attention in terms of synergies has been paid to the projects FLOW and EMPOWER. Concerning the FLOW project, specific exchange in terms of partners, workshops, webinars and trainings has already been identified and will be applied (see section 6).

The research group decided to focus on the projects undertaken in the last ten years: walking and cycling planning policy has got a foothold only in recent years, and technology for ICT and tracking is continuously changing and developing, so it would have not been useful to further proceed backwards. Moreover, the analysis groups the selected projects into seven sets, according to the main topic they address:

- (cycling & walking) planning
- behaviour change
- behaviour change/ITS
- general policy making
- ICT/ITS
- Bike sharing
- SUMP

Obviously, the boundaries between these categories are very tenuous, since almost all the projects address more issues at the same time: they focus on the development of specific aspects depending on the final objective of the project and the tools or policies they want to accomplish. However, it has been possible to identify the core topic for each project, and on the basis of it, the projects have been categorised in order to provide an overview of the most significant challenges local authorities and other stakeholders are facing and are interested to address.

Since the specific purpose of WP3 is tracking for planning, these 7 categories have been successively narrowed and grouped in the 3 sectors mentioned above (Walking and Cycling, Planning aspects and policy making processes, Tracking and ICT).

The research ranks all the identified projects according to their level of significance with respect to the mission and the activities of TRACE. A numerical scale from 1 (very low significance) to 5 (very high
significance) has been adopted, regardless the specific topic at stake (see annex list). The column beside the rank provides the motivation of the attributed score, highlighting the main common points and differences between TRACE and each project taken into consideration. Finally, the research provides a distinction between finished and ongoing project. This distinction has been made in view of an active collaboration with the projects still in progress. On the basis of the topics that each of them is developing, TRACE will be able to identify possible synergies, to be pursued in two different directions:

- **Content**: how the research or testing activities of each project can support the activities planned in TRACE, in terms of methodology and results achieved so far.
- **Dissemination**: which events or communication channels can be shared between TRACE and the other projects in order to multiply the impact of the project outputs.
3 Results and findings

During the research process, 43 projects were identified (see annex list). According to the adopted methodology (section 2), they can be divided into 7 categories:

Table 1 - Categories of identified projects

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>(cycling &amp; walking) planning</td>
<td>14</td>
</tr>
<tr>
<td>behaviour change</td>
<td>12</td>
</tr>
<tr>
<td>behaviour change/ITS</td>
<td>3</td>
</tr>
<tr>
<td>general policy making</td>
<td>7</td>
</tr>
<tr>
<td>ICT/ITS</td>
<td>3</td>
</tr>
<tr>
<td>bike sharing</td>
<td>2</td>
</tr>
<tr>
<td>SUMP</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL</td>
<td>43</td>
</tr>
</tbody>
</table>

During the analysis of these projects, it became clear that there are numerous projects focusing on planning for walking and cycling (14 out of 43). Another large number of projects highlight the behaviour change elements (12 out of 43), while 3 projects focus on behaviour change and ITS (Intelligent Transport Systems) together. As stated in section 1, these are the main areas of application of the TRACE tracking tools: it means that TRACE is addressing some of the most relevant topics when it comes to supporting initiatives in the field of active travel.

Other projects concentrate on general policy making (7 out of 43), ICT/ITS (3 out of 43), bike sharing (2 out of 43) and Sustainable Urban Mobility Planning (SUMP, 2 out of 43). As anticipated in the previous section, many projects focus on several subjects at once, however, certain common and overlapping aspects between the projects and the subjects cannot be clearly differentiated from each other.

22 of the selected projects were already finished when the research started. However, they have been included in the overall list of projects, so that the Consortium will have at any time a comprehensive overview of what has been delivered so far as regards the topics related to the projects: for specific activities of TRACE, it could be useful to consult previous findings of some of these projects. Moreover, this literature review focuses on current practices for cycling and walking planning and policy. For this reason, section 4 is dedicated to guidelines and projects focusing on these aspects, also investigating whether specific provisions and indications are considered for data collection. In particular, the general Sustainable Urban Mobility Plans process is analysed, together with two finished projects, BYPAD (became now a platform) and PRESTO.

Among the ongoing projects, five were selected because of high interest for the aims of TRACE. None of these projects cover all the three sectors mentioned above: however, they deal with topics and/or challenges very close to those addressed in TRACE. The criteria for the selection have taken into consideration the necessity to include all of the three sectors interesting to TRACE, i.e. Walking and Cycling, Planning aspects and policy making processes, Tracking and ICT (see Table 2). Section 5 provide an overview of these selected projects.
4 Overview of guidelines and projects on planning for walking and cycling

4.1 SUMP (Sustainable Urban Mobility Plans): the European policy making process and the role of data collection

4.1.1 THE GENERAL PLANNING APPROACH

In recent years local authorities in European cities’ have developed the necessary awareness to initiate the needed and desirable shift towards cleaner and more sustainable transport modes, such as, for example, walking, cycling, public transport and new way of conceiving car use and ownership.

The European Commission released in 2011 the first guidance document “Developing and Implementing a Sustainable Urban Mobility Plan”1 (SUMP), introducing the concept of SUMP and setting out the steps involved in their preparation. It defines a SUMP as a “strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life”. Such a plan should not be considered as “yet another plan”. Instead, SUMP is conceived as a new planning tool for sustainable urban mobility, it builds on existing European best practices within a comprehensive framework without imposing a top-down approach, and it “takes due consideration of integration, participation, and evaluation principles”.

The 2013 Urban Mobility Package2 set out a concept for SUMP3 that has emerged from a broad exchange between stakeholders and planning experts across the European Union. A SUMP aims to create a sustainable urban transport system by addressing the following objectives:

- ensuring that the accessibility offered by the transport system is available to all;
- improving safety and security;
- reducing air and noise pollution, greenhouse gas emissions and energy consumption;
- improving passenger and goods transportation’s efficiency and cost-effectiveness;
- contributing to enhancing the attractiveness and quality of the urban environment and urban design.

The EC aims to achieve these goals by implementing a new urban mobility planning methodology. The following table compares a traditional planning process and a sustainable one.

<table>
<thead>
<tr>
<th>Focuses on traffic</th>
<th>Focuses on people</th>
</tr>
</thead>
</table>

Table 1: A new way of planning urban mobility

---

2 http://ec.europa.eu/transport/themes/urban/urban_mobility/ump_en.htm
### Primary Objectives

<table>
<thead>
<tr>
<th>Traffic flow capacity and speed</th>
<th>Accessibility and quality of life, as well as sustainability, economic viability, social equity, health and environmental quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode-focused</td>
<td>Balanced development of all relevant transport modes and shift towards cleaner and more sustainable transport modes</td>
</tr>
<tr>
<td>Infrastructure focus</td>
<td>Integrated set of actions to achieve cost-effective solutions</td>
</tr>
<tr>
<td>Sectorial planning document</td>
<td>Sectorial planning document that is consistent and complementary to related policy areas (e.g., land use and spatial planning; social services; health; enforcement and policing; etc.)</td>
</tr>
<tr>
<td>Short- and medium-term delivery plan</td>
<td>Short and medium-term delivery plan embedded in a long-term vision and strategy</td>
</tr>
<tr>
<td>Related to an administrative area</td>
<td>Related to a functioning area based on travel-to-work patterns</td>
</tr>
<tr>
<td>Domain of traffic engineers</td>
<td>Interdisciplinary planning teams</td>
</tr>
<tr>
<td>Planning by experts</td>
<td>Planning with the involvement of stakeholders using a transparent and participatory approach</td>
</tr>
<tr>
<td>Limited impact assessment</td>
<td>Regular monitoring and evaluation of impacts to inform a structured learning and improvement process</td>
</tr>
</tbody>
</table>

Source: Guidelines. Developing and Implementing a Sustainable Urban Mobility Plan

SUMPs focus on improving life quality and not just solving traffic bottlenecks. Also for this reason there is a reference to accessibility rather than transport.

The European Commission established the European Platform on Sustainable Urban Mobility Plans, which supports the transition towards competitive and resource-efficient mobility systems in European cities by:

- Supporting the further development of the SUMP concept⁴ and the tools required for its successful application by local planning authorities (such as the new SUMP Self-Assessment Tool⁵);
- Providing the Mobility Plans portal⁶ to disseminate relevant information, publications and tools;
- Facilitating the co-ordination and co-operation across the different EU-supported actions through a Co-ordinating Group⁷;
- Offering opportunities for the exchange of knowledge, experiences and contacts

SUMPs implementation is not set as mandatory at European level, since this legislative domain pertains to MSs.

---

⁴ [http://www.eltis.org/mobility-plans/sump-concept](http://www.eltis.org/mobility-plans/sump-concept)
The current European discussion on Sustainable Urban Mobility Plans (SUMP) highlights the need for a truly integrated approach to achieve a real and lasting impact.

4.1.2 THE USE OF DATA IN THE SUMP PROCESS

In addition to the general planning aspects, the SUMP guidelines have been analysed regarding the way data should be incorporated in planning processes. Special attention has been paid on how data influences decision making processes regarding to the SUMP guidelines.

The SUMP Planning Cycle is composed of 11 steps, grouped in 4 areas: Preparation, Goal setting, Elaboration, Implementation.

Data collection is mainly addressed in:

- Step 3 - Analyse the mobility situation and develop scenarios (preparation)
- Step 5 - Set priorities and measurable targets (goal setting)
- Step 8 - Build monitoring and assessment into the plan (elaboration)
- Step 11 - Learn the lessons (implementation).

The following paragraph considers more in detail how data use affects mobility planning, but here it is important to underline that data represents an essential subject addressed in all the 4 areas of the SUMP planning process.
Regarding the way the SUMP guidelines suggest to incorporate data into the decision making process, the following results have been found.

4.1.2.1 Analyse the mobility situation and develop scenarios (Step 3)

According to activity 3.1, the local authority should identify useful data and assess their quality and accessibility, as well as secure coverage of necessary data requirements. Furthermore, available data is meant to be retrieved and its content should be synthesised. For filling gaps, additional data should be collected. It is important to mention that, according to the SUMP guidelines, data can be collected by a variety of means, including tracking data. Attention should be paid that the data itself always fits the local context, in order to enable a realistic and reliable analysis of the state of the art. Based on the collected data, suitable indicators that describe the status of transport and mobility in the respective city should be defined, always focusing on key policy objectives. By preparing a baseline analysis to identify and prioritise key problems to be addressed, the data is incorporated into the preparation of decision making processes. This activity represents an important input for the scenario building and the whole planning process.
In activity 3.2, different policy scenarios are being developed to describe developments that might result from different policies and measures. These scenarios are meant to be defined both in a qualitative and a quantitative way. Among other aspects, the data collected in activity 3.1 is incorporated into the possible scenarios and therefore has an impact on the different weights characterizing them, as well as the decision making process in general.

4.1.2.2 Set priorities and measurable targets (Step 5)

Activity 5.1, in order to define clear and measurable objectives, ensures that data gathered in the previous phase presents a reasonable level of accuracy, so that the progress towards the achievement of these objectives can be easily measured and evaluated. This activity is needed for activity 5.2, where SMART\(^8\) targets are developed, which in turn are essential for monitoring and evaluation purposes (activity 8.1).

4.1.2.3 Build monitoring and assessment into the plan (Step 8)

Further use of data is foreseen in activity 8.1, which suggests to arrange for monitoring and evaluation. In this activity, the assessment of the impact of a specific action should be the main focus. For example, by counting the number of cycling trips before and after the implementation of a SUMP plan, data is used to measure the outcomes of a particular initiative, and so its actual (quantitative) impact. A data collection strategy should also be developed when necessary. The activity 8.1 and 3.1 are directly related to each other and should be constantly coordinated.

4.1.2.4 Learn the lessons (Step 11)

Finally, also in activity 11.2 “review achievement, understand success and failure”, data plays an important role: here, a process evaluation and a broader impact assessment of the implemented measures should be run. An analysis of what went well/went badly should be carried out. Based on this analysis, strategies to strengthen success stories and to avoid failure for the next round of planning should be developed.

4.1.2.5 Final summary

This short analysis shows that data plays an important role during all the planning phases of a SUMP: the preparation of measures, the setting of the objectives, the elaboration of the plan as well as the monitoring processes which, again, lead to new action. Data should be used to analyse the current mobility situation and develop alternative scenarios, that might result from different policies and measures. Consequently, the level of accuracy of the previously collected data should be assessed, in order to develop SMART (measurable and quantifiable) targets. Once the plan is in place, monitoring and evaluation should be carried out, and the impact of a particular measure will be assessed on the basis of the type of data selected and its \textit{ex-ante/ex-post} quantification. Finally, a more general impact assessment will be implemented in order to understand success and failure: this process will consider the actual achievement of the target previously identified.

4.2 BYPAD project and platform

\(^8\) SMART: specific, measurable, achievable, realistic, time-bound
BYPAD (Bicycle Policy Audit) is a tool developed by an international consortium of bicycle experts as part of a European project, funded for the first time by the European Commission in 1999. It provides an overview of the applied measures and structures in local cycling policies. The first BYPAD-project was implemented by Langzaam Verkeer (co-ordinator), FMG-AMOR, Velo:consult and ECF (European Cyclists’ Federation).

Within the last years, BYPAD has created a pan-European network of almost 200 cities, towns and regions in 24 European countries. The main goal of BYPAD is to improve the bicycle policy of a city/region by an internal evaluation process and by learning from other experiences in European cities/regions. It aims to improve the quality of cycling policies and, consequently, increase cycle use and improve cycle safety by:

1. Implementing cycle audits in cities and regions.
2. Exchanging cycling knowledge and expertise among members of the BYPAD-network (Auditors, cities, towns and regions).

In order to reach these goals, BYPAD assesses the quality level of the cycling policy in cities as a preliminary step for a quality plan/action plan for the local cycling policy. This is achieved through the introduction of the Total Quality Management tool defines quality standards by collecting information on all different aspects of cycling policy in a standardised manner. This helps cities, regions to reset their ambitions and goals with regard to become a better cycling city.

To avoid that BYPAD becomes the next EU-supported project dying when the EU financial support ends, the BYPAD activities have been conceived to be carried out on permanent basis and not on project basis. A legal body, the BYPAD-foundation has been formed for giving this continuation. The BYPAD-foundation will:

- support the implementation of BYPAD-audits
- organize the exchange of cycle knowledge through seminars, conferences, excursions
- communicate about BYPAD via a newsletter, website
- improve and update the BYPAD-tool
- train new and existing BYPAD-auditors
- hand over the BYPAD-certificates to the BYPAD cities, towns, regions

### 4.2.1 THE POLICY MAKING PROCESS AS INTENDED IN THE BYPAD PROJECT

The goal of BYPAD is to define quality standards by collecting information on all different aspects of cycling policy in a standardised manner. However, implementation of BYPAD depends on the specific city context:

- Geography of a city
- Different BYPAD-auditors
- Different personal opinions of the people in the evaluation groups
- Different cycling culture

Each method has its own approach and the focus is sometimes on different aspects. Also the initiator who decides to work with the instrument is very important. For instance, The Cycling Balance in the Netherlands is an initiative of the Dutch cyclists’ association who wants to award the best cycling city of the year. At the same time they are delivering a status report on the comfort of cycling in that city.
In BYPAD, it is not the user groups who are the initiators of the audit. It is the local authority which decides: “I want to improve my bicycle policy, and I am going to use BYPAD to make an advice on the actual quality level and the improvement steps”.

Through BYPAD, municipalities can initiate a process of continuous quality improvement. To achieve this, BYPAD combines cognitive, conversational and learning elements:

1. **Cognitive element.** The quantitative assessment of the individual aspects of cycling policy helps to convince the rationalists.

2. **Conversational element.** Discussing the cycling policy within the evaluation group of decision makers, policy makers, executive staff and the user organisations (‘clients’) strengthens the political will to improve the quality of the cycling policy.

3. **Learning element.** Assessing the cycling policy in a moderated process supervised by an external auditor strengthens the effect of learning. Also the regional, international seminars and the good practice database strengthen the effect of learning.

BYPAD regards cycling policy as a **dynamic process** where different components need to fit together to be successful. BYPAD does not only analyse outcomes and effects of the local cycling policy, but it provides a broader picture, determining whether the planning process, with its objectives and strategy, is embedded in the political and administrative structures.

BYPAD distinguishes nine modules, whose quality levels are determined separately (see Figure 2). For each module, a quality level (from 1 to 4) is assigned on the BYPAD ladder of development. The results of all nine modules altogether determine the overall quality level of the cycling policy. Besides that, it is possible to monitor the evolution of the local cycling policy. On the basis of the results for each module, the municipality can define quality objectives and derive measures separately for each module.

The dynamic planning process envisaged by BYPAD, although with some differences regarding the single modules, presents the same approach of the Planning Cycle for a sustainable Mobility Plan described above (Figure 1): the idea is that planning is a never-ending process, which starts from the identification of the users (citizens) needs in order to improve mobility and their quality of life.
A key issue in the BYPAD approach is that the whole process of evaluation and quality improvement is carried out by a local evaluation group. This evaluation group consists of politicians responsible for cycling, policy makers and executive staff of the municipality dealing with cycling, and representatives of the local cyclists’ user organisation(s). Bringing these three different players together, BYPAD assures that the local cycling policy is critically examined from different perspectives.

The evaluation group looks for strengths and weaknesses of the cycling policy, and agrees on the fields where improvements are necessary and possible. The audit process is supervised by an external consultant, who is a certified BYPAD auditor.

<table>
<thead>
<tr>
<th>Evaluation group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users: local cyclists’ associations, individual users, ...</td>
</tr>
<tr>
<td>Officials: head of transport department, cycling officer, ....</td>
</tr>
<tr>
<td>Politicians: major, alderman for transport, spatial planning, ....</td>
</tr>
</tbody>
</table>

The principal item of BYPAD is the questionnaire, which consists of a set of questions with fixed alternatives, covering all aspects of cycling policy for cities/towns/regions. The questions cover all the nine modules defined above, and describe appropriate measures which have successfully been implemented in European cities. A quality level between 1 and 4 is assigned to each answer. If no action is taken, the quality level is zero. BYPAD allows local authorities to immediately identify the level of development of their city’s cycling policy: it detects the weakest link in the quality chain and shows where improvements are necessary and
possible. By filling in the questionnaire, the local authority (city, town, region) receives direct inspiration of what could be done for climbing up to the next quality level.

*Figure 3 - BYPAD ladder of development*

The levels of development are:

**Level 1: Ad hoc oriented approach**  
*Fire brigade principle:* Cycling policy is mainly limited to problem solving.

**Level 2: Isolated approach**  
Good infrastructure is the main concern of the policy, although some supplementary activities are undertaken. Cycling policy is characterised by some use of data and a limited knowledge of the users’ needs, global agreements with a limited compulsory character, measures which are often counterproductive, because they are not tuned to the needs of other road users or not integrated into the objectives of other policy fields.

**Level 3: System orientated approach**  
Cycling is regarded as a system, integrated into the overall mobility policy. The political will to support the cycling policy is underlined by a sophisticated local cycling strategy and appropriate budget allocation. Cycling policy is based on good data and the knowledge of user needs, but still on a project basis with limited running time.

**Level 4: Integrated approach**  
Cycling policy is regarded as a permanent task with strong relationship to other policy fields. Measures to encourage cycle use are complemented by measures to discourage car use. There is strong political support, good leadership, regular budget allocation, enough skilled staff and comprehensive in-house expertise. Systematic networking and regular exchange of information, knowledge and experiences with internal and external actors help to raise and maintain the quality standard. The cycling policy is characterised by the
availability of high quality data, regular monitoring and evaluation, strategic partnerships to let all the stakeholders participate in the definition of the local cycling policy.

Responsible policy-making is rewarded. After completion of the BYPAD-audit, the city receives the BYPAD certificate. This certificate confirms the active commitment of decision-makers, administrative bodies and citizens to a modern, high-quality cycling policy.

As a result of the BYPAD audit process, the local authority gets scores for each of the nine modules and for its cycling policy as a whole. These scores indicate straightforwardly where the strengths and weaknesses of a city’s cycling policy are. The interim and final reports of the audit, written by the auditor, are a detailed inventory of the cycling policy so far and a documentation of the audit process. The quality plan documents the objectives, main fields of action and measures the evaluation group has agreed on. This represents the basis for the resulting action plan, which will ensure the deployment of a coherent and effective package of measures to improve the local cycling policy.

4.2.2 TAILORED CYCLING POLICIES FOR DIFFERENT CITY TYPOLOGIES

Several challenges concerning the implementation of pro-cycling measures have been identified by the BYPAD project. It is important to mention that challenges depend on the specific city context and therefore differ according to the circumstances a city finds itself in. However, some categorisation is provided in the document:

Starting Cycling Cities. Cities in which the modal share of cycling is less than 10%. The goal in those cities is to make cycling possible, safe and comfortable. For example, a basic level of bicycle facilities (cycle lanes, bicycle parking, traffic calming zones) should be implemented before a city starts stimulating cycle use through campaigns or information. In terms of promoting cycling, a starter city is well advised to only communicate the cycle measures that are already in place.

Climber Cycling Cities. Cities in which the modal share of cycling is about 10-20%. In this stage, the goal is to convince more people to use the bicycle. A climber city should communicate the advantages of cycling. At the same time, a continuous improvement of the cycle conditions (comfort, safety) is necessary.

Champion Cycling Cities. Cities in which the modal share of cycling is more than 20%. In such cities, the goal is to keep people cycling. In this stage most of the short distance trips are made by bicycle (or public transport). It is not necessary anymore to convince people of the advantages of bicycle use.

According to BYPAD, it is important to achieve a good mixture of hardware (infrastructure) and software (promotion) measures. The balance between these two aspects, again, depends on the modal share regarding cycling (see Figure 4).

**Figure 4 - Balance of infrastructure measures and promotion measures**

Consequently, the package of necessary cycling measures differs according to the level of cycle use in a city or region. For example, in a city with a low cycle use it is more effective to invest in infrastructure and traffic safety before stimulating and promoting bicycle use. It would even be useless to promote bicycle use via campaigns or school projects if cycling is unsafe or uncomfortable. That is also the main reason why the exchange of experience in the BYPAD-network is organised between cities and regions who are on a similar quality level of cycling policy. However, an effective package of measures to increase cycle use and traffic safety is always a mix of infrastructure measures and soft measures (information, promotion).

4.2.3 DATA SOURCES: WHICH DATA ARE USED? HOW DATA HAVE INFLUENCED THE DECISION MAKING PROCESS?
The BYPAD guidelines, “Cycling, the European approach - Results and lessons of the BYPAD-project”, does not provide specific recommendations on how to use data for influencing decision making processes.

In terms of collecting quantitative data, BYPAD is not at the forefront. Rather, in the overview of the characteristics of the different evaluation methods for cycling policy in place in Europe, collecting quantitative data is seen as one of the weaknesses of the BYPAD method and its implementation is considered to be very time consuming.

However, BYPAD stresses the importance of monitoring and evaluation to foster knowledge and innovation for cycling: monitoring is even one of the 3 macro categories (planning, actions, monitoring), grouping the 9 BYPAD modules.

As a basic criteria to describe the four levels of development (see 4.2.1), BYPAD stresses the importance of the availability of high quality data, which supports the local authority to properly understand the actual areas of improvement. Moreover, data collection is essential to ensure the fulfilment of the cognitive element (see again 4.2.1): as stated above, the quantitative assessment of the individual aspects of cycling policy provides support to explain the need to introduce a new specific measure.

As a basis for the EU BYPAD-platform project, the Transport Research Institute of the University in Hasselt in Belgium carried out a literature review of existing data and knowledge on bicycle use (modal split data) and traffic safety, discovering that comparable data on modal share of cycle use are rare at local level. These modal split data exist at national level, but figures are difficult to compare. Different collection methods and other registration years give an approximate indication of the modal share of cycling at European level, but it is clear that there is a need for more comparable data in the future. Through BYPAD, it is possible to find different modal split data at local level, but also here the sources are really different from each other (dissimilar collection method and years of data collection not coinciding).

### 4.2.4 FINAL REMARKS

The BYPAD tool specifically addresses policy-makers and local authorities, in order to let them evaluate the quality of their cycling policy themselves by using a strengths and weaknesses analysis. Simultaneously, they receive concrete suggestions on how they can improve their cycling policy in future. BYPAD is characterised by two main aspects: firstly, it was funded for the first time in 1999 as an EU project, but afterwards it set up the BYPAD-foundation, which allows this tool to be still available without the financial support of the Commission. Secondly, the whole process of evaluation and quality improvement is carried out by a local evaluation group, composed by three different types of local stakeholders (politicians, policy makers and urban planners, user representatives), whose activities are supervised by an external BYPAD auditor, who guarantees the accuracy of the process. According to this planning approach, local authorities should start by analysing their local state of the art, and the corresponding levels of development for each different aspect of the cycling policy, because this is the essential starting point for any following tailored local action plan. However, general evaluation methods and techniques can be provided through the BYPAD tool, developed by an international consortium of bicycle experts. It is based on international Best Practice methods, it provides an overview of the applied measures and structures in local cycling policy and it is flexible and applicable to all local frameworks. Consequently, the BYPAD methodology foresees a direct involvement of local stakeholders’, the best experts of their own environment, guided step by step in their evaluation process by an external facilitator, in order to generalise and consequently better assess the particular situation.

Data is considered an essential supporting element for planning, even if the collection process in BYPAD should be made more effective and less time consuming.
4.3 PRESTO project

PRESTO is a European project, funded by the Intelligent Energy Europe programme, which took place between 2019-2012. It aimed to improve energy efficiency, reduce CO2 emissions and air pollution by increasing the modal share of cycling. It also aimed at increasing traffic safety and at improving public health by promoting physical activity. The project transferred the best European know-how on three thematic pillars:

- Infrastructure Planning, developing sound plans for better and safer cycling conditions
- Promotional "soft measures", changing people’s minds towards a real "cycling culture"
- Promotion of pedelecs, enabling and encouraging cycling among "sleeping" target groups, which usually would not cycle.

According to the general framework of the PRESTO Cycling Policy Guide\(^9\), nowadays cycling policy is on the agenda in many European cities. In recent years and decades, many local authorities have been undertaking a range of activities to stimulate cycling as a daily transport mode, because they are increasingly convinced that cycling is good for cities. For providing some orientation to decision makers and those involved in implementation, the PRESTO guidelines and fact sheets were created to bundle state-of-the-art European knowledge and experience on urban cycling policy in an easily accessible format. The guidelines are meant to not only support cities in their cycling policy activities, but also to serve as European reference guides. The guidelines are an outcome of the PRESTO project which is about promoting cycling for everyone as a daily transport mode. In that project, five cities and a range of experts united in developing strategies to tap the potential of cycling in cities. The chosen cities represent a range of diverse size, location, culture and cycling tradition. Each city deployed actions in three fields: cycling infrastructure, cycling promotion and pedelecs. For more information visit: www.presto-cycling.eu.

The policy guides presented in the PRESTO document offer a clear and systematic framework to help decision makers develop a cycling policy strategy. The frameworks are grouped in four parts, of which one presents a general framework, outlining the fundamentals of an integrated cycling policy. Three further policy guides develop one policy area each: cycling infrastructure, cycling promotion and pedelecs. The policy guides are accompanied by 25 implementation Fact Sheets giving more detailed and practical (technical) information on how to implement a selection of cycling policy measures. They are meant as a working instrument for those involved in implementing cycling policy.

In the following chapters, recommendations according to the PRESTO guide are gathered, divided into the following aspects:

- The policy making process as intended in the PRESTO project
- Main problems/challenges to address
- Data sources: which data are used (if any)? How data have influenced the decision making process?

4.3.1 THE POLICY MAKING PROCESS AS INTENDED IN THE PRESTO PROJECT

\(^9\) Dirk Dufour PRESTO Cycling Policy Guide – General Framework. Ligtermoet & Partners, the Netherlands
In the general framework of the PRESTO Cycling Policy Guide, three policy guidelines on key measures are provided: cycling infrastructure, cycling promotion and pedelecs.

There is no one-size-fits-all model for making cities cycle-friendly. This is why the guide proposes, as a first step of the planning process, to distinguish cities according to their level of cycling development as **Starter, Climber and Champion cities** (see Figure 5), and suggests approaches and packages of measures that are likely to be most effective at each stage. The level of cycling development of a given city depends on two indicators:

- cycling conditions
- cycling rate.

This categorisation is the same used in the BYPAD project, where this distinction was used to define the proper mix of hard (infrastructure) and soft (promotion) measures. This is the same approach used by PRESTO: the following diagram suggests a sequence of cycling development efforts, regarding the same types of measures, across the three cycling stages (Figure 6).

*Figure 5 - Scheme of Starter, Climber and Champion Cities*

*Figure 6 - Sequence of cycling strategy efforts*
Cycling policy at each level has different aims: this requires a different policy mix of infrastructure and promotion efforts. And within infrastructure and promotion efforts, the focus will also vary. Picture 2 illustrates a number of ideas. Finally, it suggests different scales for cycling policy, starting on a neighbourhood level and progressing to a city-wide cycling network.

In chapter 3.5, it is suggested that cities should move towards a cycling policy culture. This suggestion is based on a study among ten champion cycling cities all over Europe in which key success factors were identified. First of all, a long-term commitment to an integrated cycling policy is mentioned as the most important aspect. The strategies on how to implement the commitments, on the other hand, can differ and might need some frequent adjustment. However, it is mentioned that the key is the willingness to maintain the effort on all aspects of cycling. Therefore, keeping strengthening and consolidating cycling policy is described to be crucial throughout the three stages.

Concerning the support of effective cycling policy culture, three recommendations are provided in the document:

- Cycling policy should progressively become institutionally integrated in urban management and planning. Cycling needs should be taken into account in all relevant public departments at all levels, especially transport infrastructure, traffic management, land use planning and urban design. The city should network with other cities on cycling policy.
As cycling progresses, monitoring and research become increasingly important, to foster knowledge and innovation.

Authorities should build a constructive alliance with local cyclists and retailers and cycling associations. Their experience in the field is invaluable. They can help to create and support a cycling vision, to map out a cycling network and to aid in its implementation and promotion.

For the TRACE project, the general framework PRESTO Cycling Policy Guide has been taken into account also in order to find out how data is suggested to be used in terms of supporting cycling and how data influences decision making processes.

In general, it can be stated that, according to the PRESTO guide, the aspect of gathering and analysing data is of great importance; data is necessary to define whether a city is classified as a starter, climber or champion city. Based on this classification, the according following steps are recommended to be taken. That means that only after a thorough analysis, the actual work begins. In that sense, each political decision is based on data in the first place. However, gathering and analysing data is not meant to be finished at some point, but it should rather continue as a city improves regarding their specific cycling targets; as cycling progresses, data becomes even more important. Gathering and analysing data is a continuous, dynamic process which differs depending on the specific city conditions and is likely to change over time.

4.3.2 TAILORED CYCLING POLICIES FOR DIFFERENT CITY TYPOLOGIES

According to the general framework of the PRESTO Cycling Policy Guide, the package of necessary and justified cycling measures differs according to a city's stage of cycling development and circumstances. Therefore, the aims of a specific cycling policy depend on the development of the city level. The aims can range from making cycling possible, safe and respectable to getting people on a bicycle or keeping people on their bicycles. For further refining these challenges, broad aims and packages of measures in developing a step-by-step strategy have to be defined. Cities should of course adapt this to their local situation and move measures forward or back as they see fit.

For a Starter City, the aims are described as facilitating cycling and on how to get momentum going. As a problem regarding this challenge, it was found that on most roads and streets, traffic is too heavy and too fast to cycle safely. At the same time, road design is car-oriented and does not take into account cycling. Another common problem is the lack of cycling provision: no tracks or lanes, no signage or markings, no parking stands or storage.

In terms of Climber Cities, efforts should continue to expand and diversify cycling infrastructure. But at the same time, there is still a large potential for shifting from car trips to bicycle trips. That is why promotion efforts are important to attract new cyclists.

At the Champion Cycling City level, the described challenge is to keep people on their bicycles. At this stage, important infrastructure efforts will again be needed, but now to upgrade infrastructure to offer higher degrees of quality and comfort. At the same time, promotion efforts must be kept up to keep daily cyclists satisfied, by offering them state-of-the-art information and benefits as a reward for their cycling efforts.

4.3.2.1 Infrastructure

In terms of infrastructure, the PRESTO Cycling Policy Guide stresses the need to clear up a still widespread misunderstanding which is about the fact that cycling infrastructure does not mean a grand city-wide master plan of wide cycle tracks separated from traffic. Rather, the challenge for encouraging cycling should be about an ideal cycle network consisting of routes that are safe (mixed with quiet traffic or on well-designed specific
provision, direct (taking cyclists to their destinations via the shortest and quickest routes), coherent (connected into a city-wide network), comfortable (smooth surfaces and kerbs, well-lit etc.) and attractive (taking cyclists through agreeable environments). For a Starter City, the basic requirements are described to be safety and directness because people will start cycling if they can cycle safely and easily from their homes to other destinations nearby. This is why another challenge is described as making selected high-potential neighbourhoods cycle-friendly. As for Climber Cities (where basic provision of cycling infrastructure are considered to already exist), a new major challenge is described as improving network cohesion. This should be achieved by linking up safe cycling areas into an expanding network, so that cyclists can easily move about between areas, across the city over longer distances. Eventually, this should also mean tackling more difficult, busy areas, major road links and barriers. The challenge for Champion Cities, where a sizeable network of safe and direct routes is considered to be in place, is about keeping people on their bicycles. Therefore, it is suggested to make the network more comfortable and attractive.

4.3.2.2 Promotion

In the PRESTO Cycling Policy Guideline the promotion of cycling as a challenge for cities is mentioned. Again, the focus of the promotion and priorities are likely to shift according to the level of cycling development in a city. For a Starter City, the aims of promotion are described to be about encouraging those who just need a slight push to start cycling or to cycle more. In Climber Cycling Cities the new challenge is to reach more people and get them on their bicycles. The main aim is now to convince and activate those who still hesitate, from school children to the elderly, from commuters to leisure cyclists, from women to immigrants. In Champion Cycling Cities, the additional challenge is to keep people on their bicycle. It is suggested that promotion should continuously reward and support cycling.

4.3.3 DATA SOURCES: WHICH DATA ARE USED? HOW DATA HAVE INFLUENCED THE DECISION MAKING PROCESS?

The general framework of PRESTO provides some insight as well as some recommendations on how to use data for influencing decision making processes. First of all, it is stated that cycling policy needs to start from a thorough local analysis of cycling conditions, destinations, needs, desires, cultures and attitudes. It is furthermore mentioned that each city will have to strike its own balance between infrastructure and promotion efforts on cycling policy, set out a vision and a strategy and monitor results along the way. In terms of data, it is advised to use a two-step approach which contains of the following aspects:

- Assessing cycling conditions. In this step, the question about safety, feasibility, convenience and attractiveness is being raised. This question is a matter of not only cycling infrastructure, but also about traffic intensities and speed levels as well as traffic policies like traffic calming or car-free areas. Another important aspect is about urban layout. In this respect, data should be gathered in terms of density and mixture of a city. Further aspects, like the distances between destinations, or its sprawling and car dependency should be taken into

---

10”Dutch Quality Requirements for cycling infrastructure”, which have been widely accepted and taken up in many manuals
account as well. The framework pays respect to the fact that conditions may vary between areas within the same city as well.

- **Measuring the cycle rate.** In this step, it is advised to find out the share of daily trips done by bicycle. This is a clear-cut quantifiable indicator, to be defined by on-street counting or surveys.

It is mentioned that cycling rates rise as cycling conditions improve and that this dynamic also works the other way round: as more people cycle they will demand ever better conditions. Monitoring and research should become increasingly important to foster knowledge and innovation as cycling progresses. It is recommended to involve cyclists into the process of gathering data. They should be actively encouraged to give feedback, either through a telephone number or an online reporting platform, with fast response and follow-up action. Bicycle counters are recommended to monitor the use of the network, and provide valuable input. User surveys should shed lights on the needs of cyclists and potential cyclists. In general, it is suggested to constantly evaluate cycling safety, and accidents should be analysed in detail. For exchange in terms of data gathering, a city should participate in networking with other cities and joint projects and research. This means that the aspect of gathering data is a process that should not end at some point, but is rather ongoing. The kind of gathered data varies depending on the specific context and condition of a city, and is likely to change over time. The decisions taken during a decision making process should be based on those data. Therefore, data plays an important role for decision making progresses in each city, whereas a starter city finds itself at the very beginning of gathering and using data for shaping the face of its public space. In that sense, the way data is gathered and used can be understood as a dynamic process that is likely to change over time.

### 4.3.4 FINAL REMARKS

The PRESTO project specifically addressed policy-makers and local authorities, in order to transfer the best European know-how on the three thematic pillars mentioned above (infrastructure, promotion, pedelecs). It developed four policy guides, which provide a useful guidance for policy-makers to identify the preliminary steps needed to frame the measures to be undertaken in order to improve cycling in their city. The ratio behind this planning approach is based on the fact that there is no one-size-fits-all model for making a city cycle-friendly: it is essential to understand which is its own development stage and, consequently, put in place a strategy which addresses in a realistic way the actual challenges and needs of the city. The approach and understanding required to develop and foster a cycling culture differs depending on whether a city is a starter, climber or champion cycling city, and it has to be developed by the local authority itself, the only actor who knows the local situation and can tailor the general guidelines set at European level.

Data is considered an essential supporting element for planning. Starter cities should use data to map the current situation, e.g. measure the cycling rate, but also Climber and Champion cities should use it to constantly monitor the cycling conditions in order to improve them and maintain sufficiently high the number of cyclists. In line with the SUMP guidelines, data gathering and evaluation is a dynamic and cyclical process which never comes to an end.
5 Overview of ongoing relevant projects on walking and cycling

Table 2 - Overview of five selected projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Focus</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-TRACK-B</td>
<td>Tracking systems for behaviour change, planning for cycling</td>
<td>Families with children aged 9-15, local authorities</td>
</tr>
<tr>
<td>EMPOWER</td>
<td>Behaviour change, ITS, tracking for planning by transport authorities and providers</td>
<td>Citizens, transport authorities and providers</td>
</tr>
<tr>
<td>FLOW</td>
<td>Walking and cycling, planning</td>
<td>Cities, decision-makers, companies</td>
</tr>
<tr>
<td>SMASH</td>
<td>ICT/ITS, tracking services</td>
<td>Companies</td>
</tr>
<tr>
<td>ENDURANCE</td>
<td>SUMPs, exchange of knowledge, planning</td>
<td>City planners</td>
</tr>
</tbody>
</table>

5.1 B-TRACK-B

The B-TRACK-B project (“bike the track / track the bike”) addresses behaviour change with the help of tracking systems (e.g. RIFD, GPS). By promoting the use of bicycles among families with children aged 9-15 for their leisure (urban) trips in 7 European cities, the projects intends to engage indicatively 100 families per site in an innovative track-the-bike ”lottery” to motivate them to shift from car to bike use. Two competition-based marketing campaigns are planned and monitoring will be done through tracking systems (RIFD, GPS or simply through km counter and stamp cards). Local leisure trips generators (e.g. sport facilities, parks, shopping centers, etc.) will be involved. B-Track-B is based on a combination of previous successful experiments executed in Denmark (Frederica’s cycle registration systems), Italy, France (GPS tracking during bicycle leisure events), Slovenia (involvement of cycle associations) and the Netherlands ("Ride to School" in Rotterdam). Combining the lessons learned of those local experiments into a powerful B-Track-B concept will not only allow to foster cycling during leisure travel in the participating cities, yet also provide a convincing and proven concept that will be adopted by other EU cities and countries, during the project life time.

5.2 EMPOWER

The EMPOWER project addresses behaviour change and ITS. By adopting a “reward rather than punishment” approach, the project explores the use of positive incentives delivered through smart phone technologies and the web to persuade people to make modest shifts in their transport choices. EMPOWER is about the use of positive incentives such as information, points, discounts, rewards, community support and games, rather than charging, pricing, rationing, restrictions and regulation. There is already evidence that the use of a range of incentives can have a strong influence on travel choices. For incentives to be effective, past research has also shown that incentives should be personalised. This implies they should be tailored towards the preferences, personal goals and needs for each person at a specific time. The personalisation of
incentives is also needed in order to address the needs of specific vulnerable groups of travelers. Smart devices (phones and tablets) will allow two-way information flow between the travelers and transport authorities or providers, including the ability to offer tailored incentives relevant to the individual’s travel patterns. In this case, tracking will be useful in order to plan more effective measures to increase the use of sustainable transport modes.

5.3 FLOW

The mission of the FLOW project is to put walking and cycling on an equal footing with motorized modes, by developing a user-friendly methodology to assess the effectiveness of walking and cycling measures in addressing urban road congestion. FLOW targets three main stakeholder groups: cities, businesses and decision-makers, with the aim of shifting the way these groups think about and act on the potential for non-motorized transport to reduce congestion. FLOW will communicate the project’s results through tailored materials for use by practitioners in each of these three key fields.

FLOW partner cities will pilot an assessment tool that looks at the congestion impact of walking and cycling measures as well as improved transport modeling simulation tools. These will be used to develop implementation scenarios and action plans to add or upscale cycling and walking measures shown to reduce congestion.

TRACE could benefit from the results of FLOW Congestion Reduction Assessment Methodology, and at the same time could contribute to its development through the TRACE Tracking for planning tool, an instrument for tracking data analysis for urban mobility planning and policy making: this tool will create a better informed planning and decision making process, translating data on cycling and walking movements in urban areas into useful indicators and analyses on issues like the characterization of the demand, the performance of the mobility system or users’ preferences.

5.4 SMASH

The SMASH project mainly addresses ICT and ITS. SMASH is a Smart Sharing Device aiming to improve the access and the fruition of innovative urban mobility, through the combined use of satellite tracking technology and wireless transmission, embedded in a single miniaturized device. The proposed device, developed by greenspider and available in prototype, integrates in a single ultra-low-power electronic circuit a GNSS receiver, Near Field Communication (NFC), Bluetooth Low Energy (BLE), and GPRS module for connection to the cloud. The supported NFC is compatible with the standard nowadays adopted by major Smartphone’s manufactures and mobile operators, and it is considered a disruptive technology to enable secure authentication, mobile access and payment via Smartphone. With this characteristic SMASH permits a direct NFC interaction with end-user smart phone, and correlate positioning data retrieved from different positioning device. SMASH enables access to innovative mobility schemes, thanks to its embedded GNSS and proximity interaction between the user’s Applet and the device. The device can be integrated into vehicles and infrastructures, like parking or charging stations, or in general in any resource in a sharing scheme, allowing easy NFC controls and data sharing. Thanks to the NFC connection, the data related to the user’s access request and to the available resources, with the relative positions, are exchanged in a safe and reliable way, and shared in the cloud, enabling innovative mobility service and advanced fleet management.

5.5 ENDURANCE
By incorporating the project ENDURANCE into the research, exchange of knowledge with other European projects can be achieved. ENDURANCE aims to assist cities and regions with developing Sustainable Urban Mobility Plans (SUMPs) by facilitating networking, mutual learning and sharing of experience and best practice across countries. ENDURANCE activates 250 cities in Europe to engage in SUMPs and in their implementation. Furthermore, the project raises awareness about SUMPs and its benefits at national and European level institutions. On the long term, the strategic objective includes the establishment of SUMPs as a major urban policy supported on a local, national and European level. A further target is to reduce the modal share of the car by on average 5% in 400 of the 483 cities above 100,000 inhabitants in Europe.
6 The importance of synergies with other projects and how synergies are being detected

Since there are several European projects that are thematically related to TRACE, it is advisable to stimulate exchange between these projects and TRACE. Through exchange, potential synergies can be detected and projects can benefit from each other and achieve better results by supporting and reinforcing each other in promoting their results to relevant target groups. This is why exchange regarding measures to promote cycling and walking is of outstanding importance to TRACE. The means to foster exchange are various: by organizing joint events, by mutual promotion of the projects at their respective events, by promoting the results and outputs in respective newsletters, websites and other channels of communication (e.g. social media). Furthermore, potential synergies will be detected at meetings and events like conferences, work conferences, workshops or webinars at national, European and international levels and by communication with other stakeholders in general. Since Polis is involved in several “Mobility for Growth”-H2020 transport-related projects and is very experienced in terms of networking and exchange, it will play a key role in that regard.

In particular, TRACE should coordinate with the other CIVITAS Horizon 2020 projects which have just started, namely FLOW and EMPOWER. The following potential synergies with the FLOW project have been detected:

- There is loads of opportunity to take part in other project local events: By inviting FLOW partners and cities to TRACE stakeholder workshops, and vice versa for FLOW Congestion Busting Local Forum.
- The possibility to take part in the webinars and trainings organized by the other project: FLOW partners and cities will be invited to take part in TRACE webinar and midterm validation seminar and training. TRACE partners will also have the possibility to participle in FLOW trainings and online courses.
- Presentation of the TRACE project results at FLOW final event in February 2016 in Brussels and vice versa.

At the moment, several projects and initiatives concerning the aims of TRACE in different cities and countries stand beside each other, but are unconnected. This leads to the fact that very often, results and findings of projects do not find their way to policy making processes. But for having an effect on city planning, developers, experts and planners must be brought together. The fruitful exchange is of great importance and increases the potential of different projects and approaches. By establishing the exchange with the initiatives described above, the probability of a good exploiting of the projects will increase and even pave the way for new concepts and tools.
## 7 List of identified projects

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Title</th>
<th>Description</th>
<th>Type</th>
<th>Website</th>
<th>Classification</th>
<th>Ranking (1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-TRACK-B</td>
<td>Family cycling for energy efficiency in urban leisure travel</td>
<td>&quot;Bike the track/track the bike&quot; promotes the use of bicycles by families with children aged 9-15 for their leisure (urban) trips in 7 European cities. The action intends to engage indicatively 100 families per site in an innovative track-the-bike &quot;lottery&quot; to motivate them to shift from car to bike use.</td>
<td>behavioural/ITS</td>
<td><a href="https://ec.europa.eu/energy/intelligent/projects/b-track-b">https://ec.europa.eu/energy/intelligent/projects/b-track-b</a></td>
<td>Monitoring is implemented through tracking systems (RFID, GPS, etc.)</td>
<td>3</td>
</tr>
<tr>
<td>EMPower</td>
<td></td>
<td>EMPOWER sets out to substantially reduce the use of conventionally fuelled vehicles (CFV). Adopting a ‘reward rather than punishment’ approach, EMPOWER will explore the use of positive incentives delivered through smart phone technologies and the web to persuade people to make modest shifts in their transport choices.</td>
<td>behavioural/ITS</td>
<td><a href="http://empowerproject.eu/">http://empowerproject.eu/</a></td>
<td>Focus on supporting cycling and walking through ICT tools</td>
<td>4</td>
</tr>
<tr>
<td>FLOW</td>
<td>Furthering Less Congestion by creating Opportunities for more Walking and cycling</td>
<td>FLOW sees a need for a paradigm shift wherein non-motorised transport is placed on an equal footing with motorised modes with regard to urban congestion. To do this, FLOW will create a link between (currently poorly-connected) walking and cycling and congestion by developing a user-friendly methodology for evaluating the ability of walking and cycling measures to reduce congestion.</td>
<td>cycling &amp; walking planning</td>
<td><a href="http://www.h2020-flow.eu/">http://www.h2020-flow.eu/</a></td>
<td>It develops a methodology to assess the effects of walking and cycling measures - &gt; they address: cities, businesses, decision-makers</td>
<td>4</td>
</tr>
<tr>
<td>ENDURANCE</td>
<td>EU-wide establishment of enduring national and European support networks for sustainability</td>
<td>ENDURANCE aims to assist cities and regions with developing Sustainable Urban Mobility Plans (SUMPs) by facilitating networking, mutual learning and sharing of experience and best practise across countries</td>
<td>SUMP</td>
<td><a href="http://www.epomm.eu/endurance/index.php">http://www.epomm.eu/endurance/index.php</a></td>
<td>Supports networking and exchanging experiences in general, addresses planners, not (only) focus on cycling, walking, ICT</td>
<td>4</td>
</tr>
<tr>
<td><strong>SMASH</strong></td>
<td><strong>SMASH, SMArt SHaring device for mobility</strong></td>
<td><strong>SMASH is a Smart Sharing Device aiming to improve the access and the fruition of innovative urban mobility, through the combined use of satellite tracking technology and wireless transmission, embedded in a single miniaturized device.</strong></td>
<td><strong><a href="http://cordis.europa.eu/project/rcn/196455_en.html">http://cordis.europa.eu/project/rcn/196455_en.html</a></strong></td>
<td><strong>It includes: tracking, smart devices, not explicitly about walking/cycling, rather about cars, main target: SMEs</strong></td>
<td><strong>4</strong></td>
<td></td>
</tr>
<tr>
<td><strong>European Biking Cities</strong></td>
<td><strong>The European Biking Cities project of the Verkehrsclub Deutschland (VCD) aimed at promoting active cycling policies of European cities by learning from each other. Six cities with ambitious cycling policies formed the European Biking Cities network in 2013: Bolzano (Italy); Brighton &amp; Hove (UK); Mannheim (Germany); Potsdam (Germany); Strasbourg (France); Vitoria-Gasteiz (Spain)</strong></td>
<td><strong>(cycling &amp; walking) planning</strong></td>
<td><strong><a href="http://www.cleanair-europe.org/en/projects/vcd/ebc/">http://www.cleanair-europe.org/en/projects/vcd/ebc/</a></strong></td>
<td><strong>About promoting cycling policies -- no tracking/ICT, no walking, it addresses planners in general</strong></td>
<td><strong>3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>NISTO (SIMS, BikePrint)</strong></td>
<td><strong>New Integrated Smart Transport Options</strong></td>
<td><strong>The aim of NISTO is to develop an evaluation and planning toolkit for mobility projects which is applicable transnationally and can be adopted by planners, based on five key elements for the development of well-functioning mobility concepts: mobility, customer satisfaction, environmental quality, safety and economy.</strong></td>
<td><strong>(cycling &amp; walking) planning</strong></td>
<td><strong><a href="http://www.nisto-project.eu/">http://www.nisto-project.eu/</a></strong></td>
<td><strong>Develops mobility planning toolkit, it is available online, software is included, but no tracking software, its mainly about evaluating projects, might still be interesting for planners</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td><strong>PASTA</strong></td>
<td><strong>Physical Activity Through Sustainable Transport Approaches</strong></td>
<td><strong>It aims to connect transport and health by promoting active mobility in cities (i.e. walking and cycling, including in combination with public transport use) as an innovative way of integrating physical activity into our everyday lives.</strong></td>
<td><strong>behaviour change</strong></td>
<td><strong><a href="http://www.pastaproject.eu/">http://www.pastaproject.eu/</a></strong></td>
<td><strong>It shows the positive effects of walking/cycling, its mainly about networking, exchange, but there are tools designed for urban planners -- no tracking</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td><strong>PTP Cycle</strong></td>
<td><strong>Personalized Travel Planning for Cycling</strong></td>
<td><strong>The overall objective of PTP-Cycle is to prove the transferability of Personalised Travel Planning (PTP) to many types of sites and audiences and to many different countries. The project transfers PTP know-how, empowering cities and key actors</strong></td>
<td><strong>behaviour change</strong></td>
<td><strong><a href="http://ptpcycle-europe.eu/">http://ptpcycle-europe.eu/</a></strong></td>
<td><strong>It addresses cities and key actors, ICT included, as well as walking and cycling, but no planning</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td>Initiative</td>
<td>Description</td>
<td>Methodology</td>
<td>Key Components</td>
<td>Goals</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
<td>-------------</td>
<td>----------------</td>
<td>-------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>SWITCH</td>
<td>Encouraging a SWITCH from car-based to active mobility using personalized information and communication technology approaches</td>
<td>The SWITCH-approach uses personalized travel planning approaches to encourage people to switch car trips to active modes. The innovation comes from (i) the combination of tried and tested personalized travel planning approaches, (ii) their application to target groups of persons in life changing moments on large scale, (iii) the application of ICT solutions like Smartphone applications and Intelligent Health’s Beat the Street system, (iv) and the use of arguments from public health to motivate behaviour change.</td>
<td>behaviour change/ ITS</td>
<td>ICT included, cycling included, no urban planners adresses</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CH4LLENGE</td>
<td>Addressing Key Challenges of Sustainable Urban Mobility Planning</td>
<td>CH4LLENGE develops transferable solutions to the four common challenges faced when developing and implementing SUMP:s: participation of stakeholders; institutional cooperation; identifying effective measures; monitoring and evaluation the plan making process and its measures. CH4LLENGE supports up to 30 committed ‘follower’ cities to practice sustainable urban mobility planning.</td>
<td>SUMP</td>
<td>Mainly about political consulting in general, therefore, tracking, ICT, etc. are not specifically adressed in this regard</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CIVITAS - Urban Freight Logistics and Clean Fuels and Vehicles</td>
<td>Support cities to introduce ambitious transport measures and policies towards sustainable urban mobility.</td>
<td>general policy making</td>
<td><a href="http://www.sump-challenges.eu/">http://www.sump-challenges.eu/</a></td>
<td>Covers everything, depending on the specific needs --&gt; no specific focus on tracking, ICT, planning</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CIVITAS-CAPITAL</td>
<td>Will contribute significantly to the goals of the EU’s Transport White Paper by capitalising systematically on the results of CIVITAS and creating an effective &quot;value chain&quot; for urban mobility innovation. It will help CIVITAS to build the bridge towards a more advanced identity within Horizon 2020. Clean Fuels and general policy making</td>
<td><a href="http://www.civitas-initiativ">http://www.civitas-initiativ</a> e.org</td>
<td>see above</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Name</td>
<td>Description</td>
<td>Details</td>
<td>Focus Areas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td>---------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CYCLE-LOGISTIC S</strong></td>
<td>Move goods by cycle</td>
<td>Cycle Logistics is reducing energy used in urban freight transport, getting unnecessary motorized vehicles off the roads by using more cycles for goods transport in city centers in Europe.</td>
<td>(cycling &amp; walking) planning</td>
<td>Focus not on planning, ICT</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HIGHTS</strong></td>
<td>High precision positionin for cooperator ITS applicatio</td>
<td>This project combines traditional satellite systems with an innovative use of on-board sensing and infrastructure-based wireless communication technologies (e.g., Wi-Fi, ITS-G5, UWB tracking, Zigbee, Bluetooth, LTE...) to produce advanced, highly-accurate positioning technologies for C-ITS.</td>
<td>ICT/ITS</td>
<td>Focuses on vehicles (e.g. cars), not on walking and cycling.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MOBI</strong></td>
<td>Promotin Smart Mobility to Employee s - MOBI</td>
<td>The MOBI project will encourage employers and their employees to use energy efficient and sustainable transport modes for their commute and business travel journeys. This will be achieved through the implementation of an award winning sustainable mobility online game originating from the Netherlands.</td>
<td>behavio ur change</td>
<td>Focus on supporting cycling and walking, no ICT tracking tools, but people can fill in questionnaires and therefore data is created</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MyWay</strong></td>
<td>European Smart Mobility Resource Manager</td>
<td>Placing the traveler at the heart of mobility, MYWAY will develop an integrated platform, the European Smart Mobility Resource Manager, which will facilitate an holistic view of sustainable mobility, combining all sorts of transport services and automatically handling transactions related to their usage into a seamless point-to-point mobility service.</td>
<td>(cycling &amp; walking) planning</td>
<td>Includes ICT, but not explicitly tracking, nor planning, its rather a general tool for each individual traveler</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STARS</strong></td>
<td>Sustainable Travel Recogniti on and Accreditati on for Schools</td>
<td>STARS is launching a behaviour change programme to deliver a modal shift to increase the number of school pupils cycling to and from school. STARS focuses on delivering two proven initiatives: an accreditation system and a p2p engagement.</td>
<td>behavio ur change</td>
<td>No ICT/tracking tools, nor any planning aspects, its mainly about promoting cycling/walking (still important, its about educating the youngsters)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSG NETWORK</td>
<td>Traffic Snake Game Network</td>
<td>Traffic Snake Game Network (TSG Network) establishes an effective EU-wide and long-term support network to replicate, transfer and expand the uptake of the Traffic Snake Game as a successful proven tool for changing the travel behaviour of primary school children (age 6-12) and their parents.</td>
<td>behaviou r change</td>
<td><a href="http://www.tr">http://www.tr</a> afficsna kegame.eu/</td>
<td>no urban planners adressed, no tracking, although working with IT</td>
<td>2</td>
</tr>
<tr>
<td>VeloCittà</td>
<td>Better use of Bicycle Share Systems</td>
<td>In the next 3 years VeloCitta will bring together 10 European partners whose goal is to increase the number of people that use a (shared) bicycle. VeloCitta brings together 5 existing urban Bike Sharing Systems (BSSs) that currently not meet up to the ambitions that were set. The main outcome of the project is to launch an online Workspace of Bike Sharing containing documents, best practices, campaign suggestions, contact form and several e-courses.</td>
<td>Bike sharing</td>
<td><a href="http://velo-citta.eu/">http://velo-citta.eu/</a></td>
<td>addresses local authorities, ICT included, its about sharing experiences in terms of how to implement sharing bike systems</td>
<td>2</td>
</tr>
<tr>
<td>BIKE2WORK</td>
<td>Smart Choice for commuters</td>
<td>The main objective of Bike2Work is to achieve a significant energy-efficient modal shift from motorized modes to cycling by introducing behaviour change programs to employers that sustainably change the behaviour of commuters.</td>
<td>behaviou r change</td>
<td><a href="http://www.bi">http://www.bi</a> ke2work-project.eu/en/</td>
<td>No focus on planning, tracking or ICT, rather on mobility management</td>
<td>1</td>
</tr>
</tbody>
</table>
### Table 4 - List of finished projects

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Title</th>
<th>Description</th>
<th>Type</th>
<th>Website</th>
<th>Classification</th>
<th>Ranking (1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BYPAD PLATFORM</td>
<td>The BYPAD Platform aimed to improve the quality of cycling policies and increased the bicycle use and safety, by implementing audits in European cities and regions. BYPAD was developed as a former SAVE project. It resulted in a profound evaluation report of the actual cycling policy and a concrete Bicycle Action Plan.</td>
<td>(cycling &amp; walking ) planning</td>
<td><a href="http://www.bypad.org/">http://www.bypad.org/</a></td>
<td>Addresses urban planners and policy makers, uses surveys as a tool rather than ICT</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>PRESTO</td>
<td>PROMOTING CYCLING FOR EVERYONE AS DAILY TRANSPORT MODE</td>
<td>PRESTO aimed to improve energy efficiency, reduce CO2 emissions and air pollution by increasing the modal share of cycling. It also aimed at increasing traffic safety and at improving public health by promoting physical activity. Three thematic pillars: - Infrastructure Planning; Promotional &quot;soft measures&quot;; Promotion of pedelecs.</td>
<td>behaviour change</td>
<td><a href="https://ec.europa.eu/energy/intelligent/projects/en/projects/presto">https://ec.europa.eu/energy/intelligent/projects/en/projects/presto</a></td>
<td>Addresses urban planners and policy makers, promotes pedelecs, but no ICT</td>
<td>4</td>
</tr>
<tr>
<td>CHAMP</td>
<td>CYCLING HEROES ADVANCING SUSTAINABLE MOBILITY PRACTICE</td>
<td>The CHAMP-project facilitated the exchange of best practices, experiences and lessons learned (good and bad ones!) within a group of &quot;best in class&quot; cycling cities. A CHAMP performance analysis tool was developed.</td>
<td>(cycling &amp; walking ) planning</td>
<td><a href="http://www.champ-cycling.eu/">http://www.champ-cycling.eu/</a></td>
<td>About exchanging experiences (e.g. In workshops), therefore it addresses planning, but no ICT included</td>
<td>3</td>
</tr>
<tr>
<td>ECO-MOBILITY SHIFT</td>
<td>ECOMOBILITY SCHEME FOR ENERGY-EFFICIENT TRANSPORT</td>
<td>EcoMobility refers to the ability of any individual to travel, access opportunities and reach destinations in an environmentally-friendly, safe and healthy way. EcoMobility SHIFT has identified 20 indicators that allow it to measure how a city currently works, what it has delivered on the ground and the results and impacts achieved.</td>
<td>general policy making</td>
<td><a href="http://www.ecomobility.org/">http://www.ecomobility.org/</a></td>
<td>Promoting Sustainable travel modes, addresses planners, no ICT included</td>
<td>3</td>
</tr>
<tr>
<td>MOBILE2020</td>
<td>MORE BIKE IN SMALL AND MEDIUM SIZED TOWNS OF CENTRAL AND</td>
<td>The goal of MOBILE2020 is to enable stakeholders in small and medium cities in these countries to increase their share of biking as a mode of everyday transport. MOBILE2020 will empower municipal planners and decision makers to make the right investments, improve their planning</td>
<td>(cycling &amp; walking ) planning</td>
<td><a href="http://www.mobile2020.eu/">http://www.mobile2020.eu/</a></td>
<td>goal: improving the conditions for everyday cyclists by educating urban planners, cycling practitioners, establishing</td>
<td>3</td>
</tr>
<tr>
<td>Project Name</td>
<td>Project Description</td>
<td>Methodology</td>
<td>Focuses on</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------</td>
<td>-------------</td>
<td>------------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Europe by 2020</td>
<td>procedures and to trigger a change in mobility behaviour.</td>
<td></td>
<td></td>
<td>networks, but no tracking included, might still be relevant and worth looking at it once more</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAVIKI</td>
<td>Energy Efficiency through Web 2.0 Bicycle Navigation and Communication</td>
<td>The Naviki project aims at promoting cycling in European cities and touristic areas by rolling out a European internet platform for navigation, communication and planning in the field of cycling. In Naviki any cyclist will be able to discover the best cycle paths all over Europe and to publish them online. Official partners can specifically indicate paths with a certified quality standard. (cycling &amp; walking) planning</td>
<td></td>
<td>Definitely ICT (and tracking probably as well -- to be asked), cycling included, but no walking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENERQI</td>
<td>Energy efficiency by using daily customers' quality observations to improve public transport</td>
<td>ENERQI is short for 'Energy efficiency by using daily customers' quality observations to improve public transport'. The project implements an innovative quality monitoring system for public transport. It involves voluntary quality observers, which are in fact public transport travellers.</td>
<td>general policy making</td>
<td>Rather about PT and how to improve its quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUTRE</td>
<td>FUTURE prospects on Transport evolution and innovation challenges for the competitiveness of Europe</td>
<td>FUTURE project will highlight which future challenges and demand drivers can have a considerable impact on the global demand patterns in the passenger and the freight transport and how this might affect the competitiveness of related industries and service providers.</td>
<td>general policy making</td>
<td>No focus on walking, cycling (only among others), its more about companies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEDIATE</td>
<td>Methodology for Describing the Accessibility of Transport in Europe</td>
<td>The overall objective of MEDIATE is to contribute to the development of inclusive urban transport systems with better access for all citizens. The MEDIATE project is a Coordination and Support Action and the project objective is to establish a common European methodology for assessing,</td>
<td>general policy making</td>
<td>Focuses on accessibility, not explicitly on cycling/walking, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Name</td>
<td>Report</td>
<td><a href="http://www.h2020-trace.eu">www.h2020-trace.eu</a></td>
<td>describing and measuring accessibility to transport.</td>
<td>(cycling &amp; walking) planning</td>
<td>Platform for future cycling promotion --&gt; therefore interesting for planners, especially in terms of bicycle infrastructure planning, no tracking/ICT, and no focus on walking.</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>--------</td>
<td>-------------------</td>
<td>---------------------------------------------------</td>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Nordic Cycle Cities</td>
<td>ON 2 WHEELS IN 3 YEARS</td>
<td>The primary aim of Project Nordic Cycle Cities was to create a solid platform for future cycling promotion in each of the 11 communities by drawing up a number of core strategic documents that would establish political commitment and owner ship of cycling promotion and ensure that it was solidly anchored in the entire municipal organization across all disciplines.</td>
<td><a href="http://www.nordiskecykelyer.dk/">http://www.nordiskecykelyer.dk/</a></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OBIS</td>
<td>Optimizing Bike Sharing in European Cities</td>
<td>OBIS will advance the role and the opportunities of bike sharing as a valuable instrument to foster clean and energy efficient sustainable modes of mobility in urban areas. It will support the adoption of bike sharing all over Europe and guide the relevant actors implementing efficient bike sharing schemes.</td>
<td>Bike sharing</td>
<td>Interesting for planning (&quot;guiding the actors implementing efficient bike sharing schemes&quot;) --&gt; bike sharing always includes tracking, the project identifiers good practices, not explicitly about tracking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPICYCLES</td>
<td>Sustainable Planning &amp; Innovation for Bicycles</td>
<td>Cities need support in increasing of the modal share of cycling in their cities. SPICYCLES aimed to create this support and made tools and know-how available to the cities in an attractive format.</td>
<td>(cycling &amp; walking) planning</td>
<td>Its about tools for making know-how available for cities --&gt; not so much about tracking, walking and cycling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STADIUM</td>
<td>Smart Transport Applications Designed for large events with Impacts on Urban Mobility</td>
<td>The ultimate goal of the project is to improve the performance of transport systems made available to a wide and differentiated range of users in the framework of large events hosted by big cities, through the development of a set of guidelines and tools to implement management support systems (mainly ICT technologies).</td>
<td>ICT/ITS</td>
<td>ICT included, but hardly in terms of cycling/walking (rather in terms of large events --&gt; buses, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>Description</td>
<td>Focus Areas</td>
<td>Website</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>-------------</td>
<td>---------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAPAS</td>
<td>Transport, Air pollution and Physical Activities</td>
<td>The purpose of the TAPAS is to help decision makers design urban policies that address climate change and also promote other health-related outcomes. In particular, we are interested in assessing conditions and policies that hinder or encourage active travel, and resulting health impacts. We will develop a tool box for policy makers to calculate and demonstrate the potential net health benefits of their policies.</td>
<td>(cycling &amp; walking) planning</td>
<td><a href="http://www.h2020-trace.eu">www.h2020-trace.eu</a></td>
<td>It addresses urban planners, active modes are tackled, no tracking included, maybe ICT --&gt; to be asked, mainly about health</td>
<td></td>
</tr>
<tr>
<td>TIDE</td>
<td>Transport Innovation Deployment in Europe</td>
<td>Enhance the broad transfer and take-up of 15 innovative urban transport and mobility concepts throughout Europe: Electromobility-City Logistics.</td>
<td>(cycling &amp; walking) planning</td>
<td><a href="http://www.tide-innovation.eu/en/">http://www.tide-innovation.eu/en/</a></td>
<td>No specific categories in TIDE tackling tracking/ICT, but the project developed recommendations for urban planners --&gt; might be good to complement the other projects</td>
<td></td>
</tr>
<tr>
<td>TRENDY TRAVEL</td>
<td>Public transport, cycling and walking should be associated with positive emotions like excitement, fun, being moved (in the heart), lust for life, pride and so on. This is the aim to be achieved with the emotional approach, as developed in the EMOTIONS project and now to be continued and expanded in TRENDY TRAVEL.</td>
<td>behavi our change</td>
<td><a href="http://www.trendy-travel.eu/">http://www.trendy-travel.eu/</a></td>
<td>Not explicitly about tracking, but it is about promoting cycling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACTIVE ACCESS</td>
<td>Encouraging active travel for short trips to improve health and the local economy</td>
<td>ACTIVE ACCESS aims at increasing the use of cycling, especially walking short everyday trips in local areas, in order to benefit people’s health, and health of the local economy. It aims to transfer longer car trips to shorter walking &amp; cycling trips by changing people’s mental maps of their local neighbourhoods.</td>
<td>behavi our change</td>
<td><a href="http://www.activ-access.eu/">http://www.activ-access.eu/</a></td>
<td>No focus on planning, tracking or ICT, rather on mobility management</td>
<td></td>
</tr>
<tr>
<td>ASTUTE</td>
<td>Advancing Sustainable Transport in Urban areas</td>
<td>ASTUTE aimed to overcome the organisational barriers that prevent an increase in the use of walking and cycling in European urban centres. It used mobility management techniques such as Travel Awareness</td>
<td>behavi our change</td>
<td><a href="http://www.astute-eu.org/">http://www.astute-eu.org/</a></td>
<td>No focus on planning, tracking or ICT, rather on mobility management and organizational aspects</td>
<td></td>
</tr>
<tr>
<td>Project Name</td>
<td>Description</td>
<td>Behaviour Change</td>
<td>Focus Areas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------</td>
<td>----------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BAMBINI</strong></td>
<td>Socialisation towards clean and energy efficient transport</td>
<td>Behaviours change</td>
<td>No focus on planning, tracking or ICT, rather on toy industry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CARMA</strong></td>
<td>Cycling Awareness Raising and Marketing</td>
<td>Behaviours change</td>
<td>Mainly about communication campaigns (stickers, classroom presentations, publishing), no tracking, no planning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PRO-E-BIKE</strong></td>
<td>Promoting electrical bicycles and scooters for delivery of goods and passenger transport in urban areas</td>
<td>No planning, no tracking, no walking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transport Learning</strong></td>
<td>TRANSPORT LEARNING aims to create knowledge and capacity on sustainable transport policies and measures in municipalities and energy / management agencies of Europe’s convergence regions. It further aims to strengthen market activities on sustainable transport by integrating it in the business portfolio of energy / management</td>
<td>General policy making</td>
<td>Mainly about economic aspects, not explicitly about cycling/walking/tracking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>agencies thus supporting the regions’ catching up economically.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNEX II (Deliverable 3.1)

Assessment of potential of tracking for planning and policy making

Date: 29/01/2016

Author(s): Predrag Živanović, Slaven Tica, Stanko Bajčetić, Branko Milovanović, Ana Trpković, Vladislav Maraš, Andrea Đorđević

Faculty of Transport and Traffic Engineering Belgrade (FTTE)
Contents
1. Assessment of potential of tracking for planning and policy making .............................................. 4
1.1. Brief overview of transport planning process and relevant information ........................................ 4
1.2. Assessment of gaps in data relevant for transport planning ...................................................... 9
1.3. Assessment of potential of tracking for planning and policy making ........................................ 14
1.4. The recent experiences on the use of tracking data in other transport modes .............................. 20
1.5. The recent experiences on the use of cycling and walking tracking data for planning ................... 22
1.6. The quality of tracking data ...................................................................................................... 26
1.7. Conclusions ................................................................................................................................. 28
2. References .................................................................................................................................. 29
3. Annex ........................................................................................................................................... 32
3.1. Local Authorities Survey Crosstab Analysis Methodology ........................................................ 32
3.2. Classification of cities by modal shares of cycling and walking and number of inhabitants ....... 33

List of figures
Figure 1 Importance of promoting and improving conditions for cycling/walking (PA Survey) .................. 5
Figure 2 Priorities of elements in the planning and operational activities due to their importance for cycling (PA Survey) ................................................................. 6
Figure 3 Priorities of elements in the planning and operational activities due to their importance for walking (PA Survey) ................................................................. 7
Figure 4 Priorities of elements in the planning and operational activities due to their importance (Users Survey) ...................................................................................... 7
Figure 5 Relevancy of barriers for achieving the existing priorities (PA Survey) ................................ 8
Figure 6 Relevancy of barriers for achieving the existing priorities by city type (PA Survey) ............... 8
Figure 7 Relevancy of barriers for achieving the existing priorities by city type (Users Survey) ........... 9
Figure 8 Type of information considered for cycling and walking (PA Survey) .................................... 9
Figure 9 Type of information considered for cycling and walking – Consultation with users (PA Survey) ........................................................................................................ 10
Figure 10 Type of information considered for cycling and walking – Tracking of routes of individuals (PA Survey) ........................................................................... 10
Figure 11 Tracking data usage (PA Survey) ......................................................................................... 11
Figure 12 Type of information considered for cycling and walking – Tracking of routes of individuals – User survey ................................................................. 11
Figure 13 Tracking data usage – walking (PA Survey) ....................................................................... 12
Figure 14 Tracking data usage – cycling (PA Survey) ......................................................................... 12
Figure 15 Types of tracking devices (PA Survey) .............................................................................. 13
Figure 16 Potential of tracking data usage in future (PA Survey) ........................................................ 17
Figure 17 Potential of tracking-based information use for different planning/policy activities (PA Survey) ............................................................................................................ 17
Figure 18 Potential of tracking-based information to radically improve planning practice (Users Survey) ........................................................................................................ 18
Figure 19 Would tracking-based information be useful to your organization? (Users Survey) .......... 18
Figure 20 Potential of tracking-based information use for different planning/policy activities (Users Survey) ........................................................................................................................... 19
List of tables

Table 1 Importance of promoting and improving conditions for cycling/walking (PA Survey) ..................5
Table 2. Identification of gaps in data relevant for transport planning and potential of tracking data to
fulfil those gaps........................................................................................................................................13
Table 3. The recent experiences on the use of cycling tracking data .................................................................23
Table A1. Classification of cities (cycling)........................................................................................................32
Table A2. Classification of cities (walking) .........................................................................................................33
Table A3. Classification of cities by modal share of cycling and number of inhabitants....................................33
Table A4. Classification of cities by modal share of walking and number of inhabitants...............................34
1. Assessment of potential of tracking for planning and policy making

1.1. Brief overview of transport planning process and relevant information

Understanding travel behaviour is crucial for travel demand management as well as in transport planning. The urban planning and policy practice has been increasingly applying information and analysis tools which provide support by identifying problems and testing solutions. Such tools are commonly referred to in the academic literature as Planning Support Systems\(^1\). This section reviews literature on tracking data use in transport planning process.

Many transport planning agencies at national, regional or city level use transport demand forecasting models to help in planning transport infrastructure and management policies or to anticipate exogenous developments in travel demand patterns (RAND, 2003). Of course there are limitations to the applicability of the models in terms of the level of detail, their reliability in dealing with extreme scenarios, the length of the forecast period that can reasonably be considered etc. Moreover, based on the spatial coverage of the model and level of detail one can distinguish three levels of transport planning: macroscopic, mesoscopic and microscopic (Barceló et al., 2005). To address these diverse issues the models need to be as flexible as possible, especially regarding possibility to efficiently handle a wide set of input data (quantitative and qualitative): socioeconomic data (demographics, land-use data), network data (transport infrastructure), etc.

Travel data is one of the key input data in transport planning process. However, individual travel patterns are becoming increasingly varied and complex in time and space, due to a range of factors (spatial fragmentation, work issues (part-time, working from home), household data, etc.). Current travel behaviour research increasingly focuses on trip chaining, complete daily and weekly activity patterns, interrelationships within households and the relationship between spatial structure on a detailed level and travel behaviour (e.g. Boarnet and Sarmiento, 1998; Golob, 2000; Krizek, 2003; Maat and Timmermans, 2006; Bohte and Maat, 2008).

There are two basic concepts in personal travel behavior modeling: aggregate and disaggregate. These are distinguished based on the way how behavior is depicted, especially in model development phase. Aggregate models use data grouped by transport zones, while disaggregate are based on personal travel data. Although latter models offer a greater level of detail, the aggregate models are still used to a large extent due to their simplicity and satisfactory level of precision (Ortuzar and Willumsen 2011). However, recent research show that the paradigm had shifted from aggregated modeling to disaggregated modeling (Rasouli and Timmermans, 2013).

---

\(^1\) For comprehensive literature review on Planning Support Systems and synthesis of relevant findings for TRACE regarding behaviour analysis please refer to WP 3 Literature Review.
Activities related to cycling and walking are parts of transportation planning, although often neglected in practice due to lack of quality data. Recent trends of sustainable development imply increasing of walking and cycling modal share. To address these trends traditional transportation planning process must be changed towards more priority and better quality cycling and walking planning and decision making. Growing importance of promoting and improving conditions for cycling and walking is approved by the result of the TRACE Public Authorities (PA) Survey and TRACE Users Survey\(^2\). The largest number of respondents declares that it is very important (66.15%) or important (28.46%) to promote and improve conditions for cycling (Table 1). More detailed analysis of research results by city type\(^3\) is given in Figure 1.

Table 1 Importance of promoting and improving conditions for cycling/walking (PA Survey)

<table>
<thead>
<tr>
<th>Importance</th>
<th>Cycling</th>
<th></th>
<th></th>
<th>Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of answers</td>
<td>Percentage</td>
<td>Number of answers</td>
<td>Percentage</td>
</tr>
<tr>
<td>I don’t know</td>
<td>0</td>
<td>0.00%</td>
<td>1</td>
<td>0.77%</td>
</tr>
<tr>
<td>Not important</td>
<td>1</td>
<td>0.77%</td>
<td>3</td>
<td>2.31%</td>
</tr>
<tr>
<td>Neutral</td>
<td>6</td>
<td>4.62%</td>
<td>16</td>
<td>12.31%</td>
</tr>
<tr>
<td>Important</td>
<td>37</td>
<td>28.46%</td>
<td>47</td>
<td>36.15%</td>
</tr>
<tr>
<td>Very important</td>
<td>86</td>
<td>66.15%</td>
<td>63</td>
<td>48.46%</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>100.00%</td>
<td>130</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

In terms of walking (Table 1), almost half the respondents, 48.46% of them, declared that promotion and improvement of conditions for walking is very important, while 36.15% declared these issues are important. Only 2.31% of respondents think that the importance of promotion in terms of walking is not important.

For detail explanation on characteristics of the sample please refer to Annex.

City classification by city size, modal share of cycling and modified cycling PRESTO class is presented in Annex.
Levels of priorities of elements in the planning and operational activities due to their importance for cycling and walking determined according to result of the TRACE Public Authorities Survey are presented in Figure 2 and Figure 3, respectively.

The greatest importance of all elements respondents gave to the security and safety of cycling, with 97.50% cases with very high and high priority. Safety and security issues are followed by the maintenance, improvement and construction of infrastructure elements: cycle paths, parking facilities, streets, etc. It is interesting that respondents gave the lowest priority to the element - "Providing services for cyclists (self-service bike)" and to element related to the regulation of cycling flows – "Remove bottlenecks (reducing delays) ". These elements still have very high and high priority in more than 40% cases.

As for cycling, the most important of all the elements offered for respondents is the element that relates to the security and safety for walking, accompanied by the improvement of the accessibility for persons with reduced mobility and increasing pedestrian facilities. All these elements have very high or high priority for more than 90% of respondents. Similar priority is given to maintenance and improvement of existing infrastructure. The lowest importance has the elements of removing bottlenecks and providing information to users.
TRACE User Survey reveals that the users have slightly different priorities of elements in the planning and operational activities (Figure 4). For walking and cycling as well, users find the maintenance, improvement and construction of infrastructure elements (making roads compatible for these modes, new paths, tracks, parkings, etc.) to be the most important.

Implementing the planning and operational activities is subject to specific constraints. In spite of the public and political support, main barrier for achieving existing priorities is defined as lack of resources (Figure 5). Very important barrier is the lack of data, which is most relevant to respondents for walking (31.76%), while for cycling this barrier is most relevant in 25.16%.
The lack of data is present in all cities, but it is the most significant in “small climber” cities (Figure 6). Surprisingly, high importance of this barrier is also present in “small champion” cities, but this is maybe due to small number of these cities (4) in the sample. Next chapter is related to analysis of gaps in information relevant for planning.

From the users’ point of view, lack of data is the least important constrain for achieving the existing priorities (Figure 7). They found the lack of resources (in 25.5%) and the lack of political support (in 23.5%) to be main barriers.
1.2. Assessment of gaps in data relevant for transport planning

Regardless the model, good quality and reliable input data are crucial for efficient transport planning process. Types of information considered for cycling and walking planning can be classified as qualitative and quantitative data. Qualitative data are much wider in use in planning practice and this fact is supported also in TRACE Public Authorities Survey (Figure 8).

Different forms of consultation/surveying with users to understand their requirements, complains/advice, etc. are used in most of the cities. However, this may vary based on the city experience in cycling as shown in Figure 9. Climber and champion cities always use this data, while in every forth small starter city this data is not considered. Compared to the qualitative data, quantitative ones are much less penetrated into planning practice.
Counts of pedestrian and/or cycling volumes on transport network links and/or nodes are the most widely used quantitative data, in almost two-thirds of the cities according to the survey results. Walking and cycling planning in half of the surveyed cities is based also on OD (Origin-Destination) matrices. Tracking of individual routes is taken into consideration in around 40% of analysed cities and almost exclusively just for cycling. Penetration level of cycling tracking data usage in transport planning is recorded to be slightly less than for public transport (Figure 10 and Figure 11). On the other hand, pedestrian tracking data are used in only 15% of the cities. This undoubtedly shows how tracking data usage decreases with increase of the level of individuality in travel patterns.

**Figure 9** Type of information considered for cycling and walking – Consultation with users (PA Survey)

<table>
<thead>
<tr>
<th>Type of information</th>
<th>Considered for cycling</th>
<th>Considered for walking</th>
<th>Considered for both modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultation with users</td>
<td>50.00%</td>
<td>50.00%</td>
<td>50.00%</td>
</tr>
<tr>
<td>Counts of pedestrian and/or cycling volumes on transport network links and/or nodes</td>
<td>45.45%</td>
<td>45.45%</td>
<td>45.45%</td>
</tr>
<tr>
<td>Tracking of individual routes</td>
<td>13.33%</td>
<td>13.33%</td>
<td>13.33%</td>
</tr>
<tr>
<td>Tracking of OD (Origin-Destination) matrices</td>
<td>14.89%</td>
<td>14.89%</td>
<td>14.89%</td>
</tr>
<tr>
<td>Consultation with users</td>
<td>54.55%</td>
<td>54.55%</td>
<td>54.55%</td>
</tr>
<tr>
<td>Counts of pedestrian and/or cycling volumes on transport network links and/or nodes</td>
<td>53.33%</td>
<td>53.33%</td>
<td>53.33%</td>
</tr>
<tr>
<td>Tracking of individual routes</td>
<td>4.26%</td>
<td>4.26%</td>
<td>4.26%</td>
</tr>
<tr>
<td>Tracking of OD (Origin-Destination) matrices</td>
<td>57.45%</td>
<td>57.45%</td>
<td>57.45%</td>
</tr>
</tbody>
</table>

**Figure 10** Type of information considered for cycling and walking – Tracking of routes of individuals (PA Survey)

<table>
<thead>
<tr>
<th>Type of information</th>
<th>Considered for cycling</th>
<th>Considered for walking</th>
<th>Considered for both modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking of routes of individuals</td>
<td>50.00%</td>
<td>50.00%</td>
<td>50.00%</td>
</tr>
<tr>
<td>Counts of pedestrian and/or cycling volumes on transport network links and/or nodes</td>
<td>45.45%</td>
<td>45.45%</td>
<td>45.45%</td>
</tr>
<tr>
<td>Tracking of individual routes</td>
<td>13.33%</td>
<td>13.33%</td>
<td>13.33%</td>
</tr>
<tr>
<td>Tracking of OD (Origin-Destination) matrices</td>
<td>14.89%</td>
<td>14.89%</td>
<td>14.89%</td>
</tr>
<tr>
<td>Consultation with users</td>
<td>54.55%</td>
<td>54.55%</td>
<td>54.55%</td>
</tr>
<tr>
<td>Counts of pedestrian and/or cycling volumes on transport network links and/or nodes</td>
<td>53.33%</td>
<td>53.33%</td>
<td>53.33%</td>
</tr>
<tr>
<td>Tracking of individual routes</td>
<td>4.26%</td>
<td>4.26%</td>
<td>4.26%</td>
</tr>
<tr>
<td>Tracking of OD (Origin-Destination) matrices</td>
<td>57.45%</td>
<td>57.45%</td>
<td>57.45%</td>
</tr>
</tbody>
</table>

**Figure 11** Type of information considered for cycling and walking – Tracking of routes of individuals (PA Survey)
From the users’ perspective (Figure 12), usage of tracking data in transport planning is observed to be on similar level as for the public authority representatives.

Variations of this data usage between different cities types are shown in Figure 13 and Figure 14. According to survey results, usage of tracking data for walking is negligible in all cities even for those with high percentage of walking share.
Cycling tracking data usage is related both to city size and cycling modal share. Bigger cities consider more often this data in their planning practice. With increase of cycling modal share the level of tracking data usage is higher. For smaller cities, potential of these data is insufficiently used.

Reasons for such a relatively modest usage of tracking data in planning can be found in data collection methods. Mainstream data collection method are travel diaries (paper or phone recall surveys), giving transport planner insight on detailed information on each trip and socio-economic background data. Nevertheless, a number of deficiencies of this data collection method have emerged, i.e. large burden placed on respondents, high costs - expensive method (Ohmori et al. 2005), decrease in the quality of the recorded data - missing trips especially if diary is made for several consecutive days (Forrest and Pearson...
Stopher, et al. (2012) highlights a non-response issue as the most pressing problem faced by all surveys (response rates around 20-30 percent response from a mail-back survey, 40-60 percent from a telephone survey, and 60-75 percent for a face-to-face interview). Traditional data collection methods seem no longer adequate to satisfy all data needs of transport planners and policy makers, who demand more detailed information (see Table 2, and for more criticism on traditional data survey please refer to Axhausen (1998)). As a result, different data collection approaches arose around the world.

With the advancement of data collection techniques, such as GPS, transit smart cards, and mobile phones, various types of travel trajectory data are increasingly complementing or replacing conventional travel diaries and stated preference data (Yue et al., 2014). Out of all these methods, Global Positioning System (GPS)-based data collection methods have shown the biggest potential, especially when algorithms that include spatial data are used to derive trip characteristics from the GPS logs. TRACE Public Authorities Survey is in the alignment with this statement (Figure 15). The highest percentage of respondents declared that GPS is used for tracking (in 62.5% of cases), near field technology (RFID, NFC, etc.) in 18.75%, while the lowest presence in tracking is via Wi-Fi beacons (7.5%).

Table 2 reviews gaps in data relevant for transport planning for traditional data collection methods. It is clear that surveying as data collection method lacks with network and travel data. On the other hand, counting only gives network data, while socioeconomic and travel information are absent. These deficiencies can be mitigated by combining traditional methods with state-of-art technologies. Thus, this table gives also the potential of advanced data collection methods based on tracking to fulfil those gaps which will be discussed later.

Table 2. Identification of gaps in data relevant for transport planning and potential of tracking data to fulfil those gaps

<table>
<thead>
<tr>
<th>Input data for transport planning</th>
<th>Traditional data collection methods</th>
<th>Advanced data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveying</td>
<td>Counting</td>
<td>GPS logs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GPS logs +</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GPS logs + GIS +</td>
</tr>
<tr>
<td></td>
<td>GIS</td>
<td>SMS/app</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Socioeconomic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Age</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Household data</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Occupation</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Home address</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Work school address</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td><strong>Travel data - individual</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Origin</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Destination</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Journey start time</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Journey end time</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Exact routes</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Transport mode(s)</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Travel purpose</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Transfer nodes</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Transfer time</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Network data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road data (type and condition)</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Nodes data (Volumes, Bottlenecks, Delays, etc.)</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>Links data (Link Speeds, Volumes, Bottlenecks, Delays, etc.)</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>PT data (stops, lines, routes, etc.)</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>Parking data (location, number of places, etc.)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Zones data</td>
<td>✓</td>
<td>x</td>
</tr>
</tbody>
</table>

1.3. Assessment of potential of tracking for planning and policy making

With the advancements of different location-based technologies (e.g., GPS, Wi-Fi positioning system, etc.), it is now feasible and affordable to collect large volumes of tracking data at the individual level. GPS logs usually consist of longitude, latitude, altitude, direction, time, and speed. However, other information could
be present depending on specific cases. Pure GPS tracking offers detailed data on geolocation and temporal aspects of all trips, and possibility to reveal trip mode and purpose combining GPS tracks and other GIS data. This allows quantitative analysis of daily activity patterns, both on individual or collective level (e.g. transport zones). GPS-based data collection methods are potentially more accurate (Forest and Pearson, 2005; Ohmori et al., 2005; Vij and Shankari, 2015), incur fewer monetary costs (Vij and Shankari, 2015) and less of a burden on respondents (Vij and Shankari, 2015) compared to paper diary methods, while exact location coordinates of trip destinations, travel times and even routes can be recorded (Bohte and Maat, 2008). In this way, GPS data can be used for estimating volumes of travel on a specific route and understanding behavioural aspects through route choice (Transportation Research Board, 2014b). Moreover, the need for time-consuming data entry is avoided since data are available immediately in digital format. However, this method has some deficiencies and the main is lack of socio-economic background data necessary for transport planning. Travel mode information is also an issue, although there are some methods which derive travel modes by combining latitude, longitude and timestamps in the GPS logs without respondent involvement (Tsui and Shalaby (2006) use the average and maximum speeds and the acceleration rate). Stopher, et al. (2008) identify trip mode using multistep algorithm which includes different input data put in a probability matrix, such as maximum, minimum and average trip speed, trip distance, but also availability of bicycle etc. Another drawback is lack of trip purpose data, which is not possible to extract from GPS logs. Overcoming this deficiency usually requires some initial data (i.e. the addresses of each person’s workplace or school, and the address of the two most frequently used grocery stores, etc.). Aside these, it is also important to specify the level of detail desired in trip purpose categorisation (Stopher, et al., 2008).

To address all these deficiencies various solutions emerged combining different data collection methods. Potentials of each advanced data collection methods to fulfil gaps in information relevant for transport planning are presented in Table 2. Following text discuss relevant case studies on the potentials of these methods.

The early applications of GPS trajectory data revolved in transport parameter estimation and model calibration. According to Pearson (2001), the first regional travel survey that used the GPS-assisted approach was conducted in Austin, Texas in 1997 (117 households were equipped with GPS loggers and reported their travel). The ACTUM project\(^4\) has developed a contingency based experience sampling method relying on GPS and SMS technology. The respondents carry a GPS tracker and are asked to send a SMS to a server each time they start a trip, containing a description of the purpose of the trip, or end a trip, containing a description of mode and a description of the decision-making processes or the experience of the trip. The ACTUM project authors claim that the utilization of SMS technology means that this method can reach a wider group of respondents than is possible with specialized smart-phone applications, which demands that the respondents have smart phones and are willing to, and capable of, installing and using a specialized tracking application. However, widespread use of smart-phones have enabled evolvement of contingency based experience sampling methods towards combining GSP data and smart-phone mobile tracking applications.

Different approach combines GPS logs with Geographic Information System (GIS) data to get missing data. The quality of GIS maps and data has great influence on reliability and precision of travel mode and trip purpose data. While success of this method in determining travel mode is well documented (Tsui and

\(^4\) For more information please refer to the ACTUM project website [http://www.actum.transport.dtu.dk/english](http://www.actum.transport.dtu.dk/english).
Shalaby, 2006; Chung and Shalaby, 2005), literature examples for deriving trip purpose are few (Wolf et al., 2004) and usually only focused on car trips.

Different possibilities exist for asking respondents for additional information and data validation (face-to-face interviews, Internet recall survey, etc). Bohte and Maat (2008) present an innovative method that combines GPS logs, GIS technology and an interactive web-based validation application. The method was tested in large-scale fieldwork with a sample of more than 1000 residents of Amersfoort (137000 inhabitants), Veenendaal (61000 inhabitants) and Zeewolde (19000 inhabitants), three municipalities in the centre of the Netherlands. Their approach concentrates on the issue of deriving and validating trip purposes and travel modes, as well as allowing for reliable multi-day data collection. There are two main processes in this method. During the interpretation process, three different data sources (GPS logs, GIS data and individual characteristics of the respondents collected by a survey) are combined to derive travel patterns. When trip characteristics are reconstructed as much as possible, they are forwarded to the validation process. The main part of the validation process consists of a web application that gets its data from the spatial database. The derived data are presented to the respondents in maps and tables and they are asked to use this validation application to correct and add to the derived trip characteristics. Feedback from validation process is used to update individual characteristics which are reused in the interpretation process. The success of the interpretation process is done by determining what percentage of all travel modes and trip purposes had to be provided or changed by the respondents in the validation application. Bohte and Maat (2008) show that in almost three quarters of all cases, the travel mode proves to have been estimated correctly during the interpretation process. Car use is deduced correctly most often (75% of all trips), followed by cycling (72%) and walking (68%), respectively. Reasons for not accomplishing higher percentage are found in the fact that the assignment of a mode is almost exclusively based on average and maximum speeds of trips, and quite a lot of trips were missed by the GPS data logger. Deriving trip purpose was correct only in 43% of all cases, with trips that end at home are most often given the correct trip purpose because the home location is already known. The results from evaluation survey have shown that the participants did not consider carrying and charging the GPS device as a nuisance, and were enthusiastic about viewing their trips in the maps of the validation application (Bohte and Maat, 2008). Moreover, the majority of respondents were able to go through the validation application within a reasonably short period of time. Bohte and Maat (2008) conclude that, at present, both GPS and GIS are starting to make a significant contribution to collecting data on travel behaviour of individuals.

Previous analysis undoubtedly shows potential of advanced data collection methods to fulfil gaps in information relevant for planning. This issue was analysed also in TRACE Public Authorities Survey and TRACE User Survey. The greatest potential of tracking data usage in future is for public transport, which is in alignment with current practice (analysed in previous chapters of this deliverable). Tracking data usage for cycling in future shows increased potential compared to current level of usage. However, the biggest field for improvement is found for walking tracking data as 72% of the respondents believe that this information should definitely or probably be used in the future planning practice.
Tracking-based information use for different planning/policy activities has huge potential as shown in Figure 17. The most important fields of improvement are policy making issues (communication to policy makers and evidence-based policy making), as well as the decision making process (understanding priorities for intervention) and evaluation of effectiveness of different actions taken. Nevertheless, majority of respondents have stated that even all other planning/policy activities can definitely be improved using tracking data.
TRACE users survey have shown that almost all of them believe that tracking data have potential to radically improve transport planning process in their city (Figure 18). Just a quarter of them are undecided, i.e. think that maybe this process will be improve, while other are completely positive about this issue.

Figure 18 Potential of tracking-based information to radically improve planning practice (Users Survey)

More than 85% of users found tracking based information to be useful for their organization as communication tool in lobbying for intervention and 80% of them thinks this data help in understanding priorities for interventions. Tracking data might also be used in giving information to users, as stated by more than 70% of respondents.

Figure 19 Would tracking-based information be useful to your organization? (Users Survey)

When asked about potential of tracking based information usage in transport planning/policy activities in general, the users stated that this data will be useful mainly for understanding the priorities for
interventions and evaluation of effectiveness of different actions (Figure 20). From their point of view, communication with various entities could also be improved through using tracking data.

In the TRACE Surveys, public authorities’ representatives and users’ representatives also gave their opinion on the information they would like to get from tracking devices. Apart from standard GPS-based information, i.e. modal choice, trip length, trip duration, chosen route, transport planners are eager for Origin-Destination (OD) data (trip volume, speed/time, link volumes, etc.). Current road/pavement condition is another interesting information for them. They would like to obtain these data in ready-to-use format, tabular or graphic, but even raw GPS logs are acceptable for many of these transport planners. These answers are given in the following figure.
Users have similar attitude towards tracking data they would find useful for their purposes. Although, here it must be noted that all analysed information are almost equally important for them, as shown in the next figure.

![Figure 22 Additional information Users would you like to obtain from tracking services (Users Survey)](image)

With the advance of ICT, GPS-based surveys are expected eventually to replace traditional travel diary surveys (Wolf et al., 2001; Stopher et al., 2008). Although the feasibility of using GPS log data to replace traditional travel diaries has been affirmed in literature (Quiroga and Bullock, 1998; Wolf et al., 2001), some authors still argue that passively collected GPS-based surveys may never entirely replace surveys that require active interaction with study participants (Vij and Shankari, 2015). Latter authors add that for data from GPS-based surveys to still be useful for travel demand analysis, it will need either to be incredibly big, or it will need to be supplemented with data that can be treated as a reliable source of ground truth.

1.4. The recent experiences on the use of tracking data in other transport modes

At this moment, individual vehicle tracking has a significant application in traffic management, through collecting and processing the large amount of non-personalized data of user movements and their further use in traffic management process. Considering that amount of data collected in transportation is increasing exponentially, it is becoming clear that real potentials of tracking and collecting data will never be realized without collaboration. A good example of such cooperation is the TM2.0 ERTICO Platform launched in 2011 by TomTom and Swarco-Mizar. Today it consists of more than 20 members from all ITS sectors focusing on new solutions for advanced active traffic management. It aims to agree on common interfaces to facilitate the exchange of data and information from the road vehicles and the Traffic Management and Control Centers (TMC), and back, improving the total value chain for consistent management and traffic services as well as avoiding conflicting guidance information on the road and in the vehicles.

The recent emphasis on utilising advanced technologies has created an environment in which traffic simulation models have the potential to provide a cost-effective, objective, and flexible approach for
assessing design and management alternatives. Using this models in real systems requires of these models to be adequately calibrated for local conditions. The state of practice and an overview of national guidelines on performing traffic simulations and calibration and validation of traffic models is given by Daamen, et al. (2014). Tracking (trajectory) data are seen as one of the main inputs in processes of verification, validation and calibration in traffic simulation models. Applicability of this data varies based on the output parameter from the model. Several studies showed that measurement based on trajectories (link or a path) can give representative speed estimates with sample size of just 1% vehicles in heavy traffic (Chen and Chien, 2001).

Except the traffic management, vehicle tracking is significantly presented in car sharing and taxi service. For example, MOMO (EU) Car-Sharing is an Intelligent Energy Europe (IEE) project intended to promote a sustainable mobility culture supporting various transport options aside from car ownership; INVERS (DE) - With projects in 18 countries, INVERS supplies car sharing companies and motor pool operations with innovative, modular system consisting of our Software and InCar Technology. GPS taxi tracking data is another well documented data source to study mobility patterns and travel behaviour (Wang et al., 2011). Liu et al. (2012) established a random walk model to interpret the distance and direction distribution patterns observed from the taxi trajectories in Shanghai (1.5 million anonymous trips during 7 consecutive days). Many other similar projects use individual vehicle tracking for improving traffic conditions and mobility. Beside already mentioned, tracking potentials in transportation planning are still exploring, due to different kind of barriers which has to be overcome.

Significant usage of tracking data is also present in public transport planning. Nowadays, almost every city in the world has a smart card based fare collection system in public transport. Various information are stored within smart cards, including trip data (trip mode, start and/or end time, start and/or end stop, route, etc.) and personal identification data. Thus, smart card data can be used either in travel demand modelling (Chu and Chapleau, 2008) and demand forecasting (Mariko et al., 2006) or individual travel patterns detecting (Pelletier et al., 2011) and OD matrix extracting. But complete trip information are only available in distance base tariffs, when check in/check out fare collection system is in use. Majority of fare collection systems only require validation on trip start, thus, a major challenge in using smart card data is how to identify or estimate a complete trip trajectory (Hofmann et al., 2009) and multimodal transfers (Seaborn et al., 2009). Nevertheless, smart card data are considered to be feasible in travel behaviour and transport planning studies, but with a common concern about privacy issues when linking trip data with personal information.

While individual tracking of persons in public transport using smart card data is still evolving, vehicle (collective) tracking in public transport is well known and approved technology. Vehicle tracking data are widely use in real-time management process, as well as the input in off-line transport planning and design. In 2012 vehicle management and fare collection system is implemented in urban public transport system in Belgrade5. Basic system architecture of the Belgrade system is presented in Figure 23.

---

1.5. The recent experiences on the use of cycling and walking tracking data for planning

This chapter reviews recent experiences on the use of cycling and walking tracking data for planning. Analysis includes two approaches: review of case studies in existing literature and research of the relevant experiences within consortium using carefully developed set of research questions. The San Francisco County Transportation Authority developed the **CycleTracks** application in 2010 to better understand the needs of bicyclists. The application monitors cyclist paths to collect data about actual route choice. At the end of each trip, personal data, trip data and GPS logs are sent to server and stored in three database tables: Person table (containing personal information), Trip table (for trip data) and GPS coordinates table (storing raw GPS logs). Privacy issues are dealt very carefully within the system. All personally identifiable data are kept confidential and other data is used by transportation planners. After several months of data collection, there was a sufficient amount of data to develop a bike route choice model (Hood, et al., 2011). Output data can be incorporate into the SF-CHAMP, the official travel model for San Francisco. The list of cities collecting data with CycleTracks includes 10 cities in USA and Canada, as well as 8 more cities how have rebranded and improved this app prior its use. Hudson, et al. (2012) gave a review of CycleTracks use in Austin, Texas, on a sample of about 300 bicyclists. Continuing research on using smartphone GPS capabilities to map cycling and walking is being conducted in Montreal (Jackson et al, 2014).

When talking about cycling there is also an interesting technology, not made exclusively for tracking, called **Connected cycle**. It is the first ever connected bicycle pedal which automatically records the speed, route,

---

6 Developed by Apex Consortium and FTTE.
incline, and calories burnt of every bike trip. These statistics are sent to the cloud, and made available to users through the Connected Cycle application available on smartphones. The application has many benefits (easy setup, no charging, helps prevent bike theft). However, there is only The Connected Cycle fleet management module, but no interfaces for transport planners.

As already mentioned, the second approach in this review process was research done using a set of specific research questions. These questions were disseminated to the relevant systems and the feedback is presented in the following table.

Table 3. The recent experiences on the use of cycling tracking data

<table>
<thead>
<tr>
<th>Research question</th>
<th>The European Cycling Challenge - ECC</th>
<th>RouteCoach</th>
<th>Sistema*</th>
</tr>
</thead>
<tbody>
<tr>
<td>System development</td>
<td>Startup 2012 in Bologna; In 2013 ECC was upscaled at European level; Cycling365 app launched on April 1st 2015 and used during the ECC 2015 edition (May 2015)</td>
<td>Developed as part of NISTO project</td>
<td>N/A</td>
</tr>
<tr>
<td>Main objectives</td>
<td>Reducing car trips; Encouraging people to change their lifestyle in favour of a more active mobility; Collecting data that is useful to urban planning.</td>
<td>Collection, organization, processing, analysis and re-use of the travel data</td>
<td>Various goals</td>
</tr>
<tr>
<td>Main problems and barriers</td>
<td>Changing the app (third party were used prior development of a new one);</td>
<td>N/A</td>
<td>Privacy issues; Financial issues - data provider could ask a lot of moneys to have access to their data (historical or real-time); Big Data issue</td>
</tr>
<tr>
<td>Basic architecture</td>
<td>Cycling365 – smartphone app which is used by participants to track bike trips; The cycling365 platform – <a href="http://cycling365.eu">http://cycling365.eu</a> – where App users can see all their tracks and all related information; The website of the challenge – <a href="http://cyclingchallenge.eu">http://cyclingchallenge.eu</a></td>
<td>MOVE mobility intelligence platform; RouteCoach app.</td>
<td>A map-matching software working as web service; A relational database with geographical extension (PostgreSQL + PostGIS); 2 standard workstations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data</th>
<th></th>
<th></th>
<th>Data are usually collected via a web-service (in XML or CSV format) allowing to work in real time easily;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Collection</td>
<td>Through the App (via GPS) or manually (uploading a gpX file or drawing manually the trip on the map);</td>
<td>Through the RouteCoach app; App works online and offline.</td>
<td></td>
</tr>
</tbody>
</table>

* Data given in table are for company Sistema as whole rather then for their specific project/system.
<p>| Frequency of data collection | A GPS point every 5 seconds. | N/A | Frequency of data can vary a lot from 5/10 seconds (some GPS probes) up to 1 minute (other type of GPS probes), or much higher were we are working in system setting were portal are considered. |
| Period of data collection | ECC is re-launched every year in spring; | N/A | N/A |
| Data structure | GPS logs; Users’ info (gender, age, occupation, zip-code) Trip purpose - planned | GPS logs; Data can be stored in any format. | GPS logs; Transport mode; Bearing Raw speed Raw acceleration Status (Engine On/Off, empty/full (for taxi, bus ...), parking, opening doors, closing doors, ...)|
| Data sampling | Separate cycling from other modes based on speed; No corrupted trips filter; Automatic and manual (drawn) trips are separated. | No sampling methods, data producers upload data | |
| Data storage | Database on a specific server; All data is kept. | Mobility Data Catalogue | System storage server. |
| Data accuracy | Depends on GPS accuracy. | N/A | Depends on GPS signal precision, Bluetooth precision |
| Data privacy | Users have to agree the privacy policy during the registration phase; Each user can access only its data. | Anonymised the data for privacy reasons | Privacy issues should be handled at the origin by the data provider, who has to send anonymous data (for example the ID identifier is an MD5 checksum) |
| Aggregation levels | Trip level; Heat maps | Trip level; Mode level; | |
| Specific tracking for planning indicators (KPI’s) | Heatmaps; Raw GPS logs are given to Local Authorities for use. | Tracking activity in kilometres registered: Travelled distance by mode (walking, cycling, PT, car, etc...) and number of trips by mode (walking, cycling, PT, car, etc...). Real-time monitoring: average speed over the graph (stored into a database); Visualization of speeds by street; Offline matching for historical speed analysis; |</p>
<table>
<thead>
<tr>
<th>End users</th>
<th>Local authorities/Municipalities; App users (have insight on their personal data)</th>
<th>Users (Data consumers)</th>
<th>Local authorities/Municipalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data for users</td>
<td>Heatmaps; Raw GPS logs are given to Local Authorities.</td>
<td>GPS-track data and/or survey data (i.e. the impact on modal split is calculated using the GPS-tracks and the impact on emissions and traffic noise annoyance was based on a survey among the users of the app); The travel distances derived from the Routecoach tracking can be used to estimate modal shift and the resulting change in air pollution, noise, risk of accidents and cost of mobility.</td>
<td>Speeds over the network</td>
</tr>
<tr>
<td>End users' Benefits</td>
<td>N/A</td>
<td>The impact of the project can be estimated using travel distance by mode as a proxy indicator.</td>
<td>The capability to monitor the system; Congestion information; Dynamic journey planners; Behaviour choice, rerouting</td>
</tr>
<tr>
<td>Interoperability</td>
<td>The Cycling365 system has API, it is possible for other tracking systems to send tracked trips to Cycling365 server to be counted in the leader boards during the challenge.</td>
<td>N/A</td>
<td>Different levels. 1. Share the same graph, the same zoning, and same raw data. 2. Different graph but a system to find a correspondence between map-matched data over different graphs (OpenLR encoding/decoding)</td>
</tr>
<tr>
<td>System maintenance</td>
<td>Outsourced</td>
<td>N/A</td>
<td>System maintenance usually is based on software able to run as services, aka demons; running on cloud machines able to restart copy of themselves whenever a breakdown happen; using background scripts (SQL of whatever) to handle data warehousing.</td>
</tr>
<tr>
<td>Infrastructure and operational costs</td>
<td>N/A</td>
<td>N/A</td>
<td>Minimum: 2 servers, one for the storage and one for the map-matching computation with roughly an entry cost of 10.000 euro.</td>
</tr>
</tbody>
</table>

Experience with walking tracking data are far less present in current practice. However, still there are some examples. Walk Score is a web-based tool launched in 2007 with aim to promote car-independent lifestyles.
The Washington, DC Office of Planning is one of the governmental entities to take advantage of Walk Score data in its transport planning process.

1.6. The quality of tracking data

The quality of input data in transport planning process has significant influence on the quality of output data. However, Vij and Shankari (2015) claim no study has systematically examined the implications of using low-quality big data for traditional modes of analyses. Nevertheless, there are two basic constraints influencing the quality of tracking data: technical issues and sampling issues.

Several issues affect the accuracy of GPS data: trees and buildings obscuring GPS signals, the geometric arrangement of the GPS constellation of satellites, and the quality of the GPS unit (Wolf et al, 1999). Because of this, GPS routes can appear to bounce around to either side of an actual route when accuracy is decreased. But for tracking routes longer than only the shortest walking trips, modern GPS devices represent a relatively accurate and inexpensive way to record natural travel data (Bricka et al, 2009). One recent study that tested algorithms for calibrating GPS-observed walking trips to actual trips had the best results when trips were more than 3 min long and more than 30 m in distance (Cho et al, 2011). This deficiency of GPS can be mitigated by implementing a primary data processing phase prior to data usage for planning and/or other purposes.

CycleTracks system, described in previous chapters of this deliverable, has a data preparation phase which includes three critical components of processing GPS data: (a) cleaning the data (e.g., removing outlying signals, signal errors, or very short segments), (b) creating a complete cycling network that includes the network of streets and other links cyclists may use (e.g., park trails, parking lots, and driveways), and (c) matching the GPS points collected for each bike trip to the correct network links (Hudson, et al., 2012). Schuessler and Axhausen (2009) stressed that an important requirement for each map-matching algorithm to work properly is a correct, consistent and complete representation of the real network by the network used for the map-matching. The fact that GPS traces for cycling and walking are not aligning exactly with the network links, i.e. cyclists and pedestrians do not necessarily constrain their movement to the existing roadway network, makes map-matching a critical process in cycling and walking tracking. In car trip tracking map-matching is less challenging phase and experience have shown higher success rate (Schuessler and Axhausen, 2009).

Other issue affecting the quality of tracking data regards the representativeness of input data samples deriving from different tracking tools. Yue, et al. (2014) gave comprehensive review on a state-of-the-art review of the travel behaviour studies categorized by trajectory data types including tracking data. All
selected empirical studies have drawn conclusions and findings about the entire population based on the sampling dataset. However, there are analysis on whether the sampling data are representative to serve as basis for making overall conclusions.

The margin of error summarizes sampling error and quantifies the uncertainty of an estimate. As the sample size increases, the margin of error decreases; this is due to the fact that larger samples decrease uncertainty about population parameters (Facchiano, et al., 2008). Although increase in sample size can increase precision, this will not eliminate subjectivity in selection of elements for the sample. Therefore, large samples does not necessary imply best representativeness. A sample must be well structure to present entire population. Moreover, the large samples implies higher costs then the small ones. In Lisbon the STRAVA Heat Map is used to present tracking data for cycling. However, it was revealed to be a poor sample for the purpose of mobility planning, because the sample consisted essentially of sports related movements, which have very different characteristics and needs to commuter related movements. For the purpose of setting priorities for infrastructure improvements on the cycling network, modified Heat map was created, cleared from the leisure and recreational trips.

According to Vij and Shankari (2015), there have been three large-scale travel surveys that have relied entirely on GPS technology, two of these in the USA. The first exclusively GPS household travel survey conducted was by the Ohio Department of Transportation, in the Cincinnati metropolitan area with a sample of 2608 households. The project commenced in early 2009 with the conduct of a pilot survey, which helped establish various parameters and procedures for the main survey (Stopher et al., 2012). The main survey commenced in August 2009 and was completed in August 2010. Sampling for the pilot and the main survey used an address-based sampling procedure (Stopher et al., 2012). GSP data was complete in 80% cases and these data were used to derive travel parameters, i.e. average daily No of trips (mobility rate), trip distance, travel time, travel purpose etc. Data was presented for all days and weekdays, and on the personal and household level. Stopher et al. (2012) have reported a high standard of representativeness for the sample was achieved, while imputing mode and purpose at a sufficiently accurate level to support modeling work (96 percent on mode and around 90 percent on purpose). Therefore, their primary conclusion was that it is feasible to undertake a GPS-only household travel survey. They also recommend a longer period of measurement be used in future surveys. The other GPS survey was conducted by the Northeast Ohio Regional Travel Survey over 2012 and 2013 in the Cleveland metropolitan area with a sample of 4545 households. The latest one is done by the regional planning agency in Jerusalem over 2010 and 2011 with a sample of 8800 households.

Numerous algorithms have been proposed for inferring one or more of these missing details from the GPS data. In many cases these models imply additional data sources, such as accelerometer readings from smartphones (Feng and Timmermans, 2013), land use characteristics from GIS databases (e.g. Bohte and Maat, 2009) or ‘check-ins’ from social media applications (e.g. Hasan and Ukkusuri, 2014). However, even the most successful inference algorithm will have some error associated with it, with average accuracy level of 60–90% (Vij and Shankari, 2015). Vij and Shankari (2015) used simulated datasets to compare performance across different sample sizes, inference accuracies and estimation methods. Findings were corroborated using real data collected from smartphone users, student population in the San Francisco Bay Area. They have stated that the benefits of using GPS-based surveys will vary significantly, depending mainly upon the sample size of the data. Moreover, the accuracy (errors) of the inference algorithm can potentially compromise the quality of data collected through GPS-based surveys and the validity of travel demand models developed using this data. However, Vij and Shankari (2015) assert that if the data is truly big enough, the quality of inference may not matter, although in many cases, losses in quality may neutralize benefits of large data volume. For example, a Monte Carlo experiment, done by Vij and Shankari
(2015), finds that “a relatively parsimonious model of travel mode choice behaviour that could reliably be estimated using 100 high-quality observations could need 10,000 observations and more, depending upon the accuracy of the inference algorithm”.

Another issue affecting usability of GPS data is the desired complexity of the transport planning model and travel demand model specification. The latest conclusion is gaining relevance having on mind the fact that many existing transport planning models do not treat walking and cycling at the same level as motorized transport modes. Specific characteristics of walking and cycling require shift in planning approach and may imply use of specific input data sets (for more details on planning indicators please refer to Task 3.4).

1.7. Conclusions

Within this chapter, it was discussed how tracking can improve transport planning and policy making processes. To address this issue, two different research approaches were used: literature review and surveying. The latter included TRACE transport authorities’ (planners) survey and TRACE users’ survey. Regardless the applied approach, growing importance of promoting and improving conditions for cycling and walking is evident in today planning practice. The surveys’ results have shown that both public authorities and users have high awareness of the potential of tracking data, although this data is rarely used in everyday planning process, especially for walking. This is confirmed in the review of recent experiences on the use of tracking data for planning, given later in this chapter. This review has included not only cycling and walking tracking, but motorised transport modes as well.

One of the major issues for not putting walking and cycling on an equal footing with motorised transport modes is the lack of input data. It is often argued that tracking data can be considered of crucial importance for planning and/or radically change it, but there is common understanding that tracking data can provide us detailed information on mobility patterns and travel behaviour. Some authors even expect from tracking data to eventually replace traditional travel diary surveys.

In the TRACE Surveys, public authorities’ representatives and users’ representatives also gave their opinion on the information they would like to get from tracking devices. Apart from standard GPS-based information, i.e. modal choice, trip length, trip duration, chosen route, transport planners are egger for Origin-Destination (OD) data (trip volume, speed/time, link volumes, etc.) and current road/pavement conditions. The collected data should be stored in a format that allows the data to be easily accessed, exchanged and processed. They would like to obtain these data in ready-to-use format, tabular or graphic, but even raw GPS logs are acceptable for many of these transport planners.

Although tracking offers large data set, the main constrain limiting potential of its’ usage in transport planning practice is the quality of tracking data. No study has yet systematically examined the implications of using low-quality big data for traditional modes of analyses. Therefore, in the closing part of this chapter, two basic factors influencing the quality of tracking data (technical issues and sampling issues) are analysed, as well as the ways to overcome or mitigate their influence. It is found that if the data is truly big enough, the quality of inference may not matter. However, in many cases, losses in quality may neutralize benefits of large data volume. If tracking data is supplemented with data that can be treated as a reliable source of ground truth, tracking data can be very useful for travel demand analysis and transport planning in general.
2. References


Axhausen, Kay W., 1998. Can we ever obtain the data we would like to have. Theor. Found. Travel Choice Model, 305–323.


3. Annex

3.1. Local Authorities Survey Crosstab Analysis Methodology

The aim of this task was to evaluate tracking data potential through contextual analysis based on survey results (Trace Questionnaire 1 - Local Authorities and Trace Questionnaire 2 - Users). The sample is based on contacts by the TRACE consortium and Polis membership and there might be a self-selection effect by entities interested in the topic. The average interest on walking and cycling might of this survey not be representative of the current state in average cities. Despite these deficiencies, survey results can be considered representative on other research questions.

Initial database is consolidated, validated (i.e. municipality/region name validation) and all inconsistent data were excluded (i.e. uncompleted questionnaires) from further analysis. Next step was to group municipalities/regions by taking into account their sizes and modal shares of cycling and walking. In order to overcome modal share data inconsistencies due to subjectivness of respondance, we consulted ELTIS modal split tool. Furthermore, all municipalities/regions were classified by using modified PRESTO Cycling development levels. In applied classification methodology three basic PRESTO levels (Starter, Climber, Champion) were divided into five classes. Levels Starter and Climber were each split into two classes in order to enable more sensitive analysis of relevant issues. These new classes arose from preliminary questionnaire analysis in an attempt to avoid large class sizes (i.e. PRESTO Starter class ranges from 0-10% of cycling share, and in our case would have encompass more than 65% of all answers). ELTIS city size classification was applied on these new classes resulting in 10 classes in total (Table A1). ELTIS modal share tool was also used to determine walking modal share of analysed cities. However this approach enabled us to evaluate only those cities covered by TRACE and ELTIS database at the same time (almost 60% of those cities included in cycling analysis). We have identified three different classes regarding walking modal share. Applying ELTIS city size classification on these has resulted in new 6 classes in total (Table A2).

<table>
<thead>
<tr>
<th>City size (No inhabitants)</th>
<th>Modified Cycling PRESTO class</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100 000</td>
<td>Starter (0%-5%)-s</td>
</tr>
<tr>
<td></td>
<td>Starter (6%-10%)-s</td>
</tr>
<tr>
<td></td>
<td>Climber (11%-20%)-s</td>
</tr>
<tr>
<td></td>
<td>Climber (21%-30%)-s</td>
</tr>
<tr>
<td></td>
<td>Champion (&gt;30%)-s</td>
</tr>
<tr>
<td>&gt;=100 000</td>
<td>Starter (0%-5%)-b</td>
</tr>
<tr>
<td></td>
<td>Starter (6%-10%)-b</td>
</tr>
<tr>
<td></td>
<td>Climber (11%-20%)-b</td>
</tr>
<tr>
<td></td>
<td>Climber (21%-30%)-b</td>
</tr>
<tr>
<td></td>
<td>Champion (&gt;30%)-b</td>
</tr>
</tbody>
</table>
Table A2. Classification of cities (walking)

<table>
<thead>
<tr>
<th>City size (No inhabitants)</th>
<th>Walking Modal share</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100 000</td>
<td>&lt;20%</td>
</tr>
<tr>
<td></td>
<td>20%-40%</td>
</tr>
<tr>
<td></td>
<td>&gt;40%</td>
</tr>
<tr>
<td>&gt;=100 000</td>
<td>&lt;20%</td>
</tr>
<tr>
<td></td>
<td>20%-40%</td>
</tr>
<tr>
<td></td>
<td>&gt;40%</td>
</tr>
</tbody>
</table>

3.2. Classification of cities by modal shares of cycling and walking and number of inhabitants

In Table A3 the distribution of cities by modal share of cycling, size and Modified Cycling PRESTO class is presented.

Table A3. Classification of cities by modal share of cycling and number of inhabitants

<table>
<thead>
<tr>
<th>City size (No inhabitants)</th>
<th>Modified Cycling PRESTO class</th>
<th>Number of answers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100 000</td>
<td>Starter (0%-5%)-s</td>
<td>3</td>
<td>2.70%</td>
</tr>
<tr>
<td></td>
<td>Starter (6%-10%)-s</td>
<td>10</td>
<td>9.01%</td>
</tr>
<tr>
<td></td>
<td>Climber (11%-20%)-s</td>
<td>7</td>
<td>6.31%</td>
</tr>
<tr>
<td></td>
<td>Climber (21%-30%)-s</td>
<td>2</td>
<td>1.80%</td>
</tr>
<tr>
<td></td>
<td>Champion (&gt;30%)-s</td>
<td>4</td>
<td>3.60%</td>
</tr>
<tr>
<td>&gt;=100 000</td>
<td>Starter (0%-5%)-b</td>
<td>51</td>
<td>45.95%</td>
</tr>
<tr>
<td></td>
<td>Starter (6%-10%)-b</td>
<td>17</td>
<td>15.32%</td>
</tr>
<tr>
<td></td>
<td>Climber (11%-20%)-b</td>
<td>11</td>
<td>9.91%</td>
</tr>
<tr>
<td></td>
<td>Climber (21%-30%)-b</td>
<td>6</td>
<td>5.41%</td>
</tr>
<tr>
<td></td>
<td>Champion (&gt;30%)-b</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>111</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

Based on the data presented in the table, it can be concluded that the greatest incidence of cities that have more than 100 000 inhabitants and modal share of cycling less than 5% is 45.95%. On the second place are cities with more than 100 000 inhabitants, with a share of cycling in the modal split between 6% and 10% (15.32%), while the 9.91% share is for cities with more 100 000 inhabitants with modal share of cycling between 11% and 20%. None of the cities with more than 100 000 inhabitants and more than 30% share of cycling in the modal split have not taken part in the survey.

In Table A4 the distribution of cities by modal share of walking and size is presented.
Table A4. Classification of cities by modal share of walking and number of inhabitants

<table>
<thead>
<tr>
<th>City size (No inhabitants)</th>
<th>Walking Modal share</th>
<th>Number of answers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100,000</td>
<td>&lt;20%</td>
<td>4</td>
<td>6.06%</td>
</tr>
<tr>
<td></td>
<td>20%-40%</td>
<td>1</td>
<td>1.52%</td>
</tr>
<tr>
<td></td>
<td>&gt;40%</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>&gt;=100,000</td>
<td>&lt;20%</td>
<td>19</td>
<td>28.79%</td>
</tr>
<tr>
<td></td>
<td>20%-40%</td>
<td>37</td>
<td>56.06%</td>
</tr>
<tr>
<td></td>
<td>&gt;40%</td>
<td>5</td>
<td>7.58%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>66</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

More than half of the cities are cities with more than 100,000 inhabitants and a share of walking from 20% to 40% of total number of trips (56.06%), and 28.79% from the same category of cities with a share of walking, which is less than 20% of total number of trips. Cities with less than 100,000 inhabitants and walking less than 20% of total number of trips are represented with only 6.06%.
ANNEX III (Deliverable 3.1)

Report on the Workshop "Tracking data for planning and policy"

Date: 29/01/2016

Author(s): Mafalda Mendes Lopes, João Bernardino

TIS – Consultants in Transport, Innovation and Systems S.A.
## Contents

1. Introduction.................................................................................................................................................. 4
2. Inputs from workshop.................................................................................................................................. 5
3. Conclusions.................................................................................................................................................. 13
TRACE WP3 Workshop Report

Workshop Tracking data for planning and policy

Will tracking change mobility planning and policy practices? How?

1. Introduction

On the 22nd of January, the TRACE project held a workshop on the subject Tracking data for planning and policy. The workshop was attended by consortium members, take-up group members and several external experts on different areas of mobility, planning and technology.

The goal of the workshop was to assess the relevance and potential of tracking data in the planning process, as well as its limitations. Since TRACE aims to develop a data analysis and communication tool to support the planning and policy making process, it was also a workshop goal to understand what type of data would planners and policy makers like to obtain from such tool and how this data should be presented.

The workshop followed a world café based approach. The session was divided into four rounds of twenty minutes, each dedicated sequentially to one of the four main discussion topics:

1. **Urban mobility paradigm, local visions and goals**
   How could tracking data contribute to change and improve them?

2. **Planning and operational activities in urban mobility**
   How could tracking data contribute to change and improve them?

3. **Challenges, limitations and barriers**
   What diminishes the potential of tracking data? How could that be solved?

4. **Indicators and visualizations**
   Which ones are relevant in each situation identified under 1) and 2)?

The participants were divided into four tables (eight or nine participants per table) where they could discuss the topic in question. At the end of each round participants changed tables so that the discussions groups
would be different every round. Each new round began with the moderators of each table briefly presenting what had been discussed in the previous round.

At the end of the last round, participants were asked to write post-its with the two or three ideas they considered more important in relation to each topic. After this was done, each moderator chose one topic and summarized the ideas presented in the post-its of that topic.

This report was made based on the audio recordings of each table, the moderators’ notes and the post-its written by the participants.

2. Inputs from workshop

1. Urban mobility paradigm, local visions and goals

   “Data can be the spark that switches on the light on vision”

   - Changing the paradigm:
     - Paradigm changes come not only from decision makers but also from users.
     - The simple fact of having more info can lead to changing the paradigm.
     - Promote sharing of information and ideas.
     - Interface of mobility with other disciplines (health, economy, environment...).
     - Ask questions before intervening.
     - Develop strong communication campaigns.
     - Address planners, policy makers, users and non-users.
     - Include users in projects, know the user needs.

   - Data collection and application:
     - Importance of quality vs quantity of data
     - Data is not sufficient, interpretation is necessary.
     - Involve the citizen in the data collection process.
       - Short-term campaigns, such as the European Cycling Challenge (one month) and the Bicycle Counting Week in Flanders (one week) tend to be more effective than long-term campaigns.
       - It is necessary a balance – asking for large amounts of information will diminish the number of users willing to respond.
o Integrate different sources and types of data.
  ▪ Tracking data, surveys, counting, predictions, big data, little data.
  ▪ Enable the comparison of different zones, different policies, etc.
o The use of big data will have impacts on current ways of working.

• Tracking potentialities in terms of paradigm change:
  o Definition of goals and visions.
    ▪ Tracking should not be seen as a goal in itself or as the sole basis for establishing goals and visions. Doing so would limit the vision.
    ▪ Understand priorities, identify alternatives, evaluate situations and policies.
    ▪ Quantification and segmentation of goals.
    ▪ Monitoring goals and dynamically adjusting these goals as they are reached.
o Change the temporal and spatial scale of vision making and planning process.
  ▪ Shorter data collection cycles and constant evaluation.
  ▪ Global and localized data, leading to global assessments and localized interventions.
o Increase the visibility of certain ideas:
  ▪ Accessibility and seamless travel – these features add value to the city and routes, and tracking can be used to measure them and putting them in evidence.
  ▪ Shared spaces – tracking can help showing the need for these spaces and help monitoring them.
o Increase the visibility of groups of users (namely cyclists and pedestrians).
  ▪ More data on people and less on cars.
  ▪ Importance and dimension of walking and cycling.
  ▪ Back-up the multimodal vision.
  ▪ Finer understanding of how the city moves.
o Information on the social profile of users.
  ▪ Important for establishing visions.
  ▪ Adapt the campaigns and actions to specific target groups.
o Powerful visualization tool.
  ▪ Communication with policy makers.
  ▪ Communication with users.
o Improving the community engagement and participation.
  ▪ Make users aware of their options and choices.

2. Planning and operational activities in urban mobility

“Tracking will help us telling a more complete story, and this will make the city better”

• Tracking data added value:
  o Richer data, high level of detail.
  o User profile and segmentation.
  o Real time information.
- Information 24/7, not limited to certain hours of the day, days of the week or periods of the year.
- Localized data (neighbourhood specific).
- Complement other types of data (traffic models, counting, surveys).
- Modal shift evaluation and historical analysis.
- Lower costs than other methods (surveys, counting...).

**Tracking in planning and strategy:**
- When defining the planning process as a cycle of Vision → Problem diagnosis → Assessment of possible solutions → Implementation of plan → Evaluation and monitoring, tracking has a direct application at the phases of diagnosis and evaluation.
- Integration in the SUMP process.
- Co-tool in planning – it cannot be used to plan a network on its own.
- Influence planners, improve political decisions, raise awareness and redefine priorities.
- Add new analysis questions and topics, trigger questions (why follow that specific route from point A to point B?).
- Establish and assess scenarios.
- Increase the effectiveness of planning activities.
- Contribute to a multimodal integration in policy (which should take into account a multitude of indicators, including space consumption, pollution...).
- Change the temporal horizon of activities and programs.
- Include citizens in the planning and decision process.
- Promote behaviour change.
- Adapt the infrastructure, the actions taken, and the marketing campaigns to the relevant users.
  - Keep in mind the more vulnerable groups – children, senior citizens, people is disabilities.
  - Interpret the differences in terms of gender – a reduction in the number of women at night might mean the path is not safe or well lit.

**Operational applications:**
- Diagnosis (comparisons between the network and the actual behaviour, desire lines, trip distribution, detours and short cuts, delays and problematic junctions, specific needs...).
- Evidence and support (calibration of models – including cycling and walking models, microscopic validation of macroscopic observations, sustained policies and decisions, securing funds).
- Test small interventions (such as changes in the traffic lights).
- Provide info about localised problems (such as route conditions), enabling localised interventions.
- Improve network design on a microscale (junctions and roads, safety, accessibility) and macroscale (adapt infrastructure to demand, choosing places for bike racks).
- Monitoring and evaluation – build KPIs triggering alerts.
- Real time traffic management (e.g. adjusting traffic light cycle in real time, crowd management at big events).
3. Challenges, limitations and how to solve them

“Tracking can only provide info on symptoms, not syndromes”

- Challenges and limitations:
  - Identifying the needs of planners and policy makers.
  - Acceptance and communication towards planners and policy makers.
  - Assumptions and interpretation – the fact that tracking data has to be interpreted can be a barrier, especially when communicating with politicians.
    - How to distinguish delays caused by mandatory stops (traffic lights, congestion, waiting times) from voluntary stops (shopping, resting)?
  - Identifying “black holes” in the data, what data does not show and learn to interpret that.
  - Tracking by itself cannot be used to determine the volume of cyclists and pedestrians – its main use is knowing the routes they follow.
  - Limitations regarding the future.
    - Tracking does not tell you what people want to do, it only represents current behaviour.
    - Dangerous as a source for predictions.
  - Representativeness.
    - Sampling size.
    - Not everybody has a smartphone, not everybody wants to be tracked.
    - Risk of discrimination.
    - Invisibility of non-tracked groups – what isn’t counted doesn’t count.
  - Calibration, reliability, quality of data, noise.
  - Transparency of data.
  - Scattered and fragmented data – there are too many apps.
  - Data processing and storage:
    - Big data management.
    - High costs.
    - Interoperability.
    - Sharing across entities.
  - Misuse or underuse of collected data, loss of focus.
  - Lack of expertise in municipalities.
  - Lack of qualitative data (Are people happy? What is the trip purpose? What do people want?).
  - Privacy:
    - Difficult to use and share data between entities.
    - Users’ perception, consent and acceptance.
    - Should we protect people from their own options? Are users capable of understanding the meaning of losing their privacy?
    - Legal obligations and restrictions.
    - Data ownership issues.
- Technical and operational issues.
  - User acceptance and motivation.
  - Data provider business models.
  - Costs (of user involvement and data processing) – it is not necessarily cheaper than surveys or other traditional data collection methods.
  - Battery.
  - Reliance on external devices.
- Solutions:
  - Representativeness, reliability, calibration, quality, interpretation:
    - Link static (benchmark) and tracking data.
    - Validate tracking data through surveys.
    - Merge tracking data with other sources (weather, profile of users, traffic data...).
    - Use physical sensors to do counts.
    - Filter noise in tracking data.
    - When collecting baseline data, motivate users by giving rewards for participation only, and not for change of behaviour.
  - Quality, transparency, scattered and fragmented data:
    - Create an open data platform (European initiative needed).
    - Develop common standards.
  - Privacy:
    - Create a clear user agreement, define limits, do not provide users access to other users’ data.
    - Make users believe in the good intentions of the tool and the usefulness of their data.
  - Continuity of data collection, user engagement:
    - Design strong communication campaigns.
    - Gamification and competition.
    - Provide rewards (e.g. phone minutes in exchange for data).
    - Create awareness of the importance of usable data; make the individual part of a collective. While this approach has advantages, it may give you a rather biased sample.
    - Ensure that the users’ effort is minimal.
    - Provide feedback on how the data is being used.
  - Lack of qualitative data:
    - Incorporate a way for users to give feedback (purpose of the trip, rating of the route, problem detection).
    - Interpret the tracking data (manually or through algorithms):
      - If users are not using the expected route – the shortest one, or the one where there is infrastructure – it might mean they are not satisfied with that route.
      - If a user remains 7-8h at its destination, then the purpose of the trip was probably commuting.
• Misuse or underuse of collected data, lack of expertise:
  ▪ Define a sound model for data analysis and interpretation.
  ▪ Establish a usable set of indicators.
  ▪ Design courses for planners to learn how to make the best use of tracking indicators.
  ▪ Present information in a professional and clear way.

4. **Indicators and visualizations**

   “The city as a function of place and movement, not just traffic”

- **Strategic considerations:**
  - Identify what we need to design, and then develop the tool.
  - Identify what we need to evidence, and why we need to know it before we start identifying indicators. Ask questions: what would be your ideal route? Why are people choosing congested routes?
  - Add richer information (emotions, environment details, etc.) to spatial/time tracking.
  - Complement the information via surveys.
  - Build a campaign.
  - Data must be translated into knowledge usable for planning. It must be translated into the “language” planners are used to talk.
  - Visualization should be available to planners, users and other stakeholders.
  - Providing visualization to different stakeholders will start discussion and helps to go from “data” to “information” – adds value, context.
  - Purpose of trip is much more important in planning policy than quantitative data (opposite than for cars).
  - There’s no need for classical vehicle indicators as speed or road ratio capacity.
  - “Everything” is technically feasible; it is a matter of costs. It is necessary to define priorities.

- **Indicators:**
  - Volume of cyclists and pedestrians;
  - Level of service (capacity / volume);
  - Patterns, destinations in public space;
  - OD matrixes (profiled by time too);
  - Routes;
  - Urban sprawl/density/average distances to be covered;
  - Trip time & distance;
  - Speed:
    - Average speed;
    - Long-distance speed;
    - Commercial speed of cycling and walking;
    - Desired speed.
  - Congestion (time spent);
Waiting times;
Number of stops on a bike lane/ sudden stops/ difficult nodes in the path/ bottlenecks;
Detours;
Evaporation rate (points where people leave the path and why);
Cycling outside cycling lanes;
Parking;
Accident data (vs use);
Road quality;
Quality of infrastructure (through gyroscope sensor in phone);
Steepness, topography;
Safety;
Visibility;
Danger perception;
Day vs night;
Exposure to air pollution (clean space tag);
Ambient noise;
User perceptions;
Trip purpose;
Socio-economic indicators:
  - Age, sex, education, income, car ownership, employment status;
  - Household size (number of children, ages).

Visualization:
  - Visualizations should be scalable, not 1 line for 1 user.
  - Use the same formats as for motorized modes, with additional layers that relate to relevant data specific to walking and cycling (steepness, security, visibility...).
  - Heat maps (city wide and small scale).
  - Organic evolution of territory (film by time).

**TRACE potential contributions**

What could the TRACE project do to address some of the above issues?

- Engage users.
- Reduce data collection costs.
- Enable a day-to-day monitoring, instead of depending on historical data.
- Combine quantitative and qualitative data.
- Automatically detect the transport mode being used.
- Provide info on the purpose of the trip.
- Feedback on the journey (through marks, smiles, other classification by users).
- Report problems of the infrastructure.
- Give information to users about best routes, seamless travel, etc.
• TRACE tracking and counting features could be useful for better planning of investment and eventually postponing it for the sake of other measures for modality shifting. This could achieve great savings for the local authorities and give chance to many activities that could otherwise be neglected due to financial reasons.

• TRACE should consult the existing local planners’ demands in terms of regulations, documentation, etc. Indicators planners use must be included in TRACE tracking.

Case-studies mentioned by the participants

The participants mentioned several case studies of interest. They were the following:

• European Cycling Challenge – one month competition where cities invite their cyclists to track their movements. Its tracking data has been used by several of the participating cities (Bologna, Lille, Antwerp...).

• Flanders Bicycle Counting Week – one week campaign that has the purpose of collecting tracking data for planning operations. Users are invited to participate in order to make their demands heard: “Every cyclist count, make your cycling count”.

• Flow project – they aim to develop a methodology to measure and compare congestion levels for cars, cyclists and pedestrians. This is done by giving a higher weight to the time lost by cyclists and pedestrians, counting their waiting times as three times the waiting time of a car. Could tracking improve the journey times and level of service for pedestrians and cyclists?

• Birmingham Cycle Rewards – programme to promote cycling through a tracking app. The app provides info on the user’s bike journeys, calories burnt, money and CO₂ emissions saved, and can be used to compete with friends or other cyclists. The cycling miles can be cashed in for local and national discounted offers and vouchers.

• Birmingham Better Points – tracking app to promote physical activity and sustainable mobility. The points can be exchanged for gift vouchers or for donations to charity institutions and projects.

• Linköping, Sweden – they have volunteers to collect data (with gadgets) who mark problems (like holes in pavement) and assess the route conditions, lowering the road maintenance costs.

• Budapest – public bike sharing with tracking systems. This information is being used to redefine the location and size of docking stations.

• Bologna – tracking data (mostly from the European Cycling Challenge) has helped making policy. This data is combined with static data and calibrated through counts at strategic locations.

• Bulgaria – bikes frequently have a gadget attached that provides users info on the distances, speeds and etc. While it can be connected to the internet, several users choose not to do it.

• Rouen – the observation of the movement in three different bridges showed that the users of each bridge had very different profiles (young men vs families), which changes the actions to implement. This observation was done manually; tracking could be a faster and cheaper way to do it.

• Australia, Victoria – they looked at how seniors moved in their neighbourhood. People were doing a taking a longer route to avoid an intersection because it was dangerous. As such, if the observation were limited to the intersection, the logical conclusion would be that the intersection does not have
enough people to warrant an intervention or the implantation of traffic lights. Spot analysis can be very limited, and maybe tracking will help understanding the choices people take.

- San Francisco – they developed a database research that incorporates qualitative data. People are asked how they experience a route.
- Italy – there is a mobile company that gives free minutes to users who allow the tracking of their movements.
- Reconsidering the Bicycle: An Anthropological Perspective on a New (Old) Thing – Book by Luis Antonio Vivanco

3. Conclusions

Changing the Mobility Paradigm is a difficult task that can only be achieved through collaboration. There has to be a strong dialogue that promotes the sharing of information, ideas and questions.

Tracking will help redefining vision by providing evidence and helping quantifying goals: vision is not a technical matter, but it needs technical support. Tracking will give visibility to ideas and groups of users commonly disregarded by traditional planning and data collection methods, and may help increase the community engagement and participation. The vision goal is to influence the change based on user demand, on what people actually want, rather than planners just deciding what people need.

By profiling its users, tracking will help reinforce the idea that users are persons, not numbers, thus enabling setting goals and approaches more suited to the target groups: if you want to build a city for people, you have to have data on people.

Tracking will be standard in ten years, which, coupled with the use of big data, will have significant impacts on the planning process. Tracking data provides continuous and current information, richer detail, user segmentation, and can complement other types of data. Tracking allows knowing instead of imagining and contributes to make diagnosis, test ideas, monitor and evaluate actions, develop multimodal policies and improve the network design.

By providing data continuously, tracking will shorten the temporal horizon of activities and programs: with tracking we don’t need to wait for the elephant paths (name given in the Netherlands to the destruction of grass made by people choosing the shortest path across a park, which shows the route people actually want to follow).

However, when using tracking for planning it is important to keep in mind that it should not be seen as a goal in itself or as the sole basis for establishing goals and visions. Tracking reinforces the idea that mobility is an engineering question, and it is not. It is a mean, not a goal in itself, and it relates to personal choices, lifestyle and citizens’ well-being.

The use of tracking data faces many challenges in its relation with planners (identifying their needs, ensuring they accept and know how to use new methods, interpreting data), which may be mitigated by giving planners specific formation and developing good data analysis models.
The limitations of tracking data in terms of representativeness and reliability may be mitigated by merging tracking data with other sources and interpreting the results, paying special attention to what the data might not be showing.

The issues of quality, transparency and interoperability may be improved by developing common standards and creating an open data platform. These developments may also help mitigating the privacy issue, one of the major challenges faced by tracking. Other solutions include the creation of a clear user agreement and convincing users on the importance and rightful use of their data, which in turn may also help keeping users engaged. Other strategies for this include gamification, competition and rewarding. The lack of qualitative data might be circumvented by incorporating features in the tracking apps for users to provide feedback, while ensuring that their effort is minimal.

Finally, one of the major challenges in terms of tracking data use is how to go from raw data to meaningful knowledge. Information must be translated into a set of indicators and visualization methods that planners will actually use. Before developing the tool and choosing indicators, it is necessary to understand what is needed, and to ask the right questions.

Possible indicators identified by the participants relate to network use (volumes, patterns, OD matrixes), trip description (purpose, time, distance, speed, route), fluidity (congestion, waiting times, number of stops, bottlenecks, detours), route conditions (quality of infrastructure, safety, visibility, danger perception), environment (pollution, ambient noise), cycling specific (steepness, cycling outside cycling lanes) and socio-economic profile of users.

In terms of visualization tools, heat maps were pointed as the most useful ones, although it is a type of language that is not necessarily understood by everyone. It was suggested that cycling and walking should be represented by the same formats as motorized modes, while having additional layers to represent specific related data.

In conclusion, it can be said that tracking makes life easier, but could also make problems more complex. However, be careful not to discount benefits by worrying too much about limitations: transport modelling has been premised on gross assumptions that favoured cars for decades. Let us not let the limitations stop us from using the technology.
Table 1 - List of participants in the workshop

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Country</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patrik Toth</td>
<td>BKK Budapest</td>
<td>HU</td>
<td>TUG</td>
</tr>
<tr>
<td>Ivana Semanjski</td>
<td>Ghent University (i-KNOW)</td>
<td>BE</td>
<td>TUG</td>
</tr>
<tr>
<td>Hannah Bowden</td>
<td>RYW Community Systems Ltd</td>
<td>UK</td>
<td>TUG</td>
</tr>
<tr>
<td>Marco Boero</td>
<td>Soffeco Sismat Srl</td>
<td>IT</td>
<td>TUG</td>
</tr>
<tr>
<td>Andy Cope</td>
<td>Sustrans</td>
<td>UK</td>
<td>TUG</td>
</tr>
<tr>
<td>Leif Linse</td>
<td>Trivector traffic AB</td>
<td>SE</td>
<td>TUG</td>
</tr>
<tr>
<td>Bronwen Thornton</td>
<td>Walk21</td>
<td>UK</td>
<td>TUG</td>
</tr>
<tr>
<td>Sónia Lavadinho</td>
<td>B Fluid</td>
<td>CH</td>
<td>External</td>
</tr>
<tr>
<td>Pedro Machado</td>
<td>City of Lisbon</td>
<td>PT</td>
<td>External</td>
</tr>
<tr>
<td>Koen van Waes</td>
<td>City of Tilburg</td>
<td>NL</td>
<td>External</td>
</tr>
<tr>
<td>Loïc Martel</td>
<td>EcoCounter</td>
<td>FR</td>
<td>External</td>
</tr>
<tr>
<td>Beneditce Swannen</td>
<td>European Cyclists Federation</td>
<td>BE</td>
<td>External</td>
</tr>
<tr>
<td>Benoit Wiatrak</td>
<td>European Metropolis of Lille</td>
<td>FR</td>
<td>External</td>
</tr>
<tr>
<td>Imre Keseru</td>
<td>MOBI (Vrije Universiteit Brussel)</td>
<td>BE</td>
<td>External</td>
</tr>
<tr>
<td>Bernard Gyergyay</td>
<td>Rupprecht Consulting</td>
<td>DE</td>
<td>External</td>
</tr>
<tr>
<td>Simona Larghetti</td>
<td>Salvaiciclisti Bologna</td>
<td>IT</td>
<td>External</td>
</tr>
<tr>
<td>Alessandro Attanasi</td>
<td>SISTEMA</td>
<td>IT</td>
<td>External</td>
</tr>
<tr>
<td>Marco te Brömmelstroet</td>
<td>University of Amsterdam</td>
<td>DE</td>
<td>External</td>
</tr>
<tr>
<td>Martijn Geervliet</td>
<td>Breda</td>
<td>NL</td>
<td>TRACE</td>
</tr>
<tr>
<td>Rob Temme</td>
<td>Breda</td>
<td>NL</td>
<td>TRACE</td>
</tr>
<tr>
<td>Ina Karova</td>
<td>EAP</td>
<td>BG</td>
<td>TRACE</td>
</tr>
<tr>
<td>Kiril Tunev</td>
<td>EAP</td>
<td>BG</td>
<td>TRACE</td>
</tr>
<tr>
<td>Predrag Zivanovic</td>
<td>FTTE</td>
<td>RS</td>
<td>TRACE</td>
</tr>
<tr>
<td>Stanko Bajčetić</td>
<td>FTTE</td>
<td>RS</td>
<td>TRACE</td>
</tr>
<tr>
<td>Jeroen Blom</td>
<td>Ijsberg</td>
<td>NL</td>
<td>TRACE</td>
</tr>
<tr>
<td>Roelant Reizevoort</td>
<td>Ijsberg</td>
<td>NL</td>
<td>TRACE</td>
</tr>
<tr>
<td>João Barreto</td>
<td>INESC-ID</td>
<td>PT</td>
<td>TRACE</td>
</tr>
<tr>
<td>Paulo Ferreira</td>
<td>INESC-ID</td>
<td>PT</td>
<td>TRACE</td>
</tr>
<tr>
<td>Jan Christiaens</td>
<td>Mobiel 21</td>
<td>BE</td>
<td>TRACE</td>
</tr>
<tr>
<td>Name</td>
<td>Organisation</td>
<td>Country</td>
<td>Group</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------</td>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>Nick Deham</td>
<td>Mobiel 21</td>
<td>BE</td>
<td>TRACE</td>
</tr>
<tr>
<td>Daniela Stoycheva</td>
<td>POLIS</td>
<td>BE</td>
<td>TRACE</td>
</tr>
<tr>
<td>Giacomo Lozzi</td>
<td>POLIS</td>
<td>BE</td>
<td>TRACE</td>
</tr>
<tr>
<td>Giuseppe Liguori</td>
<td>SRM</td>
<td>IT</td>
<td>TRACE</td>
</tr>
<tr>
<td>Marco Amadori</td>
<td>SRM</td>
<td>IT</td>
<td>TRACE</td>
</tr>
<tr>
<td>João Bernardino</td>
<td>TIS</td>
<td>PT</td>
<td>TRACE</td>
</tr>
<tr>
<td>Mafalda Mendes Lopes</td>
<td>TIS</td>
<td>PT</td>
<td>TRACE</td>
</tr>
</tbody>
</table>