EMPOWER
EMPOWERING a reduction in use of conventionally fuelled vehicles using positive policy measures

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Mobility Services Infrastructure (MSI)
Deliverable no D4.1

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**A Summary**

The project EMPOWER is about rewarding change in sustainable mobility. EMPOWER researches how positive incentives can encourage citizens to reconsider their travel choices and reduce the extent to which they travel using conventionally fuelled vehicles (CFV). In this context, the overall goal of work package 4 is to utilize innovative mobility services to support positive policy measures, designed to reduce CFV use in cities. WP4 is planning to deliver:

- An architecture as a conceptual framework that helps to logically cluster services, features and technology components that can be used as tools to achieve and support CFV reduction;
- A Mobility Services Infrastructure (MSI) that provides broad capabilities to support use cases based on the architecture;
- Interfaces between EMPOWER tools existing within the EMPOWER consortium as well as third party tools that might be integrated and utilized at a later stage.

The focus for this document is to describe the MSI as part of sharing WP4 progress. Architecture and infrastructure inherit the character of loosely coupled services and interfaces as the underlying frameworks, whilst the technology components are reused from two existing innovative systems leveraging behavioural change in travel: Commute Greener and Move Smarter.

A view of the EMPOWER MSI below illustrates the open, flexible architecture that can integrate the existing backend and frontend tiers of Commute Greener and Move Smarter (note that SMART as frontend is owned and used by the Living Lab City of Enschede only):

Both Commute greener and MoveSmarter are positioned in the EMPOWER MSI

- Commute Greener is described as an example of an end-to-end Mobility Service infrastructure into a specific Facebook application context.
- Move Smarter is described as an example of a backend Mobility Service infrastructure which can be used with 3rd party development of a frontend.
The MSI can be utilized to provide and customize existing tools for the EMPOWER consortium lead cities and Take-Up Cities/Communities/Corporations and integrate third-party tools via APIs where suitable.

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## 2 Abstract

The focus for this document is to describe the MSI as part of sharing WP4 progress. Architecture and infrastructure inherit the character of loosely coupled services and interfaces as the underlying frameworks, whilst the technology components are reused from two existing innovative systems leveraging behavioural change in travel: Commute Greener and Move Smarter.

## 3 Relation to other WPs

| WP 1 | The (review) work in WP 1 is relevant to WP4 as the value proposition and incentives are partly described there. |
| WP 2 | WP4 (and especially Commute) provides a tool using social media components and therefor a relevant show case for WP2. |
| WP 3 | The business models consist of different parts, such as value propositions and communication channels to users, which are all relevant for the work in WP4. T3.1 provides insights to WP4 on important components of successful business models. |
| WP 5 | WP5 has provided requirements from lead cities and also needs to ensure a smooth utilization of WP4 infrastructure and tools in Living Labs |
| WP 6 | Provision of city data and the analysis/monitoring engine to be leveraged by WP6 |
| WP 7 | WP7 needs to understand and present technical capabilities of WP4 to take up cities and on the Empower website. |
### Challenges and Risks

The largest challenge and risk reside within the parallel progress needed among work packages in order to reach synergies, whilst at the same time as being pragmatic about the need to achieve impact with deliverables for research and innovation actions.

### Deviations from the proposal (positive and negative)

The proposal mentions the term “full integration”. In this deliverable this term has been specified by “loosely coupled” given that two large existing system infrastructures will be utilized and cities may use a specific combination, either one of the two or both.

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1 Introduction

This deliverable is the first deliverable in Work Package 4 (WP4) of the EMPOWER Project. The objective of Work Package 4 is to enable a MSI by providing value adding, personal, mobile ICT services (apps) that utilize mechanisms to distribute personalized incentives to encourage positive behavioural change and travel decision support for everyday travel. Additionally, these incentive management services provide urban stakeholders like cities, transport and 3rd party service providers, large employers and local shopkeepers with new tools to enable mobility monitoring (floating people data) and to stimulate and achieve sustainable travel behaviour towards their target groups. WP4 consists of three tasks. Task 4.1 provides mobility services backend implementations and interfaces. Task 4.2 designs and provides end-user applications. Task 4.3 provides operational management services to the Living Labs (WP5) and deals with test, maintenance and support.

This deliverable document 04.1 is a product of Task 4.1. The first chapter introduces the deliverable and discusses its goals, main results and innovations, as well as the approach applied and concludes with a brief overview of the document structure. After that the MSI will be introduced in the second chapter. Application examples will be illustrated in the third chapter. The document ends with conclusions in chapter 4.

1.1 Goals and contribution to other tasks and deliverables in EMPOWER

The scope of this document is focussed on describing the backend services of the MSI, in contrast to the forthcoming complementary deliverable 04.2, which will address frontend end-user applications.

This documents reaches out to a technical audience and researchers interested in backend architecture and functionality for a specific MSI capable of

- distributing personalized incentives to encourage positive behavioural change and travel decision support for everyday travel
- roll-out in multiple European cities or within European interurban transport services

Furthermore, the document supports the interaction between work packages within the EMPOWER Project, primarily to communicate the state-of-the-art available in WP4 as well as by documenting agreed requirements from other work packages.

1.2 Main Results and Innovations

The main result of 04.1 is the capabilities inventory provided within Chapters 2 and 3 based on a description of Mobile Services Infrastructure with Commute Greener and Move Smarter serving as descriptions with components and functionalities, and an outlook to how these can be utilized. The innovation of this deliverable may be derived through the application of these capabilities to the interests, needs and ambitions of Living Labs as described Chapter 4. Figure 1 depicts the overall EMPOWER Toolkit in which software services is a tool delivered through WP4.
The forthcoming deliverable D4.2, which will be more focused on frontend end-user applications, will build upon this deliverable as frontends have dependencies on backend capabilities. Reflecting the more visible elements of the MSI, i.e. the frontend views of the mobile ICT services, D4.2 is likely to be more appealing to city officials and Living Lab stakeholders.

### 1.3 Approach applied in Task 4.1

The chosen scope of this deliverable is based on EMPOWER consortium discussions, workshops, webinar and other activities organised by WP4 during the work of Task 4.1. For example, the webinar served as a way to enrich insight among the EMPOWER consortium and Living Lab stakeholders by sharing the capabilities of the Commute Greener and Move Smarter tools. The webinar is available as Video for later usage as well. Thereafter, a layered architecture of capabilities was developed to illustrate how the two tools are related and what hybrid solutions are feasible through loosely coupling of different components.

Lastly, the WP4 team organised ten one-to-one discussions together with key stakeholders in the specific Living Labs (city authorities and transport service providers have agreed to provide Living Lab environments to test in real-life conditions the new innovative mobility services). In several of these discussions, non-EMPOWER consortium members also participated (e.g. Transport companies, Incentive providers). The purpose of the discussion was to: (1) verify that the WP4 team had the right understanding of what each of the Living Labs intends to achieve; (2) explain the tools that the WP4 team can offer to support the Living Lab in achieving their objectives; (3) demonstrate in more concrete terms how these tools can be used together with an implementation plan and that such a plan include multiple actions for which each Living Lab is responsible for, and (4) to highlight what steps needs to be taken to become ready for operations, on the short term and on the longer term. To share more details of the T4.1 approach this document contains application examples (provided in Chapter 3) from these discussions for the Enschede and Gothenburg Living Labs that give a broad overview of relevant use cases.
1.4 Document Structure
Chapter 2 gives descriptions of the MSI with an architectural view and specific details of Commute Greener and Move Smarter. Chapter 3 provides two (use case) application examples in the context of the Living Lab cities Enschede and Gothenburg as well as discusses how tools can be used in practice. Finally, Chapter 4 concludes by discussing challenges and key factors for our MSI.
2 Mobility Services Infrastructure (MSI)

The MSI is part of achieving impact by the EMPOWER project in reducing the use of conventionally fuelled vehicles. In its role within the EMPOWER context, WP4 has the objective to provide:

- An architecture as conceptual framework that helps to logically cluster tools, features and technology components
- A services infrastructure that provides broad capabilities to support use cases for cities based on the architecture
- Interfaces that empower tools existing within the EMPOWER consortium as well as third party tools that might be integrated and utilized at a later stage

While there are implications with any type of description the aim is to highlight the architecture and infrastructure with the characteristics for loosely coupled frameworks and interfaces into the underlying technology components from two existing systems: Commute Greener and Move Smarter. Loose coupling is an approach to interconnect the components in a system or network so that those components depend on each other to the least extent practicable.

Commute Greener is described as an example of an end-to-end Mobility Service infrastructure into a specific Facebook application context. Later, in Chapter 3, there are further application examples such as an employer campaign in the EMPOWER Living Lab city Gothenburg.

Move Smarter is described as an example of a backend Mobility Service infrastructure for 3rd party development. Later, in Chapter 3, there are further application examples such as the Smart frontend application in the EMPOWER Living Lab city Enschede.

2.1 Architecture of the MSI

The focus of this deliverable is on the backend part of the MSI which will be described in the context of an overall Service-driven Architecture as it is shown in Figure 2.
This tiered architecture illustrates backend and frontend layers in which there are different tiers and components that contain various feature areas in order to illuminate different capabilities.

The backend layer consists of systems and engines of Commute Greener and Move Smarter that are functionally capable of storing, processing, analysing and enriching travel data and to provide tools to manage, plan, execute and evaluate different incentive schemes that can be used to support target group oriented behavioural change. The core backend engines utilized in EMPOWER are:

- Analysis/Monitoring Engine(s)
- Incentive Engine(s)
- Experience Sampling Engine
- Management/Planning Cockpit
- City Data Platform

Due to its loosely coupled nature, the EMPOWER MSI backend also supports third party integration on a functional and data level. For example EMPOWER also includes third party data sources (e.g., for traffic information) and third party tools and services with separate backend systems (e.g. multimodal route planning services). Moreover, data from third party tools can also be integrated to be used within an existing incentive engine for example.

The backend engines mentioned are being and will be utilized by available frontends to deliver integrated, turn-key solutions to EMPOWER Living Lab and Take up Cities (TUC):

- Commute Greener (Facebook apps for iOS, Android and Web – globally available)
- SMART (iOS and Android Apps – available and owned by the City of Enschede)
- Additional EMPOWER tool to support a broad variety of city initiatives in a simple way on smartphones (in the process of being provided unique through the EMPOWER project)

Via APIs the data collected and derived in the MSI can be made available to cities policy development and evaluation purposes or for operational or tactical level decision making processes.
Additionally, third party modules can use selected components and modules of the MSI. An example is the tracking module of the Move Smarter backend that can be used in third party service development and integration including separate third party frontends.

Living Labs as well as Take-Up Cities/Communities/Corporations can utilize selected parts of the MSI depending on the application scenarios and use cases foreseen.

The validation and further deployment of this architecture and infrastructure approach goes in line with the overall EMPOWER project approach: feedback iterations will be conducted primarily within the EMPOWER Living Labs.

2.2 Commute Greener - MSI documentation

MSI under the name of Commute Greener date back to 2009 in terms of public releases. Commute Greener focuses on smarter ways to get to work. There have been several generations of technology shift while retaining, reusing and refining many key aspects and learnings generated from community interactions as illustrated in Figure 3. There is a growing community of cities, communities and corporations that engage to various degrees. There are large differences as well as generic similarities between cities like Gothenburg and Mexico City, communities like WWF and European Mobility Week and corporations like Keolis and Vattenfall.

Figure 3 Generations of technology shift and growing community interactions

To cope with technology shifts while having a large degree of stakeholder interactions into community, business and 3rd party vendors (such as navigation providers e.g. Google Maps, travel planner providers e.g. HaCon, music providers e.g. Spotify, incentive providers e.g. Allstate Insurance) the philosophy of open innovation helps. There is also a pragmatic structures and use of terminology to describe processes, procedures, tasks, and checklists that align with ITIL standards (as depicted in Figure 4 https://en.wikipedia.org/wiki/ITIL ).

![Figure 4 Commute Greener align with ITIL framework](https://en.wikipedia.org/wiki/ITIL)

The development methodology basically adhere to PRINCE2 terminology and processes with a strong emphasis on agile capabilities while regarding resilience of the platform (see for example [www.slideshare.net/apmg-inter/integrating-agile-into-prince2-apmginternational-webinar](https://www.slideshare.net/apmg-inter/integrating-agile-into-prince2-apmginternational-webinar) as a reference). The current technology infrastructure and experience for dedicated Mobility Services include Postgres, SQL, Ubuntu, Linux, Apache, Ajax, GWT, Java, Scala, HTML, XML, REST, JSON, Python, Android (since Froyo, KitKat, Jelly Bean, LolliPop...), iOS, Xcode (since beginning), Cocoa Touch, CSS, jQuery, JavaScript and constantly evolving. For Facebook APIs and SDKs there have been a rapid development including the rise and fall of FBML and iframe, canvas, the Social Graph API, now Graph API, Open Graph protocol etc. Figure 5 gives an overview of possible interactions with Facebook while for on-line references please also visit [https://developers.facebook.com](https://developers.facebook.com) as well as remain with a rigorous approach and apply critical thinking to address lock-in, privacy, business risk and other technology related concerns.
2.2.1 An end-to-end service into a specific Facebook application context

The following sections describe the specific end-to-end Mobility Service infrastructure part of Commute Greener in a Facebook application context. Facebook is currently a dominating force in social networks. The Facebook Developers community provides a rich basis for third party developers to launch and expose their engaging social applications using Facebook’s library of open source APIs. During 2014 the social network’s users shared 50 billion pieces of content from apps. More than 30 million apps and websites use Facebook’s developer tools and in a figure from 2012 there were more than 800,000 developers around the world building applications enabled through the Facebook channel (Wikipedia). Facebook keep on gaining a huge number of users and has become increasingly popular with more than 1,3 billion active users who did more than 3,5 billion app installations during 2014 [http://fortune.com/2015/03/25/facebook-f8-developers-conference-numbers/](http://fortune.com/2015/03/25/facebook-f8-developers-conference-numbers/). The community as well as infrastructure still evolves and hence there are regular upgrades. With this growth it becomes important for multiple stakeholders such as product managers, developers and testers to know about the benefits and risks for application development and run-time context.

Before going into further details of the Facebook example the general MSI of Commute Greener can be described as providing features that enable capabilities such as:

**Incentives, acknowledgement & rewards**
- Promoting modal shift
- Mobility incentive and loyalty schemes
- Challenges, badges, leaderboards
- Social network features CO2 and cost reductions, health gains
- Graphs & reports

Available options
- Personalized ride share suggestions
- Ride share match making – multi modal
- Ride share chat & messaging
- Personalized traffic alerts

Analysis & Planning
- Travel pattern analysis
- Modal split analysis
- Driver/passenger/rider satisfaction analysis

Overall the segments and target groups for Commute Greener services include stakeholders such as:

- **Mobility Management**
  - Engage, Measure, Check, Act
- **Public transportation authorities (PTA)**
  - Traffic planner
  - Customer service manager
- **Public transport operators (PTO)**
  - Transport planner
  - Customer service manager
- **City authorities**
  - Mobility manager
  - Environmental manager
  - Mobility Management Agencies
- **Agencies**
  - Mobility management consultant
- **Private companies**
  - Fleet manager
  - CSR
  - Environmental manager

Coming back to Figure 5 the Facebook Developers enable actors such as Commute Greener to reach ways to make Mobility Services match needs of stakeholders primarily by enhancing access to a very broad and potentially huge user base. This may give mobility management websites more social capabilities by offering a number of social features integrated with applications. Social Plug-ins, such as the Like Button can drive user engagement with a small effort in terms of HTML extensions. Other examples allow the Facebook Login Button and Registration Plug-ins to replace user registration and sign-in procedures.

Integrating with Facebook APIs can allow access to certain social graph data of a given user, enabling both personal experiences and sharing data of various socio demographic natures. Social Graph and Social Channels are schemes of users and objects interactions and to some degree actions (especially when it comes to games). These actions and objects can actually be created by various third-party applications. Actions can be displayed on user’s individual page and an application may create a
persistent connection and relation between the application and application users. This can also be used to drive new users to the application. The social channels are ways apps can reach users on Facebook and has relations to the ‘Appstore’ of Facebook also known as Appcenter. There are different appearance depending on language as well as country and community specifics relating on usage, results and the divided communication can for native developers both present opportunities and constrains.

Depending on perspective and profiling it is possibility to get some different perspectives for example on www.facebook.com/appcenter/CommuteGreener and Figure 6. Other examples include news feed, application requests and bookmarks. There are also inherent implications for strategic choices of a portfolio as relates for example to other appstores such as Apple Appstore and Google Play for Android mobile as well as in terms of desktop versions for different browsers/versions. On top of any strategy different ways by which an application can connect with users enable interactions, may it be pages, sites, groups, roles, devices etc.

Figure 6 Screenshoot from a Facebook Appcenter page with CommuteGreener.

With the Commute Greener Facebook apps EMPOWER tools cover a broad range of social media features to be used in initiatives planned.
2.2.2 Commute Greener architecture layers
Taking a view into layers for creating end-to-end Mobility Services and its infrastructure it is possible to describe these from frontend to backend. In the frontend the width of devices and display properties influence how to address the run-time environment. Commute Greener have addressed the web/mobile frontend with HTML5 as well as other desktop and browser based versions along side with the ‘appstore’ enabled frontends into iPhone iOS and Android hybrids. These are shown in the top of Figure 7 going down through to a database layer. In the business services layer there are various cashing and stylesheet properties and a blend of direct Facebook and Google Map items in everything from frames to generic features such as zoom in/out and menus.

Figure 7 Commute Greener end-to-end service in a view of layers
The features layer has proprietary aspects but also an application generic layer, ranging from pre-processed to transactional real-time data from integrated travel planners and other sources (the latter being an example of the blue application generic layer in the figure above). The foundation for the run-time environment is a sound data base technology layer with architecture and optimisation for performance into the Commute Greener proprietary data as well as into 3rd party databases according to OLA and various conditions. Although being a specific example this is of course still a high-level abstraction and just looking at another perspective of how a Facebook browser and its users may interact. Figure 8 shows such interaction on a business level.
2.2.3 Commute Greener services repository

In terms of design and product management, as with a service catalogue description visualized into Figure 4, a Mobile Services infrastructure benefits from being able to address implications of operations, maintainability and continuous improvements addressing future user expectations. A generic services repository is depicted in Figure 9.
Mobility Services often rely on access to open data resources, for example traffic information, commuting patterns, bus schedules etc. Open data can be discussed at length, but in this report it is limited to one of the examples in which Commute Greener have opened its data through public Open APIs. The aiming is to help other applications reuse Commute Greener’s existing features and thereby their application focus can instead be on new feature developments. The first two open APIs were published in TrafikLab in 2012 (www.trafiklab.se). For selected data sets it is possible to search commuting patterns based on parameters like locations, time intervals, start and end positions, region, transport modes, CO2 emissions. It can be used for analysis, comparisons, and innovative ways to encourage other users and/or use cases to improve their everyday travels. Since a service repository can be illustrated and described in many ways it is often useful to have a dialogue among stakeholders in order to identify actual use-cases in order to detail intended usage for each stakeholder etc. By sharing an use-case extract from Commute Greener, which include the Facebook API, it may serve as sample to how system of systems appear into actor network diagrams and grouping of features appear on such levels, see Figure 10 (e.g. UC14, API service user).
2.2.4 Performance Indicators to run a MSI

This section will show performance indicators important to successfully run a Mobility Service infrastructure. A generic list of such performance indicators includes:

**Performance**
- Response times - application loading, screen open and refresh times, etc
- Processing times – functions, calculations, imports, exports
- Query and Reporting times – initial loads and subsequent loads

**Usability**
- Look and feel standards - screen element density, layout and flow, colours, UI metaphors, flows
- Internationalization / localization requirements – languages, spellings, keyboards, paper sizes, etc
- Support, training, documentation and add/change/delete user processes
Capacity
- Throughput – how many transactions does the system need to be able to handle?
- Storage – how much data does the system need to be able to store?
- Year-on-year growth requirements

Availability
- Hours of operation – consider weekends, holidays, maintenance times, etc
- Locations of operation – where is it used, what are the connection requirements?

Security
- Login requirements - access levels, CRUD levels
- Password requirements - length, special characters, expiry, recycling policies
- Inactivity timeouts – durations, actions

Reliability
- Mean Time Between Failures – What is the acceptable threshold for down-time?
- Mean Time To Recovery – if broken, time available to get to run time again?

Integrity
- Fault trapping (I/O) – how to handle electronic interface failures, etc
- Bad data trapping - data, flag-and-continue or stop the import, etc
- Data integrity – referential integrity in database tables and interfaces

Recovery
- Recovery process – how do recoveries work, what is the process?
- Recovery time scales – how quickly should a recovery take to perform?
- Backup frequencies – how often is transaction data, set-up/system backed-up?
- Backup generations - what are the requirements for restoring to prev instance(s)?

Compatibility (E2E from I/O to web, mobile)
- Compatibility, shared applications – What other systems does it need to talk to?
- Compatibility, 3rd party applications – What other system connectivity exist?
- Compatibility on different operating systems – What does to be able to run on?
- Compatibility on different platforms – What platforms it needs to work on?

Maintainability
- Conformance to architecture standards – conform to or exclusions?
- Conformance to design standards – design standards or exclusions?
- Conformance to coding standards – coding standards or exclusions?
- Governance structure and Change and Requirements Management

The emphasis is on combining agility with resilience together with a philosophy of open innovation. Therefore, the V-shaped approach to address the generic aspects in the list above in the process of Figure 11 below shall not be understood as too rigid but rather as a type of checklist needed to derive valuable analysis of any MSI usage.
2.3 MoveSmarter - MSI documentation

2.3.1 Introducing the MoveSmarter backend platform

MoveSmarter is an instance of a mobility service infrastructure for 3rd party mobile and web App development focusing on personal mobility and sustainable travel behaviour. Personal mobility is the paradigm that puts the traveller in the centre of the transport system in terms of needs and goals. A focus on personal mobility in relation to sustainable travel behaviour provides benefits at the individual and the collective (city) level. As such the MoveSmarter mobility services presented in this section contribute to solving sustainable mobility and smart urban transport challenges in our society.

The MoveSmarter services infrastructure delivers a white label personal travel behaviour measurement and analysis core service utilizing the Smartphone of the traveller supported by a number of modular software engines that can deliver personalized information and incentives based on the measured travel behaviour of that individual. With these engines, public or private stakeholders like local or regional public authorities, employers, transport companies, local retailers, service providers and event organisers can couple, integrate or build their own (cross-sectoral) services, Apps and campaigns on a scale of their choice to inform and incentivise travellers in a personal, targeted way. For example they can provide pre-trip local travel information and advice or post trip rewards, insights and suggestions to selected target groups. The platform approach is illustrated in the following figure.
This approach creates a fast growing market as these type of ICT services are flexible and cost-effective opposed to more traditional traffic- and mobility management solutions and allow for new business models— for example in information exchange and incentive distribution between third parties, city authorities, transport suppliers, employers and end-users.

2.3.2 MoveSmarter approach

The MoveSmarter approach is devoted to influence mobility demand side by stimulating behavioural change. Existing examples in the market that work on the demand side include services and Apps to help people to find the best (sustainable) travel route or alternative, to challenge and reward people for avoiding rush hour or to travel at all or to enhance intrinsic motivators by creating awareness on the impact of an individual’s travel behaviour in terms of costs, time, environment and safety. In all examples, information provisioning to and from the traveller plays a central role.

The MoveSmarter mobility services take these examples to a new level as MoveSmarter introduces innovative ways to measure and evaluate people’s actual travel behaviour in a 24x7 fashion utilizing the Smartphone of the traveller and creating personal mobility profiles out of that. With this knowledge, personal mobility demand can be influenced in a personalised way connected to, both, the preferences and motivations of an individual and the specific role, situation and context of that individual throughout the day\(^2\). This allows governmental authorities, but also stakeholders such as employers, transport companies or event organisers, to approach the challenge of CFV reduction in a highly effective, target group oriented way.

\(^2\) M. Bijlsma, A travel app to make you — and your environment — feel better, Research*eu results magazine No 23, June 2013.
2.3.3 MoveSmarter capabilities

The MoveSmarter MSI covers the classical learning cycle approach of measuring (monitoring) and evaluating travel behaviour against individual and collective goals. As such MoveSmarter facilitates decision support and behavioural change processes of travellers towards the sustainable travel choice.

The MoveSmarter MSI has the following functional capabilities and features:

1. **Sensing and Monitoring**
   Automatic 24x7 multimodal door-to-door measurement of travel behaviour (trip logging) utilizing the Smartphone of the traveller as intelligent sensor system. Monitoring of measured sustainable travel behaviour of (groups of) travellers over time, place, routes and chosen modality.

2. **Analysis and Evaluation**
   Travel pattern analysis and personal profiling. Travel goal and motivation evaluation against sustainability objectives. Modal split analysis, driver-passenger-rider satisfaction analysis.

3. **Experience Sampling**
   Situational and contextual questioning of travel attitudes, perceptions and opinions triggered by measured travel behaviour of (groups of) travellers (either based on real-time or long term behaviour). Possibility to sample qualitative opinions of travellers. For example with respect to mode choice or the availability of sustainable alternatives in travel.

4. **Cost benefit analysis**
   Feedback of the impact of personal travel behaviour and choices in terms of CO2, monetary costs, time, distances, calories/health gains, zero emission miles, CFV, public transport and ride share distances.

5. **Messaging**
   Capabilities to notify, alert and deliver personalised or group based (travel) information or advice to travellers utilizing mobile or web based channels. For example personalized ride share suggestions or ride share match making.

6. **Incentive Management**
   Acknowledgement of sustainable travel behaviour, reward and loyalty schemes, individual or group-based challenges and progress monitoring. For example challenging groups of employees to consider alternative commuter options to the car and rewarding the group when the challenge is met.
Important element in influencing travel behaviour within the Living Labs will be the ability of MoveSmarter to create meaningful, pin-pointed incentive schemes on the basis of actual travel patterns of the Living Lab participants. EMPOWER will design a number of incentive schemes focused on the objectives of the project. This includes challenges aimed at stimulating car commuters to avoid driving and to shift modality to cycling or public transport. A drawback of more pin-pointed, personalised challenges is that they only become relevant and feasible to the minority of the overall participants. As a result one-size-fits-all schemes must be replaced by a portfolio management approach.

2.3.4 MoveSmarter platform

The MoveSmarter platform is an open software infrastructure for third party mobile app development that implements the capabilities described in the preceding section. The MoveSmarter platform is a next generation development of the tripzoom platform\(^3\), which has been developed and validated in the EC FP7 R&D project SUNSET (www.sunset-project.eu)\(^3\). MoveSmarter heavily relies on state-of-the-art Internet and Smartphone technologies to deliver services and to interact with the traveller. Nowadays, Smartphones can be considered as irreplaceable and indispensable personal devices, which provide 24x7 connectivity for the owner with the outside world. In addition, the GPS features of modern Smartphones allow the Smartphone to be used as a powerful sensor to directly measure personal movement. This implies that Smartphones can be used to measure travel behaviour at the individual level and, using this knowledge, to provide tailor-made feedback and personalised travel information to the user and to encourage and entice the individual to smart mobility choices.

Therefore, the MoveSmarter platform consists of a modular set-up that can be configured and deployed for different application and user scenarios following a ‘carrot’ type of approach to effectively motivate people to adopt behavioural change. Core service of the platform to support this change is a two-step automatic sensing and travel behaviour analysis process.

2.3.4.1 MoveSmarter sensing and travel behaviour analysis process

The automatic travel behaviour detection process of MoveSmarter consists of two stages\(^4\). The first stage takes place on the Smartphone of a user via the installation of a MoveSmarter-enabled App. A Sensing Library software component integrated in the App creates the measurement capabilities. This module also manages authentication and communication with the MoveSmarter backend to perform measured data analysis in the second stage of the process.

The sensing module is an intelligent software component that uses an array of available sensors in the Smartphone (GPS, WiFi, Accelerometer and cell-ID information) to automatically sense trip start, movements and trip end. In this way for each trip a coherent trace of GPS locations is collected (a ‘Raw Trip’) without any user involvement. The sensing module runs as a background process on the Smartphone and restarts itself at operating system (iOS, Android) booting. With the current generation of Smartphones there is a clear trade-off between measurement accuracy and battery consumption.

\(^3\) P. Holleis et al, Tripzoom: a system to motivate sustainable urban mobility, Proceedings of the First International Conference on Smart Systems, Devices and Technologies (SMART 2012), May 2012.

Here, we aim for 24x7 sensing with normal Smartphone use throughout the day. A number of battery saving strategies are deployed to achieve this objective. First of all, the concept of ‘static’ versus ‘en route’ is used to prevent excess battery use by the GPS sensor. Only when the sensing module detects significant location changes, the GPS sensor is triggered and the App becomes ‘en route’. GPS sensing is automatically stopped when the sensing module detects that the Smartphone no longer moves (App becomes ‘static’). During the ‘en route’ mode GPS positions are collected with a frequency of approximately once per 2 seconds leading to typical accuracies between 3 and 30 m depending on speed of the Smartphone and GPS accuracy. Secondly backend communication is kept to a minimum. Upload is only performed when a trip has been marked as ended by the sensing module and communication with the MoveSmarter backend is possible. Otherwise the Raw Trip is cached in the Smartphone.

After upload, the Raw Trip is processed in the MoveSmarter backend. The processing includes filtering, cleaning, map-matching (using the open source OpenStreetMap network) and data enrichment. Also via interpolation and averaging routines, the quality of the data is further improved.

![Figure 14: Left panel: example of raw sensed data; Right panel: cleaned and map matched data.](image)

Transport mode deduction takes place using Bayesian probability statistics taking into account: i) speed patterns, ii) sensor data characteristics, iii) infrastructure network (i.e. location of road, rail, water and air infrastructure), iii) public transport information (i.e. location of public transport stops), and iv) personal trip history. Especially for shorter trips, where less measurement data is available, or more densely populated areas, where more mode options are available, this mode deduction is consequently more prone to errors. Furthermore, in combination with advanced trip splitting algorithms and reprocessing unimodal trips are generated with properties such as start location, end location, start time, end time, trip duration and modality. Finally, these trips are clustered in a personal mobility profile of an individual user.

### 2.3.4.2 MoveSmarter building block overview

Given the MoveSmarter sensing and travel behaviour analysis process a number of value adding services are offered by the platform consisting of modules for Cost/benefit analysis, incentive management, messaging and experience sampling supported by internal modules for user management and security management.
The building blocks of MoveSmarter are schematically depicted in the following figure.

![Figure 15 MoveSmarter functional building blocks](image)

### 2.3.4.3 The Sensing library

The MoveSmarter platform collects displacement data of registered users via their Smartphone. To this MoveSmarter leverages on an in principle arbitrary 3rd party App, which is installed by the end user on his or her Smartphone and which is equipped with the MoveSmarter Sensing Library. At first use, users can register to the MoveSmarter services. The Sensing Library is a software component, integrated beforehand in the App, which enables the App to automatically detect and record significant open air displacements (called ‘trips’) over time without any needed user interaction (like start/stop actions). Battery consumption of the software component is optimised so that on average a 24 hours period without Smartphone recharging can be covered. The Sensing Library takes care of

- user authentication and authorisation;
- determination of significant displacements of the Smartphone via a combination of sensors of the Smartphone;
- automated time stamping and measurement of geo-locations during significant displacements;
- local caching of data;
- secured data-communication with the MoveSmarter backend.

The Sensing Library is configurable. There is a Sensing Library implementation available for iOS and Android.
2.3.4.4 Analysis & Evaluation Module

After trip ending, the measured data is transmitted to the MoveSmarter backend data centre through a secure data connection. There, the data is processed, enriched and added to the personal mobility profile of the user. To do this, the MoveSmarter platform consists of a number of interconnected and cooperating software components in an open, scalable software-as-a-Service (SaaS) architecture. A web-based management cockpit provides an interface for user management, module configuration, data visualization and data export for reporting purposes or for further processing. Before any export, the data is anonymized such that the privacy of the individual end-user is always guaranteed.

The Analysis & Evaluation module provides processing, enrichment and analysis of measured data such that a multimodal personal mobility profile is built consisting of all trips of a registered user. On the basis of a configurable script a city administrator can select enrichment or analysis functions. The module takes care of automated

- time stamping of each trip start and end
- location mapping of trip origin, route and destination
- deduction of modality of each trip
- splitting of multimodal trips
- determination of frequent visited personal places
- determination of frequent routes
- probable motive of each trip
- percentage used modalities ('modal split')
- weather conditions with each trip
- quality indicators of each trip registration

The personal mobility profile is the basis for the other MoveSmarter value adding services.

2.3.4.5 Cost-benefit Analysis Module

With this module the impact of measured travel behaviour can be calculated on a personal and group level. The impact is calculated according to a number of indicators reflecting different intrinsic motivators and can be fed back to the user based on what motivation is important to that user⁵.

<table>
<thead>
<tr>
<th>Motivator</th>
<th>Calculated indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainability</td>
<td>CO2, zero emission miles, CFV.</td>
</tr>
<tr>
<td>Costs</td>
<td>Monetary cost, time loss</td>
</tr>
<tr>
<td>Well being</td>
<td>Calories/health gains</td>
</tr>
<tr>
<td>Safety</td>
<td>Distances, routes</td>
</tr>
</tbody>
</table>

At the same time indicators can be calculated on a city level to monitor or to evaluate network-level behaviour.

⁵ R.Carlson, Individual sustainability performance indicators for urban everyday traveling, Proceedings of the Ecobalance 2012 conference, Yokohama, Japan
2.3.4.6 Experience Sampling Module

As the Sensing Library and the Analysis & Evaluation Module provides quantitative insights into actual travel behaviour, the Experience Sampling Module provides the capability to determine qualitative aspects. The Experience Sampling Module allows for situational and contextual questioning of travel attitudes, perceptions and opinions triggered by measured travel behaviour of (groups of) travellers (either based on real-time or long term behaviour).

The Experience Sampling module is designed so that in a simple and flexible way city administrators can define and activate a single question or a short set of questions (questionnaire), define specific target groups and conditions for these questions to fire and collect the answers by this target group at the appropriate time and place. All of that with the least possible burden on the traveller (minimum number of ticks and clicks).

The Experience Sampling Module consists of the following functional blocks:

- Experience Sampling design and management. With this component city administrators (or assigned third party researchers and administrators) can define question definitions and questionnaires. Moreover they can add conditions and workflow scripting and can modify, activate and delete questions and conditions. The module supports different types of questioning/answering: open questions, multiple choices, multiple select and Likert (5 point) scale;
- Experience Sampling monitoring component: This component autonomously monitors, based on the defined conditions and audiences, when a question is asked to which users and manages the associated-reply or non-response by the user;
- Experience Sampling accounting component: This component provides an overview of the activated and answered questions by user, group or domain, including usage statistics for each question, condition or script.

2.3.4.7 Message Centre Module

With the Message Centre Module city administrators can target news and information in a very focused way to a target group tailored to the mobility behaviour of travellers in that pool. The Message Centre Module covers various available channels, such as email and push messaging on the Smartphone. The Message Centre consists of the following functional building blocks:

- Prepare new messages ready to be sent to a specific target group in a specific mobility situation;
- Collection of messages from other MoveSmarter components and the continuation of these posts towards the configured notification services for push messaging or email through specific adapters. All messages sent by the adapters are also stored in the Message Centre local storage database;
- Providing overview of acquired, new or missed messages concerning the traveller and book keeping of all sent messages.

The city administrator manages the Message Centre via the MoveSmarter management portal, the traveller manages its messages primarily through the App or her own e-mail program.
2.3.4.8 Incentive Management Module

With this software module challenges, rewards and remuneration conditions can be defined, managed and monitored for specific end-user groups. The module consists of a number of functional building blocks:

- MoveSmarter Incentive design and management. With this component city administrators or assigned third party administrators can define target groups and design, activate, modify and delete challenges and rewards for these groups. Types of incentives that can be offered are information / tips / pointers, points, badges, medals and vouchers. The set of conditions on which rewards can be based are: duration and timing of travel, passing or avoiding specific locations or routes, used transport modalities, longer-term personal mobility statistics, dynamic traffic intensity (delays) and the acquired set of points, badges and medals;
- MoveSmarter Incentive monitoring. This component monitors progress on challenges and determines who deserves what reward and when and issuing the corresponding merit to the user;
- Incentive bookkeeping. This component creates an overview of the merits of each user, enables the monitoring component to add new merits and enables third parties to write off unredeemed vouchers.

2.3.4.9 Management cockpit

A web-based management cockpit provides an interface for user management, authorisation and authentication, security management, module configuration, data visualization and data export for reporting purposes.

2.3.5 Technical architecture and interfaces

MoveSmarter follows a classical client-server architecture offering a scalable service infrastructure that provides a set of core mobility and networking services guarded by an OAuth security layer and accessible via REST based API’s. Users mainly interact with the system via a Smartphone Client App as described in the previous section. The MoveSmarter server side interacts with this App Client.

The MoveSmarter backend follows of three tier architectural model with separated data, business logic and user interfacing layers. The server side user interfacing consists of a web portal for city administrators. Third party services can integrate with the MoveSmarter system via the data-layer or the service layer by REST API’s.

MoveSmarter provides a number of interfaces as schematically depicted in the following figure:
The **Measurement API** provides an interface to retrieve measurements out of the Sensing Library and to set settings. Implemented interface methods (REST style GET and POST operations) include:

- Get sensing events for the specified user, with a timestamp, ordered by timestamp ascending
- Get number of trips by period and user
- Get trips that have been modified for a domain, ordered by LastModified ascending
- Updates the specified trip. Trip must contain an ID and already exist. Processed attributes are modality, objective and the names and types of the from- and to places.
- Get trip by id
- Get last trip per user
- Get trips by period
- Get trips that have been modified for a user

The **Experience Sampling (ES) API** provides an interface to register new questions and to provide answers to those questions. Implemented interface methods (REST style GET and POST operations) include:

- Get active question definitions in a domain

The **Incentive API** provides an interface for retrieving incentives and awards. Implemented interface methods (REST style GET and POST operations) include:

- Get active, currently visible incentives where the specified user is in the target group
- Get all individual awards of a user in a certain period. If no period is specified then the default is a two-month period ending now. The maximum allowed period is six months.
- Get all summarized awards of a user over a certain period, one award summary for each unit type. For vouchers and batches, one summary is returned per individual instance.
- Get incentives where the user is in the target group
• Gets incentives that were visible in the specified period where the user received an award. If no period is specified then the default is a two-month period ending now. The maximum allowed period is six months, unless an offset and a count are specified.
• Gets the running incentives for a user.
• Get incentive providers and whether the user is interested in them
• Set incentive providers where the user is interested in
• Get incentive types and whether the user is interested in the
• Set incentive types where the user is interested in
• Gets incentives that were visible in the specified period where the user did NOT (yet) receive an award. If no period is specified then the default is a two-month period ending now. The maximum allowed period is six months, unless an offset and a count are specified.
• Get details for a single incentive
• Gets a summary of all awards that a user did NOT collect (because the incentive was not achieved).
• Get all individual awards and spent awards of a user in a certain period as a single list. If no period is specified then the default is a two-month period ending now. The maximum allowed period is six months, unless offset and count are specified.
• Get progress for incentives for the specified user
• Get all individual spending of awards of a user in a certain period. If no period is specified then the default is a two-month period ending now. The maximum allowed period is six months.
• Get all summarized spending of awards of a user over a certain period, one summary for each unit type. For vouchers and batches, one summary is returned per individual instance.
• Adds a spending of some award for a user
• Get progress for a single incentive for the specified user
• Get awards (if any) and progress (if any) for a single incentive for the specified user

The Message API provides an interface to retrieve rendered messages and message categories per user, and to provide read or delete update. Implemented interface methods (REST style GET and POST operations) include:
• Get allowed message types for a domain. The API key must give access to this domain.
• Get the number of messages for a user with a specific status
• Get active public message definitions in the domain of the API key
• Get active message definitions where user is in the target group
• Get allowed message types for the current user with indication of the interest of the user
• Report interest to a list of message types
• Report status on a specific message
• Get a message rendered for a specific use

The (Personal) Mobility API provides an interface that can be used to request the personal mobility profiles of the user. Implemented interface methods (REST style GET and POST operations) include:
• Request the mobility profile for a user over a given period of time. If start and duration are not specified, the observed period will cover the last 28 days.
• Requests the statistics over a given period, will contain an entry for every day/week/month/year in the given period, optionally split per modality. The years, months and weeks are calendar years, months and weeks.
• Requests the statistics over a given period, will contain an entry for every day/week/month/year in the given period, optionally split per modality. Periods start from
now backwards. The months and years are not calendar months/years, instead they are
30 day and 365 day periods respectively

- Requests the regular trip that matches the specified trip, if any
- Combines requests for multiple mobility profiles, period statistics and/or recent
  period statistics. No more than 5 requests may be grouped in a single call
- Gets a regular trip. Can be used to retrieve details filtered when retrieving the regular
  trip list through MobilityProfile/user/{userId}
- Requests the list of RegularTrips, optionally sorted and/or filtered

The **Identity API** provides an interface for user management and authentication. Implemented
interface methods (REST style GET and POST operations) include:

- Validates a user by checking the token he/she received per mail
- Gets ID for the specified username in in the specified domain.
- Authenticates a user
- Sets the password for a user
- Gets the number of users that have been active during the specified period
- Creates a user with the specified credentials and returns the new id, returns an error if
  the user already exists
- Sets the password for a user using a reset token
- Gets IDs of users in the specified domain
- Gets the password reset token for a user
- Store data for the user. Will only store non-null fields. Properties will be added or updated.
  To remove a property using this call, set its value to null. Password setting in the submitted
  data will be ignored. Property names must start with 'user.' otherwise they will be ignored.
- Creates a user with the specified token and returns the new id, or returns the existing id
  if the user already exists
- Add/overwrite the specified properties for the specified user. Existing properties that are
  not part of the properties in this request will remain unchanged. To remove a property
  using this call, set its value to null. Property names must start with 'user.' otherwise they
  will be ignored.
- Checks whether the user allows to receive a particular notification type (for example e-mail)
- Retrieve the specified properties for the specified user.
- Authenticaates a user and returns a one time token for access to the web portal
- Gets password reset tokens for a (list of) user(s)
- Checks if the token specified matches the token key for the specified user

Finally, the **External services API** and **data API** are API's of third parties that MoveSmarter
uses depending on the application scenario and use case.
3 Application examples

This chapter provides a walkthrough of application examples, more in-depth with use-case example into settings of EMPOWER lead cities of Enschede and Gothenburg. Demonstrating how the MSI may be used in Living Labs can provide a basis for understanding Living Labs in general as well as setting context for Take-Up Cities/Communities/Corporations and even follow-on uptake with reduction of CFV usage as impact in particular.

3.1 Use case example Enschede

Enschede is a middle sized city (158,000 inhabitants) in the Eastern part of the Netherlands. Traffic in Enschede is characterised by 66% internal traffic whereas 34% is external traffic. 60% of the internal traffic is made by car, whereas 80% of the external traffic is made by car. Trend: 20,000 (20%) more cars in Enschede in 2020.

SMART (Self-Motivated And Rewarded Travelling) is a practical, free App for iOS and Android phones supported by the Move Smarter MSI. SMART helps Enschede citizens to travel smarter and more environmentally aware from and to the city of Enschede. For example, by avoiding traffic jams or by choosing a different mode of transport. SMART focuses on optimising travel behaviour in a human-centred approach. The target groups that SMART covers include commuters, city visitors, event visitors and shoppers. SMART offers for these target groups:

- Personalised transport options
- Support for ‘good’ travel decisions
- Rewarding of ‘good’ behaviour

SMART analyses the travel behaviour of the SMART user and responds with personalised advice, challenges and rewards. The main objective here is to reach a win-win situation between individual and city goals. The challenge system consists of a points-based incentive scheme. Citizens can collect points by taking up challenges and complete these challenges in terms of actual travel behaviour as measured by SMART. Points can be redeemed via a voucher mechanism in local shops. Examples of challenges include:

- Travel this week at least three times by bicycle to your work and earn 150 points
- The city centre is crowded on Saturday. Take the bus and earn 100 points
- Don’t get stuck in traffic before the football game of FC Twente. Take the train to Drienerlo station and earn 100 points.
SMART informs, makes travellers aware and nudge them to choose the better travel option. A typical commuter oriented use case scenario is illustrated in the following figure. In the use case the commuter shows habitual behaviour using the car to get to work although the commuter is aware that a traffic jam situation is likely to happen during rush hour travel.

![SMART Use case in a commuter scenario](image)

**Figure 17 SMART Use case in a commuter scenario**

In terms of functional building blocks (see also Chapter 2) SMART is an end-user oriented frontend on the MoveSmarter backend infrastructure as indicated in the following figure.
The SMART App is the central interaction mechanism with the end-user. Next to the App, SMART also uses a website to communicate with end-users and to provide a web landing page. The SMART App home screen is depicted below and consists of, both, intrinsically and extrinsically oriented motivating information elements to the user. Therefore, the home screen is divided into different areas. All information elements have their origin in the underlying Move Smarter backend. Also the challenging and rewarding based on individual behaviour is managed from the Move Smarter backend (notably the Incentive Management Module, see chapter 2). City administrators, but also other third party stakeholders like employers, transport companies or mobility service providers can define, activate and analyse their own challenge/reward-based incentive portfolio in such a way that it attracts and binds their target group(s) of choice. For example as being part of an engagement campaign.
Via a menu (upper left) the user can access more detailed information screens such as an overview of all measured trips of that user by SMART, an overview of all available challenges and the progress of the user with the associated number of points earned with respect to these challenges. Finally the App includes a shop, where points can be redeemed for vouchers from local retailers and other sponsors.

### 3.2 Use case example Gothenburg

The application examples in this section will relate to the second largest city in Sweden, Gothenburg. This use case example will extend the previous section on the Commute Greener architecture with the objective for designers and technology providers of MSI to benefit from access to more in-depth aspects as opposed to broader and generalised examples. Therefore the key elements of Commute Greener and social network features, in particular Facebook, as well as employer campaigns will be used as a foreground although, several other situations from Gothenburg exist and are part of the EMPOWER project.

Gothenburg embrace a population of more than 500,000 persons and is in a growth phase with a city centre divided by a river and a metropolitan area of almost 1 million people on the west coast of Sweden. Its maritime heritage does together with large industries and universities and the largest harbour in northern Europe contribute to a dynamic area. Even if the city has well developed public transport the most common way of transport takes place with CFV into single occupant cars. There are local, regional and national targets on reducing CFV usage and most measures are repressing, such as congestion charging introduced into 2013. However, since the foundation of Commute Greener in 2009 there has been several campaigns including positive incentives and the city of Gothenburg engaged its own employees as early as 2010 into the first generation of the technology and have grown together into different forms.
Innovative Mobility Services is increasingly on the agenda even if it should not be underestimated how tough it actually is to maintain and develop a robust and resilient infrastructure. The EMPOWER project will re-use and re-arrange parts of the existing ICT infrastructure at the same time as experimenting with novel use-case examples. Without side-tracking other deliverables and also keeping focus on technology items there are use-case situations that may include ‘electric bicycle as part of renting an apartment’ (i.e., apartment rent does not only include heating and water infrastructure services, but actually incentivising the tenant to use more sustainable modes of transport). Other examples may include last-mile service with ‘electrical tuk-tuk’ (promoted as faster than the bus and cheaper than the taxi) and yet other involve more transit related aspects.

Campaigns targeting to change behaviours with positive incentives can, as organised by employers, take many forms. Reliable measurements of the effects are often missing and when they exist they are likely to be survey based and limited to the awareness aspect. An employer in Gothenburg may have different motives to engage and run a campaign that has the objective to reduce CFV usage. It can be CSR driven (CSR = Corporate Social Responsibility) but better imperatives exist when there are direct business gains, such as reduced costs for company cars, parking locations and health gains among staff. Figure 21 is an extract from an illustrative use-case that combined university staff, students and companies within a science park in a central part of Gothenburg and gives an example for a specific campaign as it also can be done within the EMPOWER context.

New contest: Who can commute greener?

NEWS: APR 06, 2011

The academy at Lindholmen is challenging the surrounding companies to commute greener during an eight week long climate campaign starting this week.

It is students and employees at the Department of Applied IT - which is part of both Chalmers University of Technology and Gothenburg University - who are encouraging the companies in the vicinity at Lindholmen to accept the challenge. Who can change their behavior the most? That is the question.

The campaign will go on until 31st May. The goal is to reduce the emission of carbon dioxide and improve health and economy amongst the participants. There are also goals on a societal level, such as with the help of information regarding the participants’ travels to and from Lindholmen contribute to better public transportation.
An employer campaign normally has three phases with defined activities as shown in Figure 22. In the first phase target groups and channels need to be defined. Second comes the actual execution of the campaign and monitor progress with measurable results of real improvements being achieved and fine-tuning of incentive effects among other activities. The third phase is for follow-up and reporting as to take further activities to address new target groups, new sites or similar. The illustration in Figure 22 gives a view of the phases just described in which two months of consecutive improvements were encouraged to establish lasting behavioural changes and not only create increased awareness.
A key activity for a campaign organiser is to set challenges that attracts their target group. This does also involve deciding geographical uptake areas, which depend on local sponsors with incentives. It is about setting time aspects and includes considerations for mode of transport to be in focus (one or several as depicted in Figure 23. The upper part of the figure is part of user experience interface which is to be further described into EMPOWER project deliverable WP4 D4.2. The lower part of the figure describes a flow for setting a certain incentive that concern a specific geography (i) during a particular time (ii) and promote usage of a particular mode of transportation (iii). This is done as part of rewarding change with possibilities for the target group to win a prize.

![Image of a challenge set-up interface](image.png)

**Figure 22 Extract from Gothenburg suburbs making challenges during European Mobility Week**

Before the concluding remarks of this document it is essential to highlight that the application examples provided into the context of Enschede and Gothenburg have been presented to give more in-depth understanding in the light of descriptions for an EMPOWER MSI. However, these two lead cities represent only a part of the whole scope for Living Labs in the EMPOWER project need to be understood together with other EMPOWER deliverables that compose the overall research and innovation actions. The figure below is arising from the early stages of the EMPOWER living lab design process and illustrates the potential overall scope within the living labs.
To reach the full potential of how EMPOWER can work in the process of rewarding change there is a very conscious focus beyond the Living Labs of the lead cities in order to expand the actual usage of core capabilities and reach actual impact. There are intrinsic dependencies not only to the WPs of the project and the stakeholders involved into Living Labs since there are also Take-Up Cities/Communities/Corporations who directly shall engage towards common objectives.

**4 Conclusions: challenges and key factors for Mobility Services Infrastructure**

The MSI developed and documented in deliverable D4.1 provides the basis for the tools to be used in EMPOWER building on proven technology solutions and modern standards and frameworks.

This way EMPOWER captures and provides valuable experience and know-how on organisational, methodological and technical aspects of traffic and mobility initiatives featuring innovative information and communication technologies, applications and services to cities in Europe and worldwide.

The EMPOWER MSI is on the one hand specific enough to address needs and requirements of cities trying to make an impact on traffic and mobility because it supports key services and use cases. On the other hand its open architecture and APIs allow a wide usage supporting different use cases and tools.

However, it is important to understand that the tools considered here will mainly support cities in the areas of awareness building and motivation. It will still be up to the cities or stakeholders to provide service improvements and to ensure convenience and value for money when it comes to their alternatives to conventionally fuelled vehicles.
A key challenge will remain to be the diversity of situations cities are in when it comes to their initiatives and campaigns. With very diverse prerequisites regarding goals, budget, target groups, approach, timelines etc. it will always require discussions, education and timely preparations to build or utilize tools and services infrastructures. Here the EMPOWER project intends to make significant progress in creating impact for cities faster and more effective.