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Summary

The main aim of this deliverable is to provide an overview and analysis of the user and SUNSET system requirements. The deliverable builds on the content and structure of a generic scenario in terms of a set of ordered use-cases where a scenario is taken to be an informal narrative description that describes human tasks in a story and that allows exploration and discussion of context, needs and requirements.

The main criteria for the use of a scenario approach was to show how the use of the proposed system related to the project goals: to promote the use of sustainability indicators; to support the use of existing social networks of participants and to promote social incentive driven changes in mobility patterns that together influence urban travel behaviour. The scenario also gives the project the flexibility to cover different Living Lab (LL) situations and the opportunity to show that it: addresses policy problems; can actually impact on the travel practices of the participants and that the chosen instruments to deliver changes are effective. The developed scenario and uses cases were mapped to user requirements. The total set of user requirements were analysed and mapped to the proposed system requirements.

Two user consultations were carried out. The first was aimed at end-user travellers and the second aimed at local transport authority users. The first was a survey of over 130 respondents from a number of countries of residents. It has already highlighted some significant features for design of the system however. In particular it is clear that there are some differences in terms of use of social networks by country and by gender. Some types of incentive have emerged as being more likely to influence particular sub-groups than others. Different age groups have differences in transport related priorities and factors of importance. These initial findings will be taken forward in the design and implementation of the system.

The second stakeholder consultation was conducted with the municipality of Enschede as the main urban transport authority. The sample was too limited at this stage of the project to profile user characteristics and because the system is still in development.

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History

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1 Introduction

This deliverable is the first of two SUNSET WP1 deliverables concerning Scenarios as problem models and user requirements. According to Sharp et al (2007), a scenario is defined as in an informal narrative description that describes human tasks in a story that allows exploration and discussion of context, needs and requirements. D1.1 covers the results of both its two main tasks: task T1.1 (scenario requirements analysis) and Task T1.2 (system requirements analysis).

1.1 Goals

The goals of this deliverable are to:

- Describe the SUNSET scenarios, which illustrate how SUNSET's social mobility services help travellers to change their travel behaviour and what the effects are on a city's sustainability goals;
- Report on the results of our stakeholder survey (involving users and local transport authorities) and discuss how their feedback was analysed;
- Provide an anchor point in the project for the system's requirements coming out of WP2 and WP4;
- Contribute to the evaluation methodology (WP6) - this will be explained not in D1.1 but in Deliverable D6.2, the Evaluation methodology and measurement approach, which is due in M24.
- Guide the other WPs in SUNSET, such as the operation of the city-wide Living Lab (LL) in WP7 [D7.1, 2012];
- Develop the scenarios in such a way that we can show to technical and non-technical audiences what the project is about and what topics we're going to tackle.

1.2 Main Results and Innovations

SUNSET innovations	Contribution of this deliverable
Social mobility services that motivate people to travel more sustainably in urban areas	D1.1 defines motivating examples in its scenario to change mobility behaviour that includes social interaction.
Intelligent distribution of incentives to balance system and personal goals	D1.1 defines motivating examples in its scenario for the use of incentives.
Algorithms for calculating personal mobility patterns using info from mobile and infrastructure sensors	D1.1 defines the requirements for sensor inputs into the algorithms;
Evaluation methodologies and impact analysis based on living lab evaluations	N/A

Table 1: Contributions of this deliverable to SUNSET innovations

The main results of this document are a set of user requirements derived from a combination of scenario analysis, external user and stakeholder consultation. Table 1 explains how the results of this deliverable contribute to the project's main innovations. In this table, N/A" in the right column indicates that this deliverable does not contribute to a particular project innovation.

1.3 Scenario Development

To create the preliminary user and system requirements we use a scenario approach. The main criteria for the use of the scenarios is that it enables us to show how the use of the proposed system related to the project goals: to promote the use of sustainability indicators; to support the use of existing social networks of participants and to promote social incentive driven changes in mobility patterns that together influence urban travel behaviour.

The scenario also gives the project the opportunity to show that it (a) addresses policy problems and (b) can actually impact on the travel practices of the participants and (c) that the chosen instruments to deliver change are effective. Perhaps to put this in a mechanistic way we can say that there is a set of independent variables, these are the instruments and stimulus that we can control and expose trial participants to. There are sets of dependent variables, these are the changes we expect to see such as changes in mode use and we can specify these in quantitative terms such as increases in trips using walking. In addition, there is the policy context which relates to the problem that policy-makers wish to address. These are expressed in terms of sustainability targets resulting from increases in sustainable travel practices and behaviour.

It follows that the scenario should include the elements listed above, i.e., social networks, incentives, and mobility patterns. It is also useful to have an understanding of policy context or policy aims and an understanding of the causal model or models of travel practices and behaviour that the project is setting out to influence.

In transport there are many understandings of the motivations to travel, e.g., utility maximising, positive utility, theory of planned behaviour, theory of space syntax, time/space analysis, not to mention the social theories of mobility. But in all the theories and understandings there are some factors which are always prominent including social status, social norms, time and money. It would be useful for the scenarios to include some of these factors. So for example, time comes up in many different forms and is very prominent in all of these conceptualisations of why people travel. It is one of those resources that are important in the travel decision making.

There are two options how to develop city-based scenarios in SUNSET: to support a generic scenario across all LL cities; or to support each LL to

independently specify its own scenarios (Table 2); or some hybrid combination of these.

Pro's	Con's
Local influences on user behaviour can best be studied	Scenario might not fit local preferences
Only one scenario has to be developed	Not all cities have the same technique / sensors available

Table 2: Pros and cons for a common generic scenario

A second option is that each living lab could quite independently have its own scenario, based on local preferences and situation of each LL city (Table 3).

Pro's	Con's
Perfect fit with local preferences	Difficult to study differences between cities if target groups are unequal
Adaptive to locally available technique / sensors	Different scenarios have to be developed

Table 3: Pros and cons for each LL to have its own scenario

All living labs use the same generic scenario but can propose additional parts that will also be considered by other individual LLs. It was decided to specify the generic LL set as an intersection or common denominator of these with LL specific extensions.

1.4 Approach

The main objective of this deliverable is to describe how the potential needs or requirements of users of the SUNSET platform and other stake-holders are acquired and are translated into system or technical requirements from which a detailed specification of the design can be undertaken (described in additional SUNSET deliverables [D4.1, D5.1].

Section 2 and 3 serve as stepping-stones in the scenario development. In Section 2 the main travel objectives and indicators with reference to the potential city sites and the living labs (LLs), where SUNSET will be evaluated, are considered. Section 3 includes location dependencies in terms of the traveller characteristics, transport characteristics, transport sensing capabilities in these Living Labs (section 3). This results in a generic user scenario described in Section 4.

Subsequently, user requirements are deduced from the use-case scenario, i.e. from models of the problem space. Two of user consultation are carried out and analysed and reported (Section 5). The set of user requirements are analysed (Section 6) and mapped to the system requirements (Section 7). Finally, the main conclusions of this deliverable are reported (Section 8).

2 Scenario Development: Indicators & Objectives

The first step towards defining scenarios that will shift mobility behaviour is to make an inventory of the sustainability indicators and objectives of the different Living Lab (LL) cities. There are two major purposes of such indicators: 1) To measure that the project delivers what it is set up to deliver, and 2) to assist in the design of the social media and network services so that they are actually delivering the intended result.

2.1 System level objectives & indicators

The design of objectives and their indicators is strongly interlinked with WP3 (objectives) and WP6 (indicators for evaluation). Using the insights of [D3.1, 2012] 'Objectives,' section 3, we are able to identify the city user objectives for sustainability which are presented in the next sections. These objectives will function as input for WP6 where indicators for evaluation are being designed [D6.1, 2013].

Following the system level objectives, there are objectives for the individual user, and businesses. The individual user's objectives will be part of the user survey. A small intro to the business objectives is given in this chapter but is mainly defined in [D5.3, 2013].

2.1.1 Enschede

From a traffic perspective, the municipality of Enschede strives toward a decrease of 5% in car mileage during peak-hours. In its sustainability paper, Enschede commits to the national climate agreement, which means a 30% reduction in CO_2 compared to 1990. Related to transport, the target is set on 2% reduction annually. Among other, this has to be achieved by creating a modal shift towards Public Transport (PT) and bicycle and a reduction of cars in the inner city.

Also, Enschede wants "20% of all households to show energy efficient behaviour"[1]. Other fields in which Enschede tries to achieve this reduction are green energy production and energy efficient building including upgrading of current buildings.

[1] Nota Nieuwe Energie voor Enschede. Long term vision on sustainability by the municapility of Enschede: http://www.doegroendatscheelt.nl/algemeen/Nota/

2.1.2 Gothenburg

The sustainability indicators that are already measured in Göteborg region are presented using the table of European Eurostat's Sustainable development indicators (SDIs).

Theme	Headline indicator
Socio-economic development	Growth rate of real GRP* per capita
Sustainable consumption and production	Sustainable consumption and production
Climate change and energy	Carbon dioxide/GRP Particle emissions/GRP
Sustainable transport	Energy consumption of transport relative to GRP

*GRP = Gross Regional Product

Table 4: Sustainability indicators for Göteborg [Vision VästraGötaland, 2011]

The sustainability indicators of Gothenburg are referenced to the sustainability goals of Gothenburg, basically with regards to the CO2 emissions of Gothenburg. The target values for Gothenburg are related a relative CO2 emission reduction value for the target group of the Living Lab. The key focus is to identify a base value, with regards to different shares of transport modes, and to keep track of the changes in the shares of transport modes based on SUNSET results.

Personal travel is expected to increase, according to Traffic Authorities, from 2,200,000 to 3,000,000 journeys (36%) 2005-2025 in the Gothenburg region. Transport-related CO2 emissions should decrease by 7% in 2011 and 75% in 2050, compared with 1990. In order to cope with CO2 reductions it is estimated that the share for public transportation must increase from 24% to 40% by 2025 and that commuting by car to and from work must drop from 65% to 35%.

2.1.3 Leeds

The transport and travel objectives for the city of Leeds have been taken from the West Yorkshire Local Travel Plan (WYLTP) 'My Journey' published in 2011 (http://www.wyltp.com/). Travel planning for the city of Leeds is integrated with the plans for economic development, land use and transport at regional and city levels. The current plan is for a 15-year period from 2011. The significant objectives for Leeds for the forthcoming years are given in the following table. The two columns describe the significant Leeds city objectives and where applicable and available, the selected indicators to quantify and monitor those objectives in Leeds and/or West Yorkshire. Not all objectives have been linked to a city level indicator.

Leeds city level transport objectives[2]	Leeds city level transport indicators
Economic development Deliver transport improvements to support ambitions.	No indicator specified in the WYTP
Reduced congestion **Bus journey time** Increase the % of the core bus network where journey time variability in the peak period is equivalent to inter-peak conditions. **Car journey time reliability** Increase the % of the core highway network where journey time variability in the peak period is equivalent to inter-peak conditions.	No indicator specified in the WYTP. 'Journey time variability' is a measure of reliability and can involve more than one indicator Baseline is 69%. Objective for 2014 is 73.6%.
Greener towns and cities **Public transport patronage** Increase rail and bus patronage within West Yorkshire	Indicator in revenue terms is: For rail: to £29.3 mil from £27 mil. For bus: to £175.3 mil from £184.7 mil. (Sums refer to the whole of WY)
Smarter towns and cities **Travel Choices**: Encouraging and influencing more sustainable travel choices by understanding people's wants and needs and tailoring marketing, information, education and support activities to them.	No indicator specified in the WYTP
Improved accessibility Access to labour Market Increase the number of the total accessible workforce to each of the West Yorkshire centres. **Access to local services** Increase the % of residential population within 30 min of a local centre by public transport. Availability of **key health facilities** (e.g. GPs	Currently it is estimated at 102.000 for Leeds. Increase this to **107.500** by **2014**. In 2011: Peak **69.6%**. Inter-peak: **72.6%**. In 2014: Peak **69%**. Inter-peak: **70%**.

[2] http://www.wyltp.com/partnersandstakeholders/wyltp3qna and http://www.wyltp.com/NR/rdonlyres/1CF40EA9-62D8-4611-964E-C6D1B663628E/0/V101a20110406Plandocument.pdf

surgery, Hospital A&E etc.) within reasonable travel times. Access to facilities/assets that **promote positive health** (e.g. leisure, green space, parks, community centres etc.).	Improve the overall levels of accessibility to health facilities and facilities/assets that promote positive health.
Improved safety and security Reduce the risk of injury or death in a traffic related accident[3] **All road casualties – people KSI** A 33% reduction in West Yorkshire road user casualties killed or seriously injured (KSI).	From **1046** in 2011 to **960** in 2014 (Figures refer to the whole of WY).
Reduction of Greenhouse gases **Low-carbon trips** (Interim indicator) **NOx / PM10 emissions** Annual road traffic emissions of NOx and PM10 across the core highway network.	Increase the % of (non-single occupant car trips) crossing main district centre cordons form **63%** for **2014 rising to 70% by 2026**. (This indicator will be replaced over time by an indicator derived from satisfaction surveys). NOx - 10,367 PM10 - 278 CO2 - 2,225,736

Table 5: Sustainability indicators and targets for Leeds

2.1.4 Comparion of Objectives & Indicators across LLs

LL	Objectives	Indicators
Enschede	Limit use of cars Increasing use PT and bicycle Greener transport	5% ↓ car mileage during peak-hours. 30% ↓ CO_2emissions.
Gothenburg	Limit use of cars Increasing use PT Greener transport	Car trips to work ↓ 65% to 35% PT ↑ 24%to40% by 2025 CO_2 emissions ↓ 7% in 2011 ↓ 75% in 2050, c.f. 1990.
Leeds	Limit use of cars	Indicator not specified. Indicator for increase in low carbon travel

[3] http://www.leedscityregion.gov.uk/uploadedFiles/Research_and_Publications/Transport/4.%20LCRTS%20Main%20Report(1).pdf 2009

	Increasing use PT and bicycle Greener transport Road safety	Objective to increase patronage and indicator used is revenue 0% change in CO_2 by 2011, 20% ↓ in NOx From **1046** in 2011 to **960** in 2014 (Figures refer to the whole of WY).

Table 6: Comparison of System level objectives & indicators across LLs

Table 6 gives a comparison of System level objectives & indicators across LLs. Both Goteborg and Enschede have a core objective and indicator of limiting car vehicle use in cities despite the increasing trend. Leeds recently set a new set of objectives in 2011 and the change in emphasis in objectives reflects the current economic climate and changes in economic prosperity. All three cities have objectives about lower carbon emissions and a shift to greater use of public transport but in addition Leeds has specified goals and indicators for road safety. The comparison of objectives across LL cities is cautious because different indicators and metrics are used and are calculated differently as well as being set for different time horizons.

2.2 Sustainability Indicators for All Living Labs

To measure whether the SUNSET results is contributing to these goals it is necessary to identify quantifiable and measurable indicators. These indicators need to be measurable, as consequences of the SUNSET results and a mechanism that relates these results with the goals need to be identified. To stabilize the results, we need to find a good way to acquire these data, and to make the statistics at least a little insensitive to external biases. This research will be carried out in work package 6.
Based on [D3.1, 2012] the system level objectives that will be used are the efficiency of the system and the externalities. These are described in more detail in D3.1, section 3.6.

2.3 Business Indicators & Goals

There are three relevant business impact areas for the SUNSET services:

1. **Commercial attractiveness**: The first business impact area is the 'commercial attractiveness' of the SUNSET service will be attractive to the intended end-users, i.e. the travellers and any relevant transport provider and facilitator.

2. **Eco-system actor**: The second business impact area is that SUNSET services are successfully integrated with, or adhered to in, a commercial eco-system. This means that the SUNSET service has a commercial interaction of dependencies with for example suppliers, investors, industrial organizations, transport providers, city governments, business regions, user groups and different social media network providers where the different eco-system parties contribute to a spiral of commercial positive feedback to the entire eco-system.

3. **Business catalyst platform**: The third business impact area for the SUNSET service is the business catalyst platform function. This means that the SUNSET service and its eco-system establish a foundation where other businesses and commercial activities can flourish. For example may the combination of incentives for travellers and advertisement and marketing of restaurants, cultural events and commercial stores facilitate for different vendors to meet their customers and vice versa. Other examples are if transport providers with yet small market shares may grow because SUNSET services improve the contact between providers and customers. Yet other examples may be that new businesses may be established in regions where labour, customers and eco-system more easily and quickly communicate within the urban region.

For each of these three business impact areas different indicators will be developed, to measure the success of the SUNSET service, and its associated system. The indicators need to be further developed and refined in order to allow for real quantification and measurement in a SUNSET implementation. Further details of this work are described in [D5.3, 2013].

3 Scenario Development: Living Lab Characteristics

3.1 Primary Target Groups

The principal target user group contains citizens (also called travellers) who travel often routinely within the LL cities, e.g., employees who live and work within the city or people who have regular trips for shopping. Next to these, a visitor to a city, who may temporally inhabit the city, might be an interesting target group. In chapter 5, a stakeholder survey is described which supports target groups definition. [D7.1, 2012] will zoom in on the target groups, recruitment strategy, and numbers of participants needed.
For some cities multiple mobility initiatives will likely co-exist, e.g., i-Zone and SUNSET will co-exist in Enschede, and ISET and SUNSET will likely coexist in Gothenburg.

Also, there are additional stakeholders of the system, which might use the system, but are not the primary target group for using the mobility app. These include employers of inhabitants that travel, road authorities and service providers. These additional stakeholders are considered elsewhere (Section 4.3).

The three different LLs have a slightly different evaluation approach, which is reflected in the resources requested and the less-concrete involvement of city partners for Gothenburg and Leeds compared with the case for Enschede. Enschede will be the main site where the full system will be deployed. The reference labs in Gothenburg and Leeds typically have fewer participants and are designed around a more specialised (personal) monitoring exercise. For the Enschede lab and Leeds reference lab, a twin approach to sampling will be taken to ensure the sample size is sufficient for testing, i.e. a structured sample alongside an 'open' recruitment of participants will be taken. The structured sample that will be taken will be designed to ensure a sufficient minimum representation from each of the three variables of interest (age, travel category and transport characteristics) for analysis. In addition to this, the concept of social networking will be used to expand this sample (friends, colleagues, family) with an open group of subjects over which (inherently) there will be little experimental control in terms of the variables of interest. The recruitment for Gothenburg is distinct to that for Enschede and Leeds as here a panel-approach is being taken for a much more detailed and in-depth analysis of lifestyle factors around travel. This involves a process of continuous monitoring with a long-term group of subjects and lends itself to a different type of evaluation.

3.1.1 Enschede

From a municipal perspective, Enschede strives for a decrease in car use during peak hours but also supports the other SUNSET objectives (emission reduction, social safety, personal wellbeing) that match with the municipal policies. Therefore, Enschede will set up a broad living lab in other to address different incentives to different people. In order to realise a change in behaviour, car based commuters are identified as a high potential group. Together with early user consultation in WP3, a more refined profile of these high potential users will be made.

For the ease of recruitment and the desirability for a geographically condense group, employers with a high number of high potential users will be asked to assist in recruitment. Using existing networks of employers who have committed themselves to mobility management, should limit the effort in recruiting users.

Recruitment will be in parallel with recruitment for i-Zone. In order to prevent confusion by users, there should be a clear distinction between both populations.

3.1.2 Gothenburg

The primary target group in Gothenburg is commuters within the Gothenburg Region, commuting from the surrounding residential areas to the city centre and back. Since 2007 the region systematically works to change how citizen's travel within the region through an innovation program named K2020[4]. The overall aim with this program is that Gothenburg Region will be developed as a strong, distinct growth region that is attractive to reside, work and live in. Public transport is viewed as an important means of achieving sustainable development. One of the goals in the program is that at least 40 per cent of journeys should be by public transport in 2025, which entails doubling the share of travel done by public transport. This requires that commuters, which today take the car to the work place and back, shift their travelling behaviour from cars to public transportation or bicycle. This in turn not only makes demands on how public transport and on how the route network are designed. These types of transportation then become attractive alternatives, but in addition, information regarding travelling within the region could be distributed to the commuters in a way that stimulates travel to become more sustainable. Besides massive improvements in the physical infrastructure (the route network, the traffic flow and new interchanges) that support value creating services should be developed for the commuter to:

- Strengthen the competitiveness of public transport and other sustainable ways of transportation by value creating services;
- Improve the accessibility of public transport and other sustainable ways of transportation;

[4] For more information see Http://www.K2020.se.

- Enhance the perceived quality;
- Offers added value;
- Make combination of travel easier.

3.1.3 Leeds

Leeds City Council has identified a number of target groups using criteria based around socio-demographic characteristics, modal use, and spatial characteristics, particularly the work-based destination. Leeds City Council is not as involved in the project as the municipality of Enschede and the role and commitment of the city authorities to complete the reference city site is still in development as part of WP7 [D7.1, 2012]. However the Leeds Living Lab with the city authorities and other stakeholders, have begun with problem definition and targeted the groups they would like to participate in the SUNSET project. The principal research aim for the LL in Leeds is to test the efficacy of the SUNSET system within the particular constraints and circumstances of this typical north European city; and in addition, to identify those elements of the SUNSET system that have the greatest impact on sustainable behaviour particularly changing the demand profile for those areas experiencing congestion.

Leeds has twin approaches to develop. The first is a corridor-based approach. Leeds aims to target travellers who work in the city centre and are most likely to use the A61 corridor. This corridor has been upgraded recently and investment into infrastructure provision to provide alternatives to car travel has been made, e.g., refurbishment to the guided bus way, and cycle paths. It is intended that Leeds use the West Yorkshire Travel Plan Network which is a group of employers who have adopted a green travel plan, to recruit potential participants. Then the participants will be offered incentives tailored to their movements and the specificities of the corridor to raise awareness of and encourage sustainable behaviour.

The second approach is to target user groups that are time-poor and/or at a critical life-stage experiencing many stresses and changes to mobility patterns, such as families with two jobs and young dependent children or children just starting school or in the first year, or with children who are just about to start being independently mobile; usually this will coincide with a child starting secondary school. Users can be located anywhere within the city boundary although it may be useful to have some spatial criteria as a part of the recruitment to allow the exploration of social network incentives to travel problems. A comparative user group may also be recruited. This would be a group with key characteristics such as, dependent-free, time rich (but with commitments resulting in spatial and temporal patterns of movement), rich in social capital opportunities, and early adopters of social media and technology. We expect that this group can give insight into the key determinants of the success of the SUNSET system in Leeds.

3.1.4 Some Final Remarks about Target User Groups and LLs

It is a difficult to estimate how many users are foresees as users, not only in Enschede but also in other LLs at this stage. The goal for the main LL in Enschede is between 100 and 500 users but these estimates may face additional constraints from an evaluation perspective [D3.1, 2012] and due to WP7 for recruitment [D7.1, 2012]. Being a reference living lab, the recruitment of users will be to a lesser degree in Gothenburg than for the prime living lab in Enschede. As the purpose is to provide more in-depth evaluation of the use of the service, then a rough estimation is to recruit a minimum of 50 commuters in households and engage these in the living lab. The recruitment process as well as other conditions for the living lab is described in [D7.1, 2012].

However, this issue isn't just about how many users are recruited per se but rather what type of users will be recruited. There are two types of recruitment – a more general recruitment versus a more 'purposeful' sampling of a smaller group, maybe around 40, which are targeted to have particular transport issues and particular socio-demographics. In addition to that other users will be recruited and encouraged to take part on a more 'random' basis. So an overall total of at least 100 would seem reasonable. That number may not be the same in across LLs due to different LL designs.

Other issues concern how do the requirements for the different LLs relate to: prime questions to be addressed in the different LLs, about other traffic than commuting traffic and about other modes of transport, etc. These issues cannot really be addressed in this deliverable as the design of the LL in WP7 is not yet mature enough [D7.1, 2012]. However it is correct to say that we need to be able to write a coherent description of the LL (eventually), to understand the relations between them and to have some firm research questions to be answered for each. It may be as far as it is possible to go at present to say that the description given in this deliverable is just an overview of the characteristics of the LL, an outline of the problems and objectives, a summary of the potential data available and that these characteristics together form the background against which the design of the LL will be made in WP7. These characteristics offer both opportunity and constraint to the LL as a research context for the SUNSET system. Needless, the nature of the opportunities and constraints are likely to be different in each city.

3.2 Sensor Infrastructures

This section describes the data availability of the different sensors in the city. More or less continuous, real-time, sensor data are available depending on the city. Data is available in different categories:

- Ri River
- R Road network
- P Parking
- PT Public Transport

- W Weather
- C City

3.2.1 Enschede

3.2.1.1 At the Start of the Project (Feb 2011)

Cat	System	Availability
R	Induction loops measuring passing vehicles at all the traffic lights, data available of 80% which is connected to the "quality server" (see Figure 1)	Data (counts, intensities, waiting time, queue length etc.) real-time (5 min) available from third party database.
R	Licence plate cameras (resulting in travel times) on three links in Enschede-West (see Figure 1 or http://bit.ly/enschede-west).	Data registered by third party on a 15-minute basis. Real time available at website, data of monthly reports.
P	Parking space availability (garages only, see Figure 1)	Real-time available. Already used in municipal mobile website, so shouldn't be too difficult.
PT	API from National Railway (NS) including time tables and real-time delays	API is momentarily a free beta version. Future unsure, but so far so good.
W	Weather data KNMI	Historic data for NL available via KNMI for free. Actual weather data available from the i-Zone weather API currently covers NL, but it is easily extendable to global data using the geonames.org services.

Table 7; Sensor Infrastructure description and senor data availability in Enschede in the run up to the Living Labs

3.2.1.2 Just Before Living Lab Operation (Month 18)

Cat	System	Availability
R	Travel Watcher, personal mobility application on smart phones (Android and iPhone).	Real-time available, based on user consent.
R	VIP-system, travel time calculation based on induction profiles at different intersections.	As with traffic lights: data is available, but has to get connected to SUNSET. Quality of the data has to be evaluated.
R	Additional traffic lights will be connected to the server.	As above.
PT	SABIMOS, real-time location	Will be real-time available

	based data on bus services.	

Table 8; Sensor Infrastructure description and senor data availability in Enschede at the time of the Living Lab operation

Figure 1 shows the density of the sensors for the city of Enschede.

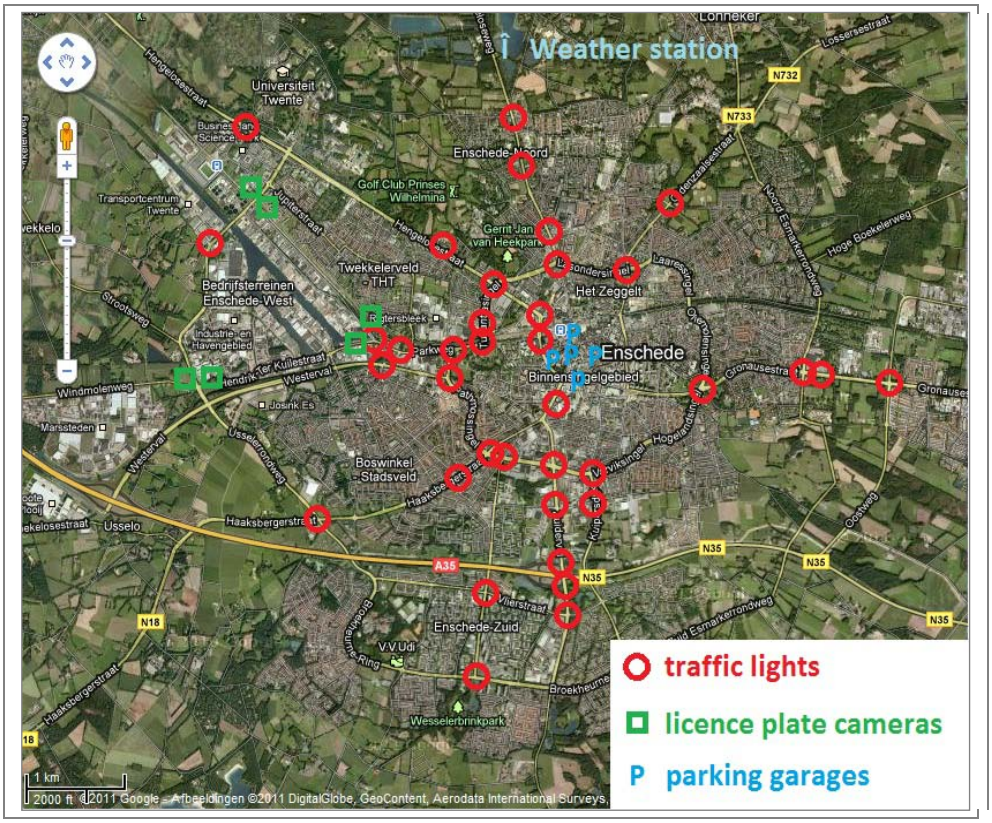

Figure 1: Density of the sensors for the city of Enschede at the start of the project

3.2.2 Gothenburg

	Publication)	
Ri	Water level in GötaÄlv (Measure stations ID, Description, Geographical Coordinate, Last Registration Time of Measurement, Water Level, Get Water Levels for Specific Station for Specific Time Period)	http://data.gotebor g.se Free resource; requires that the user register as a member in the labs community. Data is allowed to be used in commercial services, however not for services that require payment.
P	Event parking (Name of car park, Number of free parking spaces, Geographical Coordinate)	
	Parking service (*to be completed*)	
R	Exceptional traffic situations (Geographical coordinate, Location, Section, Cause, Restrictions, Impact, Start time, Estimated end time)	http://datex.vv.se Information about access will be added
	Road bearing capacity (Geographical coordinate, Location, Section, Cause, Restrictions, Impact, Start time, Estimated end time)	
	Event information (Geographical coordinate, Location, Section, Cause, Restrictions, Impact, Start time, Estimated end time)	
	Platooning (Geographical coordinate, Location, Section, Cause, Restrictions, Impact, Start time, Estimated end time)	
	Queue warning [city access roads only] (Geographical coordinate, Location, Section, Cause, Restrictions, Impact, Start time, Estimated end time)	
	Road obstacles (Geographical coordinate, Location, Section, Cause, Restrictions, Impact, Start time, Estimated end time)	
	Road works (Geographical coordinate, Location, Section, Cause, Restrictions, Impact, Start time, Estimated end time)	
	Deviating ferry times (Ferry route, Estimated deviation time, Restrictions)	
	Rest areas (Geographical coordinate, Equipment, Position)	
	Estimated travel time (Road section, direction, road network reference, time, current travel	

	time, free flow travel time, declaration of quality in estimation)	
	Road condition (Geographical coordinate, Road section, Type of road condition)	
	Road weather from weather stations (Geographical coordinate, Air and surface temperature, Precipitation, Wind directions, Wind speed)	
	Road cameras (Geographical coordinate, Position, Time, Description of camera, Camera image)	

Table 9; Sensor Infrastructure description and sensor data availability for the Gothenburg Living Lab

3.2.2.2 Just Before Living Lab operation (Month 18)

PT	HaCon-based API (Multi modal travel planning)	Planned: during 2011
P	Parking spaces (Geographical coordinate, Available parking spaces, Capacity, Entrance address, Exist address, Operating Hours, Price, Contact information, Payment options)	Planned_ during 2011/2012
R	Road cameras (within the city) (Geographical coordinate, Camera image, Direction, Time)	
	Borrow bicycle (Geographical coordinate, Available slots, Available bicycles, Total number of slots, Address, Excepted means of payment)	
	Bicycle service stations (Geographical coordinate, Name, Address, Bicycle pump availability, Type of service, Operating hours)	
PT	Means of transportation in actual service (Geographical position, Vehicle type, Emission driver, Emission type)	Requested
PT	Detail route data (Precise route, Stops on route)	Requested
PT	Time tables per stop	Requested
P	Closest parking space during an event	Requested
P	Number of free parking spaces in commute parking lots	Requested
R	Bicycle counters within the city	Requested
R	Traffic counters within the city	Requested
R	Actual average speed on selected road sections	Requested
R	Traffic disturbances within the city	Requested
R	Parking meter status	Requested
R	Road work within the city	Requested
C	Land lease data	Requested

Table 10: Sensor Infrastructure description and senor data Availability in Gothenburg at the time of the Living Lab operation

3.2.3 Leeds

3.2.3.1 At the Start of the Project

Cat	System	Availability
R	Induction loops at all the traffic lights to measure the presence of vehicles. Critical network sensors are connected to the optimising programme (operating based on traffic counts, speed). It is unclear whether queue lengths are considered in the optimising programme.	Data not available to SUNSET.
R	Traffic cams and internet website available. Data include travel time (in minutes) between specific road sections (specified by road/street names or motorway junctions) within Leeds and surrounding motorways road network.	Data available on the internet through Leeds City Council website: http://www.leedstravel.info/cdmf-webserver/jsp/routes.jsp?viewRoutes=true
R	Traffic cameras offering (live) traveller information on road conditions via internet.	Data available on the internet through Leeds City Council website: http://www.leedstravel.info/cdmf-webserver/jsp/livecctv.jsp
R	Roadwork information provided by Leeds City Council website. Data include road name, start/end date and time of roadwork.	Data available on the internet through Leeds City Council website: http://www.leedstravel.info/cdmf-webserver/jsp/UTMCRoadworksServlet
R	Road incident updates provided by Leeds City Council website. Data include road (section) name, start date/time, brief details and expected end time/date	Data available on the internet through Leeds City Council website: http://www.leedstravel.info/cdmf-webserver/jsp/UTMCIncidentsServlet
R PT	Travel info website coordinating travel information for Leeds residents and visitors	

P	Parking space availability for Leeds City Car parks only. Information provided in good faith by car park operators. Limited input to date.	No frequent live space information available. Data are as % of capacity and as trend (e.g. filling, emptying). http://www.leedstravel.info/cdmf-webserver/jsp/carParks.jsp
PT	Real-time (bus) location based data on some bus routes.	Data commercially owned by (private) bus operators. Not available to SUNSET.
PT	YourNextBus application provided by West Yorkshire Metro is based on GPS technology and tracks buses in the region. It provides route number, bus stop, expected arrival time (to bus stop) in minutes. Scheduled times are shown in 24hr. About 1000 electronic YourNextBus displays are already installed (mostly in bus stops).	Data available from WY Metro website: http://wypte.acislive.com/pip/stop_simulator.asp?naptan=45010922&pscode=56&dest=

Table 11; Sensor Infrastructure description and sensor data availability for the Leeds Living Lab

3.2.3.2 Just before Living Lab Operation (Month 18)

Cat	System	Availability
R PT	Travel Watcher, personal mobility application on smart phones (Android and iPhone). A small sample of users is anticipated to participate.	Real-time available, based on user consent.
R	Following discussions with Leeds City Council, some form of agreement is expected on data use provided by them (e.g. road works, traffic lights optimisation).	Pending.

Table 12: Sensor Infrastructure description and senor data Availability in Gothenburg at the time of the Living Lab operation

3.2.4 Use of Mobile Sensors

It is noted that not only does SUNSET seek to leverage the fixed sensor infrastructure in cities. It also seeks to promote the use of travellers' mobile phone sensors including core sensors of GPS. This can be supplemented with other positioning sensors such as Wi-Fi, GSM cell location and phone accelerometers. When such sensor data is acquired and aggregated at a sufficient density of mobile phone sensors within a spatial-temporal domain, it

can be also used by SUNSET to monitor crowd mobility to supplement the fixed sensor infrastructure in cities.

3.3 Transport Characteristics

This section describes the transport situation in each of the Living Labs. This information functions as background to get insight in the differences between the cities.

3.3.1 Enschede

Modal Split	Car 49%, Walking 22%, Cycling 21%, PT 6%, Other 2%. Percentages of trips (all day, all motives) based on data of a large sample group (MON, 2009)
Transport system	Bus lanes in all wind directions Car-free inner city Cycle paths on major arterials Cycle lanes on main streets Local airport being converted from army to civil purposes
Landscape	Flat
Special interests	"TwenteMobiel" – Taskforce for mobility management
	FC Twente – Successful local soccer club with logistic challenge during home games
	Enschede Facebook Group – 5,404 members

Table 13; Transport Mode Split in Enschede

3.3.2 Gothenburg

Modal Split (2005)	59% Car trips, 18% Walking & Cycling, 23% PT; Percentages of trips based on daily trips of 2,2 million recorded for Gothenborg.
Transport system	Central pedestrianized streets surrounded by bus and tram stop network. Car-free inner city Commuter trains north, south, east Many bus routes connecting local district centres. Bus lanes on the routes to and from the city Limited cycle provision; expansion during 2011 and 2012 Bus and taxi transport to and from Airports (City airport and Landvetter International Airport) Traditional pedestrian network tied to road network. Central station and central bus station in the middle of town Medium amount of bicycle lanes in city; expansion planned Road fees are scheduled to be implemented in January 2012
Landscape	Central river valley, flat in the inner city, flat terrain in the north and south (with some small hills), in the east small hill terrain
Special interests	Commuter interest (specific) must be investigated (during the scenario work)

	Road fees are being implemented 2012
	The city has announced that the share of people using public transport should be doubled in 2030
	Göteborg is an event city - all year long

Table 14: Transport Mode Split in Gothenburg

3.3.3 Leeds

Modal Split	Car 55.7%, Walking 3.2%, Cycling 0.9%, Bus 22.8%, Train 16.9% M/C 0.5% Modal share figures based on cordon counts of am peak (730 – 930) traffic travelling into Leeds and on automatic ticketing counts.[1]
Transport system	Central pedestrianised streets surrounded by bus stop network. Two central ring highways 3 lanes each and ring road approx. 4 miles from centre. Partial bus lanes on all major arterial routes in both directions changing according to peak flow direction, some using guided buses with dedicated capacity. Bus network morphology of centre with spokes along major arterials supported by land use plan. Very few bus routes connecting local district centres. Limited cycle provision. Traditional pedestrian network tied to road network. Local train network +/- around the local district centres. Public transport delivery private enterprise and some public and third sector activity.
Landscape	Central river valley, parallel valleys running east/west with associated small hills
Special interests	Large student population c.60k

Table 15: Transport Mode Split in Leeds [West Yorkshire, 2009]

3.3.4 Some Final Remarks about Transport Characteristics

Some information on problems in the transport system such as air quality, congestion, accidents, etc. should also be given. This is very useful but for consistency this information should be presented in a similar for all the LLs. Currently, we don't have this information to hand for all the LL at present. This will be addressed in [D7.1, 2012]

4 Scenario Description

The purpose of Scenarios within SUNSET is that it is one of the major sources of requirements to develop a system that enables the system to be useful, usable and will get used.

In order to make requirements traceable to specific parts of specific scenarios each scenario is given a unique identifier and each part of the scenario referred to as a use-case is given a unique identifier as follows:

- Core User Scenario (US) has 22 use-cases US1..22
- Core Stakeholder Scenario (SS) has 6 use-cases SS1..6

Note that the generic user scenario (Section 4.1.1) focuses primarily on traveller type end-users of the system but this does include parts or use-cases that relate to other stake-holders such as: employers with employees that travel to work and local authorities, e.g., US12; service providers that offer incentives to change the mobility of others, e.g., US13 and US14. In addition, there is an additional stakeholder scenario focussing mainly on the local transport authorities described in Section 4.3.

4.1 User (Traveller) Scenario

4.1.1 Generic User Scenario

A number of prerequisites are necessary to make this core scenario a viable and feasible one, and are thus critical success factors for SUNSET and its living labs:

- Sufficient spatial and temporal densities, covering the mobility behaviour of the travellers
- Sufficient cohesion in the social networks of the SUNSET participants
- Sufficient coverage of different personal situations: people working in shifts versus 9-5 office workers, people with and without children etc.
- Analysis of mobility behaviour at a place level around hotspots, such as a business and science park, university campus, soccer arena, of major transport hub, which serve as important attractors of people during certain peak hours.

The SUNSET approach is to attract as many users in a local area with mobility applications that are of real value to the users, and with viral campaigns, and extract from their personal profiles how well specific target groups are covered by SUNSET. Additionally, we recruit by snowballing among a social network and paying attention to users frequently visiting the specific SUNSET hotspots, and inviting them personally.

Nr.	Generic User Scenario	General explanation
US1	A user installs a **mobility monitoring** application that can run on a mobile phone.	This mobile monitoring app measures location traces and divides them into single-modality trips
US2	Existing (**local) social networks** can be re-used within the living lab. Friends and colleagues might see the user joining SUNSET on Facebook, and decide to join too or keep a close eye on his progress on mobility goals.	SUNSET has a local identity manager, where identities can be linked to social networks e.g. Facebook, for unified login to the SUNSET portal. Relations in the social networks are re-used in SUNSET in a dynamic fashion, and not only imported once. This serves as a bootstrap to get sufficient density of the SUNSET community in a local area.
US3	Within two weeks the SUNSET system has **automatically determined an initial mobility pattern** for the user from her actual travel behaviour in those weeks.	These patterns provide overview of modality choices, temporal and spatial densities, frequent routes, and activity overviews. SUNSET provides quick results with patterns over two weeks, or even earlier, but these results are further improved over time when more data becomes available. It is however crucial to user acceptances to give the user a sneak preview of the long-term results of SUNSET.
US4	This pattern will be **continually improving** over time.	The locations between trips can be automatically matched with personal and public places (my office, supermarket stop, or school drop-off)
US5	The user receives first **recommendations from the living lab** to improve travel behaviour in some way.	Profile matching depends mostly on start and end location of the detected frequent home-office trips, as well as timing of those trips, plus some extra preferences (modality, smoking, favourite topics, personal recommendations)
US6	The user may award other users **with a positive mobility recommendation** which is shown on his profile page.	In SUNSET users can reward and rate everything in their personal sphere that is mobility related: places, vehicles, transport lines, and also users. This is in itself an Incentive as a mixture of normative belief, identity, social status, but it requires an audience (people whose opinions matter to John) which has implications for the density of social contact and recruitment methods.

US7	The user receives mobility statistics about her public transport choices and consequences, via the **SUNSET living lab portal**, and be able to spot trends.	The mobility profile is visualized in an attractive way on the SUNSET portal, mobile clients, but also existing social networks. It also shows consequences of personal transport choices, and an easy link to join SUNSET for potential new users. Personal profiles easily link with goals from a stakeholder perspective, e.g. in the UK public health advice is for individuals to aim to take 10,000 steps a week.
US8	On the exact right time, the user receives **a SUNSET mobility suggestion to change behaviour**. This suggestion states the change in the regular situation and proposes an alternative to the regular trip	This assumes a silent background monitor that observes the situation for all users on their regular trips at this moment of time, and alerts them in case situations deviate from normal. Alerting should be direct and personal, e.g. via a mobile app.
US9	SUNSET system learns from the behaviour of all members of the living lab.	Apart from road-side sensors, SUNSET uses extrapolations and current travel/delay times of other users on the regular routes of Chantal. Both personal mobility and road-side sensors have their limitations (limited to main roads or no sufficient temporal coverage), but combining the two alleviates these limitations.
US10	SUNSET system can use road-side sensors to decide the current traffic status.	These sources are strongly city-dependent, and should typically by best effort based on what is available.
US11	SUNSET system allows users to verify the validity of the suggestions and statistics.	This check is not necessary, but users might need information about the sources on which a recommendation is based, to build trust in the quality.
US12	Other stakeholders get an **anonymised overview** of the travel times and statistics of all employees/citizens/visitors and the trends therein.	Not only the user is a stakeholder, but also employers and the local government (item 19), and these stakeholders must be fed with the proper information to take measures improving mobility. This requires sufficient contact and spatial densities again, as well as a successful recruitment strategy. The smaller the group, the more important this is, e.g. city level is easier than employer level, which is again easier than place level.

US13	SUNSET offers **incentives** to users to support travel behavioural change e.g. to avoid rush hours on specific days.	These incentives can be added to the system by the stakeholders, and are presented and monitored by the SUNSET system. Incentives available for use at the moment can be broadly categorized as being: information-based; finance-based; feedback-based; and social network-based.
US14	In traffic jams, the user gets **a proposition** from nearby stakeholders, with a win-win situation between the user, the stakeholder, and the city mobility.	Stakeholders, such as local shopkeepers, retailers, business owners, road authorities and many more, can enter their own incentives into the system. A good incentive should contribute to both the business model of the stakeholder and the mobility performance indicators of SUNSET.
US15	The SUNSET allows **ad-hoc grouping** of users, e.g. all users on the same bus line, and offer group incentives.	Entering the bus she is joining a group in an ad-hoc fashion and leaving this group after leaving the bus. These temporary groups can be an incentive to change travel behaviour for example by saving money for the ticket fare, or easily grouping people for additional transport in case of severe delays, e.g. finding transport home in case of a blocked train track
US16	The SUNSET application **automatically recognizes the vehicle and line number**, e.g., of bus or train.	SUNSET supports automatic vehicle detection for public transport, to support ad-hoc grouping, incentives and improved statistics
US17	SUNSET can pose **ultra-short questions** on the user's mobile phone regarding mobility, and provide overviews of the answers of all users in the living lab.	SUNSET supports experience sampling to ask participants in the living labs about things that cannot be measured automatically: personal opinions, ratings, feelings, or to obtain control samples.
US18	Users can automatically **post mobility status updates** on social network and micro blogging sites.	It should be easy to communicate about your current means of transport, delays, mobility-related experiences, with explicit links to location, transport providers, etc.
US19	The living lab portal offers a number of mobility widgets to show long-term and real-time mobility statistics, trends, and progress on goals.	These widgets can be configured in the SUNSET portal by user, and placed wherever he wants (in particular social networks), and these are updated automatically so that they always represent the latest status. Commonalities are good to increase social communication and use social norms to

		influence behaviour.
US20	T**hese widgets can be re-used on personal websites** and the diverse social networks.	Improving on mobility and its negative consequences is a community effort; more participants increase the impact, and (collaborative) progress is the reward for people's effort. In the widgets people can easily compare their behaviour with the average or the friend group, and also see progress in these groups.
US21	SUNSET analyses the user's travel patterns, and comes with suggestions for **long-term improvements**.	This period could be a month or longer, and provide Chantal with suggestions such as: better take the bus on this frequent trip, it saves you 5 minutes per day; or: better take this route by car instead of your normal route, it has less accidents; or: better travel with person X on Tuesdays to the office. Inter-urban trips or trips abroad can also be included. The longer the observation period the better the suggestions will be.
US22	Users can offer **personal suggestions** to other users, e.g. to point others to safer routes during cycling.	Personal contact and suggestions of trusted people work best and are facilitated by SUNSET. Comments from total strangers are not facilitated by SUNSET because of safety considerations.

Table 16: Generic Scenario description

4.2 How Scenarios Relate to the SUNSET Project Objectives

The scenarios illustrate how the SUNSET system can be used to achieve its four main overall objectives as defined in the projects proposal:

Congestion reduction: traffic-jams are an increasing problem to tackle. The average travelling times should be reduced. Our objective is 5% less traffic (measured in car kilometres in a specific area) during the rush hours for users of the SUNSET system.

Safety: people must be able to optimize their route, to avoid roads with many cyclists for car drivers, to report local road and weather conditions within community, to detect unusual conditions, or to avoid waiting times on dark and silent railway stations.

Environment protection: for a liveable climate we need reduced CO2 emissions, improved air quality management and reduced noise pollution.

Personal wellbeing of citizens: the system allows individuals to set and monitor personal objectives, like increase individual safety, reduce travel times, reduce costs, improve comfort, and increase health.

The crux of the project is to achieve these system goals by influencing personal goals of travellers via the following plan actions:

- **Optimizing personal mobility patterns** through the careful use of personal, mobile ICT services and by providing mechanisms to distribute incentives to adopt new ways of travel.
- Providing mechanisms to **share information about the travel conditions**;
- Enabling travellers to inform and help each other **using ICT-enabled social networking**
- **Distributing incentives to commuters** to modify their mobility patterns
- **Evaluating** the system effectiveness.

No.	Scenario Short Description	Project Goals & Planned actions
1	Mobility App registration & Download	Optimizing personal mobility patterns
2	Social Network Reuse	Social Networking
3	Mobility Pattern Analysis & View	Optimizing personal mobility patterns
4	Improved Mobility Pattern Analysis	Optimizing personal mobility patterns
5	Trip-based Pattern Analysis &Recommender	Optimizing personal mobility patterns
6	Trip Recommender Acceptance & Feedback	Social Networking
7	Real-Time Trip, Historical Trip, Transport choice Info.	Personal wellbeing
8	Planned Real-time Trip Info and Recommender	Optimizing personal mobility patterns
9	Real-time Trip Info. Confirmation using individual mobility monitoring and traffic sensors	Optimizing personal mobility patterns
10	Use of Roadside sensors to check traffic status	Congestion reduction
11	Check validity of traffic status	Congestion reduction
12	Group-based aggregated Views of multiple individual Trips	Social Networking
13	Trip Change Incentives	Incentives

14	Event-driven Mobility Changes	Optimizing personal mobility patterns
15	Ad hoc group Travel Offers	Incentives; Environment protection
16	Public transport recognition	Optimizing personal mobility patterns
17	Experience sampling	Evaluating
18	Sharing Mobility Status Updates	Social Networking
19	Display travel statistics, trends & goals	Optimizing personal mobility patterns
20	Sunset App reuse in other Apps	Social Networking
21	Long term improvements	Environment protection, Wellbeing, safety
22	Users can offer others Personal Travel Tips	Environment protection, Wellbeing, safety

Table 17: Summary of how each part of the generic user scenario relates to the overall project goals and to the planned project actions to meet those goals.

The actions associated with optimising personal mobility patterns dominate the scenario because this is at the heart of the system. In addition, heavy use is also made of social networking.
In the next sections, this scenario is considered from the perspective of each LL in more detail and then the individual LL scenarios are compared and contrasted.

4.2.1 Comparison of the User Scenario in Different LLs

In Appendix 1, the scenarios have been adapted in detail towards different LL cities. In this section, the support for the end-user / traveller scenario in each LL is compared and contrasted against the generic user scenario use-cases. First, an overview is given in Table 18.

No.	Short Description	Enschede	Gothenburg	Leeds
1	Mobility App registration & Download	**Y**	**Y**	**Y**
2	Social Network Reuse	**Y**	**Y**	**Y**
3	Initial Mobility Pattern Analysis	**Y**	**Y**	**Y**
4	Improved Mobility Pattern Analysis	**Y**	**Y**	**Y**
5	Trip-based Pattern Analysis &Recommender	**Y**:	**Y:** ↑public transport focus	**Y**
6	Trip Recommender Acceptance & Feedback	**Y**	**Y**	**Y**

7	Real-Time Trip, Historical Trip & Transport change choice	**Y**	**Y**	**Y**
8	Planned Real-time Trip Info and Recommender	**Y:** ↑ roadwork info.	**Y**	**Y**
9	Real-time Trip Info. Confirmation using individual mobility monitoring and traffic sensors	**Y**	**Y**	**Y:** RT trip info. Only from mobiles
10	Use of Roadside sensors to check traffic status	**Y:**	**Y**	**Y**
11	Check validity of traffic status	**Y:**	**Y**:	**Y**
12	Group-based aggregated Views of multiple individual Trips	**Y**	**N**	**N**
13	Trip Change Incentives	**Y:** ↑ bike use	**Y**	**N?**
14	Event-driven Mobility Change	**Y:** Location-specific Mobility Change	Y: school child ill notified	**Y**
15	Ad hoc group Travel Offers	**Y**	**Y**	**N**
16	Public transport recognition	**Y**	**Y**	**N**
17	Experience sampling	**Y**	**Y**	**N**
18	Sharing Mobility Status Updates	**Y:** Pre. vs. Post trip	**Y**	**N**
19	Display travel statistics, trends & goals	**Y**	**Y**	**Y**
20	Sunset App reuse in other Apps	**Y**	**Y**	**Y**
21	Long term improvements	**Y**	**Y**	**Y**
22	Users can offer others Personal Travel Tips	**Y**	**Y**	**Y**

Table 18: Comparison of use of the user scenario in LL cities. (Key Y= Yes, supported in that LL; N = No supported in that LL; N? = probably no as significant further work is needed to support it).

The details of the differences and the explanation for each use case in the individual LL are described in section 10.

The following aspects of the generic scenario vary across individual LLs:

- Types of end-user/traveller: employees in specific parts of a city and (Leeds, Enschede), their employers (Enschede), family members commuting to work (Gothenburg, Leeds);

- US1 &US2: Users can elect to register to use the SUNSET App in different ways
- US5: What recommendations are specified How these are generated
- US6: The way users give feedback about journeys
- US7-9: availability and access to real-time traffic information
- US11: flexibility commuters have to change journeys in response to detected traffic congestion
- US14: the triggers for propositions
- US16-18: do not apply in the same way in some LLs
- US19: the types of different indicators for travel, health, sustainability

4.3 Additional Stakeholder Scenario

The primary scenario focuses on the traveller / user perspective. In Sunset, additional stakeholders with different goals and perspectives play their role:

- The first stakeholder is the **road or infrastructure authority**, who is provided with a system level view of the entire living lab across time. In the city dashboard he/she has a complete but aggregated and anonymised overview over the living lab city, and can issue incentives and experience sampling questions for each member in the living lab
- The second group of stakeholders are the local **employers**, who are provided with a partial view of the living lab. In the employer dashboard (which is the same as the city dashboard but with limited functionality) he/she has limited overview over the living lab city, namely only over those members who approved the employer-employee relationship, and for those trips to or from the business premises. The employer can issue incentives only for his employees or people travelling to/from/past his premises.
- A third group of stakeholders are the local **shops and services**, or **event organizers,** who are provided with a limited view (geographically and time-wise) of the living lab. In the place owner dashboard (which is the same as the city dashboard but with limited functionality) he/she has an aggregated and anonymised overview over the visits of and travel intensity (history) along his premises or event location. The place owner can issue incentives only for his visitors or people travelling in the near vicinity of his place location.
- There are many other potential stakeholders (e.g. environmental campaign organizers, political parties, market research organizations, ...) who can use the SUNSET system as well, but the functionality will be limited, based on geographical location, group membership, relations of the living lab members with stakeholder, or other behaviour of the living lab members.

This scenario shows the different possibilities for the road authority to interact with the system. Other types of stakeholder, e.g. employers, service providers, are in fact subsets of the stakeholder scenario for the road authority. It also

gives an insight in the way the system level goals are addressed. This scenario is also split in two parts: the core stakeholder scenario at a more abstract level and the scenario tailored more towards the narrative local authority with examples of local use of the system.

4.3.1 Generic Stakeholder Scenario

Nr.	Generic Stakeholder Scenario	Explanation
SS1	The stakeholder at a city or regional level has access to the SUNSET city dashboard, one per living lab, that provides an **overview of transport movements in the city**	This combines the information coming from the personal mobility sensing in an anonymised way, and the information coming from road-side sensor.
SS2	The stakeholder **can identify and monitor sub-optimal situations** in his city, via the dashboard.	The overviews should have a special focus or indication of abnormal or exceptional situations.
SS3	A Stakeholder can design a measure that might improve the situation, and models that as an incentive into the SUNSET system, i.e., **creates incentives**	Incentives should at least contain what is offered (e.g. points, monetary reward, free parking space), whom it is offered to (the target group, e.g. all recurring visitors of road X), when it is offered (e.g. when it is raining), and how often is offered (once, once in a period, always, and other options) and whom it is offered by.
SS4	The coming days he observes how many times the incentive is issued to travellers in that area, and **monitors the effect of incentive use**.	The situation before and after the incentive offering should be comparable, both on a place level (to measure the community effect) and a personal level (to see how individuals respond).
SS5	Stakeholder can **issue new experience sampling** questions to get the user's opinion about a foreseen road closure.	The answers to those questions are analysed in the city dashboard as well.
SS6	Using the city dashboard, stakeholder can **view aggregated data related to policy objectives**.	Aggregated data can be used for policy analysis of different sorts.

Table 19: Core Stakeholder Scenario description

4.3.2 Local Authority Stakeholder Scenario

This scenario gives some examples on how a road authority can influence on a system level, trying to steer on system level goals with respect to different

living lab regions. The scenario shows different examples of possible incentives, therefore covering SS2-SS4 four times.

NR.	Local Stakeholder Scenario	explanations & limitations
SS1	Richard, the local traffic expert, arrives in the office on Monday morning. The first thing he does after coffee is to switch on the SUNSET city dashboard. The statistics over the last week look very good, even less traffic jams than the week before and the same week last year. Modality usage is quite stable though, and could use some improvement.	
SS2	Especially the people living in eastern part of town seem to hesitate using the bus during morning rush hour, although high quality bus transport is available. Compared to the other neighbourhoods, bus usage is 24% lower for this area in the morning.	
SS3	So he creates an incentive where all people living in the eastern neighbourhoods, travelling to the city centre by car, get an informational message saying explicitly how much time and/or money they just lost compared to the same trip by bus. The message is shown 10 minutes after the completed the home-city trip.	
SS4	On Friday, he sees that the incentive already has been issued 172 times to mostly male travellers, but the female travellers were more responsive. In the week after he sees that 35% of the addressed people have more bus trips than before, and the rest is stable.	If this did not work as planned, new incentives can be designed.

Alternative Example #2

SS2	Another week, Richard hears from an elder man that there are a lot of complaints about social safety at the sub-urban bus stops.	
SS3	Therefore, he creates an incentive where people get the specific time the bus arrives, so waiting time at the bus stop is minimised. This incentive is triggered when someone uses the public transport planner or can be consulted whenever a user needs it.	
SS4	A week later, he sees that the incentive is hardly used. Arriving at exactly the right time seems impossible. He starts brainstorming for other solutions.	

Alternative Example #3

SS2	Yet a week later, the involvement of users is decreasing. Users are needed for the system to work efficiently, so Richard is bound to take action.	
SS3	In a meeting at a coffee stand at the train station, the idea rises to give away free refills. The city and the local shopkeeper both pay for half of the costs. SUNSET system alerts al registered users in town that a free refill is available this week, when they have recorded at least 5 trips in the last week.	
SS4	After the two week action period has ended, the incentive is evaluated. The city sees an increase in use of the system. The coffee shop has seen a lot of new customers returning after the period, and asks if they can get another incentive period where they cover all costs themselves.	
Alternative Example #4		
SS2	In the local health awareness week, the city teams up with the organisers in order to get people to walk more often.	
SS3	Together, they brainstorm about possible incentives. They choose for a low cost option; giving away small gadgets. When people walk at least 5/10/25 km during the health week, they can unlock a bronze/silver/gold "badge". This can be shared with friends using social networks.	
SS4	The use of these badges turns out to be a huge success. In close cooperation the incentive is available each week. Users who get 40 badges this year, can get a 40% reduction at the local running centre on purchase of shoes during the next walking awareness week.	
SS5	The road authority is intending to make one famous secret route a non-transit road for cars. Richard polls how the users think about it, and makes a clear distinction between the inhabitants and the travellers of that area.	Only people who are regularly in that area receive the experience sampling question. The answer is a single click to a multiple choice.
SS6	In the yearly discussion of monitoring results, the data collected with the SUNSET system gives an	

	overview of the modal split of last year. Also, the carbon footprint of transport in the city can be estimated.	

Table 20: Local Stakeholder Scenario description

5 Stakeholder Input

This section will first outline the different levels of stakeholder and user consultation envisaged in the project, which part of the SUNSET Workplan, the workpackages (WPs), this would take place in, how the findings would be used in different ways in different WP's e.g., in design, paramaterisation, evaluation etc and this forms the downward link to the development of the research in the WPs. As findings emerge from the consultation streams, it will be possible to synthesise upwards to the overall objectives of the research and the extent to which the system design is likely to achieve this.

5.1 Objectives and Expected Outcome

The purpose of user consultation and fit to the development and schedule of the research overall is broken into seven streams as follows:

(a) The functionality of the system: what it will provide to travellers and how it may be used.
(b) Perspectives of high level policy makers e.g., NGO (policy acceptability and support for the system, publicity and awareness raising). Consultation of this type will run throughout the duration of the project and has already got underway.
(c) Interface of the application/system (how useable the software interface is). Completion of some initial design will be needed for this to get underway. The consultation will extend into the early stages of the LL (Jan-Mar 2012) and be part of a feedback loop within WP7 for the remainder of the LL duration.
(d) Incentives development (as part of the design of the incentives and understanding the behavioural responses). This type of consultation is part of the fundamental research within WP3 so is driven by the timetable for WP3.
(e) Prototype testing and evaluation of the SUNSET system (to provide a feedback loop on design, functionality, incentives offered). As soon as a prototype at any level is available, this process will get underway and extend to the start of the LL (e.g., Jan 2012)
(f) LL testing and evaluation of the SUNSET system. Full trials for the system according to the outline of WP7 and largely driven by the WP7 timescales.
(g) Business case development. Interface with business and other sector representatives to ground truth the business case to be developed in WP5. This will be largely driven by the WP5 timescales.

Within the 1st phase, month 1 to 10, of this work-package, WP1, the user consultation will month 10 is about to finish by now isn't it focus on two main types of stake-holder, end-users / travellers (a) and local authorities (b) using a Web based questionnaire. Activity (a) was got underway from September to November 2011 and can extend into the early stages of the living lab (Jan-Mar 2012). Activity (b) was got underway from September to November 2011 and can also extend into the early stages of the living lab (Jan-Mar 2012). The

other types of user consultation (c) to (g) will be undertaken during later phases of SUNSET and many will be managed by other parts or work-packages of SUNSET.

The stimulus is the set of visual, auditory and textual prompts that will be presented to people as part of the different streams of user consultation or survey. The stimulus will be designed around aspects of the SUNSET system that we wish to assess requirements for. In the context of the project there is considerable diversity in the samples (e.g., in terms of geography, structural disaggregation of citizens, and timespan for data collection and other variables). The potential types of stimulus for each of the consultation streams and the expected outcomes are given in Table 21. The purpose of Table 19 is to clarify the different types of user consultation that will take place, the type of stimulus and data collection that will be undertaken and the expected outcomes. It gives a short summary of how the user consultation will feed into the design and refinement of the SUNSET system at different stages of the research. The type of stimulus for each activity will be appropriate to the technical focus of the consultation and the participants to be consulted.

Consultation stream or activity	**Types of Stimulus**	**Expected outcomes**
(a) Functionality of the system for the main end-users	Focus group and on-line questionnaire. Presentation of main features of the system and spectrum of functionality. Presentation of alternatives in terms of range, complexity, 'what if',	Usefulness of system (as a whole), preferences on type and range of travel information presented, likelihood of adoption, unintended consequences, comparison with alternatives, barriers to adoption
(b) Perspectives of high level policy makers	In-person presentation giving broad overview of project. Level of detail as known at project outset	Potential to achieve transport objectives, wider societal objectives, practical/operational feasibility, financial feasibility (rating)
(c) Application Interface	A software presentation of the interface and interface alternatives. Ideally	Design features including ergonomic data: menu navigation, key use, and ease of use. Screen design: size, presentation, complexity etc.

	on the device or alternatively as a presentation	
(d) Incentives development	Consultation and stimulus to be led by WP3 and to include 'in-person' data collection.	This stage will inform the development and refinement of the incentives to be offered through the system.
(e) Prototype testing and evaluation	Functioning prototype to be presented to potential users. This stage ideally to follow (c)	Design features, functionality, incentives offered
(f) LL testing and evaluation	Functioning software to be used by early LL participants. This stage to follow (e) and to be led by WP7.	Any implications for design will form a feedback loop from the LL for refinement and adjustment to the functionality and interface of the software.
(g) Business case development.	In person interviews, presentation of underlying economic and financial paradigm. Comparison with alternative and especially 'classic' transport business case.	Understanding of strengths, weaknesses and opportunities to business case. Understanding of comparison against small range of alternatives, elicit new information on unexplored business facets, understanding of preferences, barriers, etc. understanding of synergy and conflict in business objectives against those of SUNSET system

Table 21: types of stimulus for each of the consultation streams and the expected outcomes

5.2 Design and Execution

Following the objectives, the main parameters driving the design and execution of consultation of the SUNSET system are as follows.

Users and stakeholders: the citizen, city transport operators, third party investors (either private businesses or not-for-profit companies), policy makers and elected representatives, the client. There will be a need to sub-divide groups according to exposure to the SUNSET system so find out people's views of the system as non-participants to the living lab and views of people who have exposure to the system working in some way. Other divisions should be by population sub-groups e.g., by gender, age, employment categories etc.

Purpose of the consultation; initial design of the system, testing the operation of the system (does it work functionally), to test the design interface of the system, as experimental subjects to derive models and parameters, to understand choices, to assess long term reliability/functionality, to publicise/disseminate the system. This will lead to different types of data that are needed including qualitative responses, individual scores/performance indicators, discrete choices, and values.

Target Sample and sample size: the Geographic location of users is primarily those of the proposed living labs (Enschede plus Gothenburg or Leeds), secondary those at other locations across the EU or internationally. The appropriate sample size will depend on the type of survey and the axis of variation we wish to capture. This is discussed in more detail in Deliverable [D6.2, 2013]. If we wish to capture gender and age differences as two sources of variation, plus geographic variation (for example) we may need more groups. On-line questionnaires may attract larger sample sizes and we may wish to direct sampling purposefully towards particular sub-populations to capture variation. Panel data may require a trade-off between the cost of recruiting and maintaining panel participants and gaining sufficient data to produce robust results. From a statistical perspective, we would ideally have 50 repeated observations for each source of variation. In practice we can carry out 'large sample' analysis with as few as 26 repeated observations. Below this number we are still able to analyse the data, even for small samples of less than 10 repeat observations but the type of analysis would change and the contribution towards inference and transferability analysis could be lessened. Th

Type of survey: the type of survey will depend on the preceding parameters but could include small focus groups, longitudinal panel, on-line questionnaire, stated preference, dynamic choice experiment, individual interviews, automatic sensor data, and larger group 'voting'. Some data will be collected through 'experience sampling which is an alternative form of survey, this will be either highly personalised and/or generic to the users.

As a result the stimulus for user consultation should satisfy the following features to the extent this is pragmatic:

- Unambiguous in both the prompt and type of response requested (this may be an issue for dynamic experience sampling via the device where limited prompts are needed)
- Be presented in an appropriate language (the stimulus may need translation and this may introduce local nuance, it is also likely to introduce a financial cost element)
- Consistent between different samples for the same stimulus (replicability). A specific example is focus group material presented to different groups. It should be possible to introduce consistency by using recorded video, shared written material etc.
- Have an appropriate workload (stress) for the respondent in terms of timing, number of transactions, frequency of transactions, duration, level of intrusion. This is an issue for off-line consultation but potential a more significant one for dynamic experience sampling. Further research on best practice may be needed to inform the design.
- Be designed to elicit requirements that map to all aspects of the system we wish to inform.

Data collected: There is a distinction between data that is collected in static (off-line) mode and that which is collected in dynamic fashion whilst the subject is travelling. Data collected whilst travelling will have different features in terms of expected accuracy, completeness (of responses or outputs), storage and analysis. Data collected dynamically is expected to be largely quantitative (e.g., position, choice) with some qualitative data from short prompts to the system user. Data collected off line will have a strong qualitative aspect alongside some quantitative values. It is expected that the type of data to be collected will include: preferences and concerns, attitudes, behaviour, behavioural intentions, perceptions, ergonomic data: menu navigation, key use, error frequency, ease of use, and others. There may be challenges in consistency and method of analysis of data collected by different means. For the coherence of the project there is a need to check the consistency of the data and synthesise across the whole.

Recruitment Strategy

- We need to be mindful of those streams of consultation where the process must be design led and where an open consultation is an alternative
- There could be some opportunities to combine consultation streams or introduce efficiencies, for example in recruiting and retaining focus group participants, sharing and adaptation of materials
- Some hard costs are likely to be involved in terms of incentivising/rewarding participants and this is a matter for the consortium.

- Recruitment: Some consideration has already been given to recruitment at the LL sites as follows. These avenues can be mapped onto the streams of consultation as part of firming the process of consultation.

Possibilities to get Enschede-specific results are as follows:

- TwenteMobielquestionnaire which has been carried out among different companies.
- Extended version of the above carried out at UTWENTE
- Enschede Panel: 8,000 inhabitants get this web survey. (Costs involved, limited flexibility)
- Early results of the i-Zone system

Possibilities to get Göteborg results are as follows:

Utilize the vast amount of knowledge produced in the project ISET as springboard

- Utilize developed deep interview questions as springboard in the construction of a data collection instrument in SUNSET
- The interview questions used in ISET in order to evaluate prototype services constructed within in the program were divided into four classes of questions. The first class of question aimed to stimulate the participants to describe their life situation and their everyday travelling pattern/behaviour. The second class of questions is directed to stimulate the participants to describe and also value what they today used in order to make their everyday travel efficient. What type of information do they usually use during an everyday trip? How do they acquire the information? How do they value the information and the means by which is acquired? The third class of questions was directed to the prototype tested. The participants were told to point out strengths, weaknesses, perceived changes and additionally features and functionality not currently covered in the prototype. In this dialogue the interviewer related the participants' answers to the answers that the participants had given to the more contextual questions that were asked earlier in the interview. The fourth and last set of questions was aimed to stimulate the participant to identify mobile digital services and service characterizations which he/she valued as good and useful in his/hers everyday living. His/hers answers was jointly turned into do's and don'ts when the prototype tested should be improved.
- Use the project ISET as driving force to connect to users.
- Use the project ISET as driving force to connect to other stakeholders (such as information and Service providers)

Possibilities to get Leeds results are as follows. Leeds has a number of existing groups that we could approach:

- Citizen panel

- Green employers group.

5.3 Traveller User Survey

5.3.1 Purpose, Design and Implementation

The design and implementation of a general questionnaire forms part of task 1.1 within WP1. The questionnaire was therefore developed in order to:

- To gather information on the use of alternative devices and preferred means to receive information
- Understand the difference in use and perceptions of social networks
- To understand the motivations for choosing particular applications and the means through which those choices were made
- To take a point estimate of the importance of different factors in the two main types of trips undertaken by travellers
- To understand potential differences in levels of trust and other perceptions of the information posted via social media, and
- To take preliminary feedback from potential SUNSET systems users on the factors ('incentives') that might have leverage in engendering behavioural change in transport related choices.

For each of these main categories of research, the main set of potential determinants was: gender, age, country of residence, neighbourhood type, occupation, travel needs and transport options available. A number of other and related factors were included in the survey such as access to smart technology and familiarity with social networks. The questions are in the form of multi-choice questions (either with a response or multiple responses), scale and rating responses. A number of freeform responses were also invited, generating a corpus of qualitative data for analysis. A copy of the questionnaire and the variable names that were assigned to the questions is provided in Appendix (Section 12).

The analysis reported here represents only a preliminary analysis as further data collection will continue and be reported in a subsequent deliverable. The survey was conducted in October-November 2011 through an on-line questionnaire available at a range of websites in the UK, Netherlands, Sweden and EU wide via the SUNSET project website. As a result the respondents were expected to originate primarily from the three countries associated with the Living Labs put could potentially originate internationally. The questionnaire contained the facility to use a translated version from English into Dutch, Swedish and German. As a result, the qualitative data arises in four languages and will be subject to separate analysis. The

questionnaire has been subject to the ethical considerations of the SUNSET project and more specifically to detailed ethical review at the University of Leeds. As a result of the ethical review, whilst the questionnaire was not targeted at minors, a decision was taken to discard any responses which may have arisen from subjects within the <18 age category. In practice no responses were generated from this age category. The questionnaire was also administered in such a way that only complete (full) sets of responses were finally recorded and therefore there are no issues relating to missing information or partial data.

The summary reported within this deliverable is structured according to the main research questions outlined above and focuses on some major responses only. Section 2 below begins with an overview of the socio-demographics of the respondents.

5.3.2 Results and Analysis of User Survey

A total of 138 responses were generated across 6 categories of nationality, which were determined as:

- Netherlands
- UK
- Sweden
- Germany
- Other EU
- Other non-EU

It should be noted that the SUNSET system is to be developed with the notion of universal potential, i.e., it is not a-priori targeted at a particular country or location, or at a particular age group, gender or other socio-economic characteristics. The Netherlands, Enschede and Sweden will host a living lab within the project and as such it was of research interest to observe any significant differences in responses arising from those localities. Figure 18 and Figure 19 ((Section 11 Appendix)) show the distribution of male and female participants across selected countries, including those which will host SUNSET Living Labs. It can be seen that the majority of the participants are from the Netherlands, followed by Sweden and then by the UK. Only a few participants reside in other EU countries and only a handful in non-EU countries. 88 of the responses were male, indicating some gender bias in the responses. The age distribution is as indicated in Figure 20 (Section 11 Appendix) and it can be seen that the largest age category is that of 30-55. The distribution of the country of residence is indicated in Figure 3 below, with the majority of the respondents residing in either the Netherlands or Sweden.

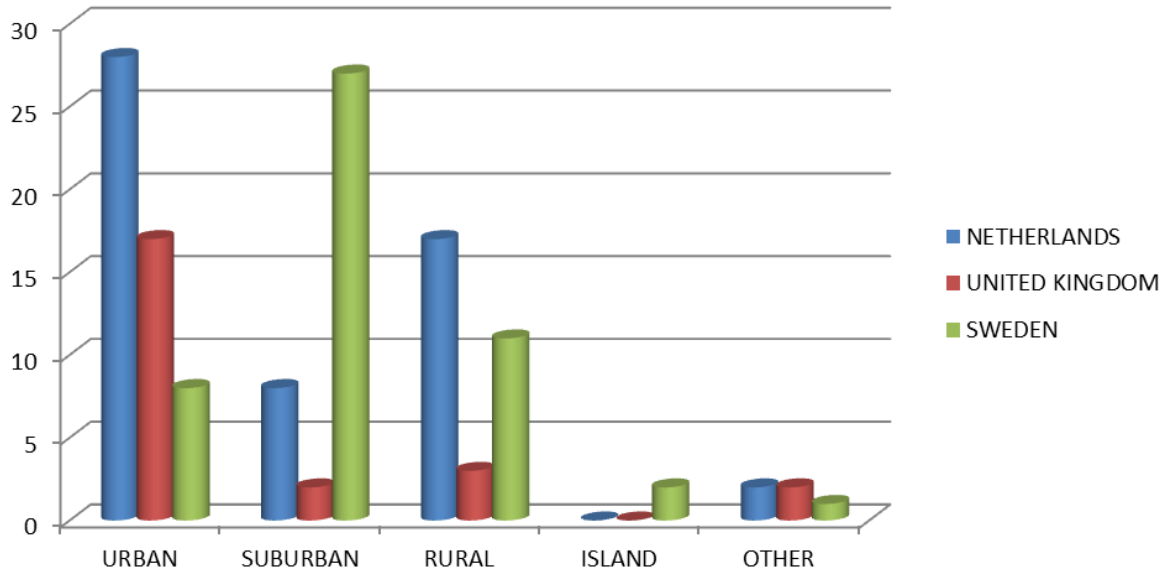

Figure 3: country of residence of respondents

As illustrated in Figure 21, the majority of the respondents were employed as an occupation with the second highest category being those in Education.

The extent to which alternative smart devices are available and in use within the population is a factor of strong relevance to the SUNSET system as it is based around access to Web2.0 technologies. This question also raises issues of equity in terms of access to transport information and potential disadvantage of particular socio-economic groups. Whilst national information is available in some countries (e.g. the UK), the data on device use for the respondents here is as shown in Figure 4 and Figure 22.

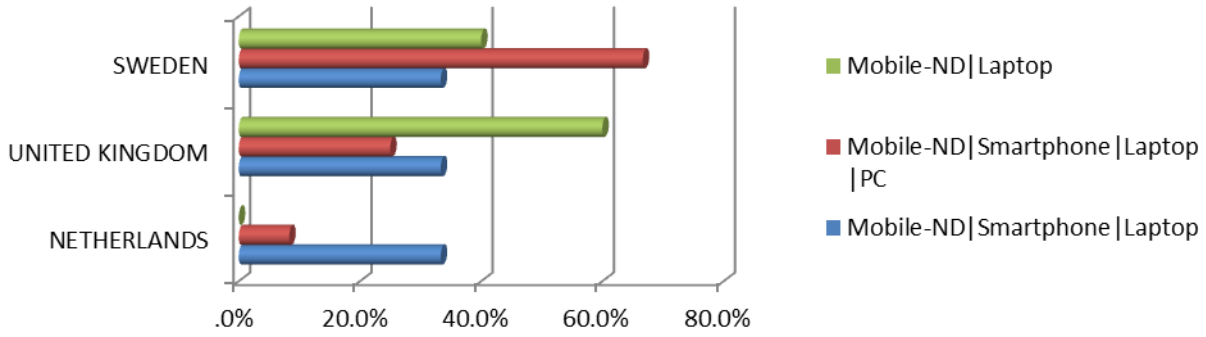

Figure 4: Device use by country (Key: Mobile-ND = standard mobile with no data access)

It is apparent from Figure 4 there is a significantly higher penetration of pervasive technologies of all types within the Swedish respondents than within those respondents from other countries. A more detailed breakdown is given in Figure 22 (Section 11 Appendix). As can be seen from Figure 23, Figure 24 and Figure 25 (Section 11 Appendix), high proportions of both male and female respondents used a smartphone 'often', whilst at the time of sampling, few used a tablet.

Questions on the use and perceptions of social networks were concerned with the extent to which the respondents used social networks at all, the reasons why not (where that was the case) and the main purpose of using the network. As Figure 26, Figure 27 show (Section 11 Appendix), the vast majority of respondents (over 80% in the case of males and females) already used social networks. The reasons given for not doing so fell into the categories of: privacy/concerns about information sharing and other individual reasons. The analysis of use by age categories highlighted a tendency for the older age group to be less inclined to use social networks than other age categories (Figure 5). When purpose is considered by country of residence (Figure 6), the data suggests that respondents in Sweden use social networks for information finding to a more intense degree than respondents from other countries.

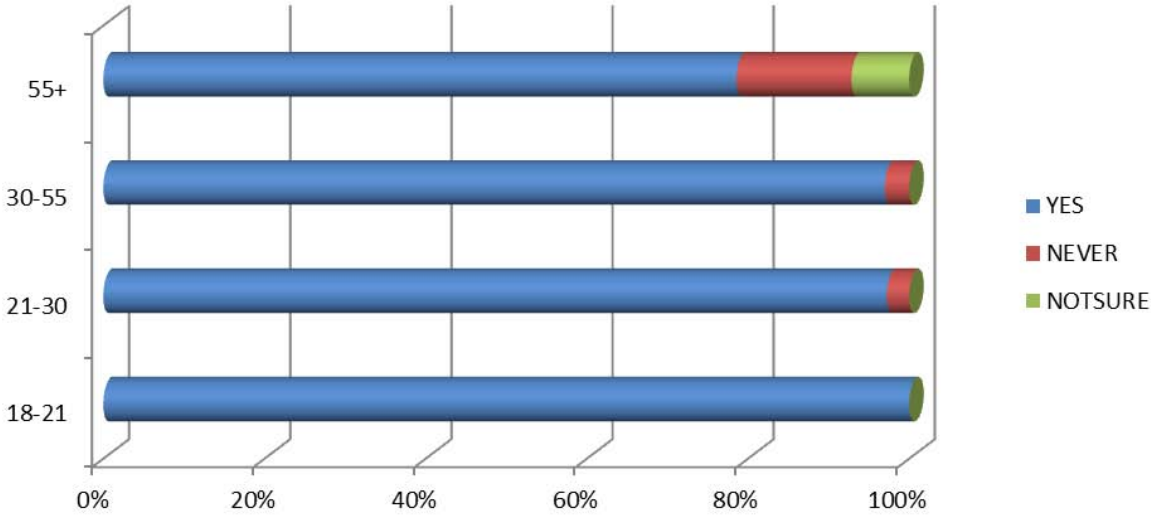

Figure 5: Social network use by age group

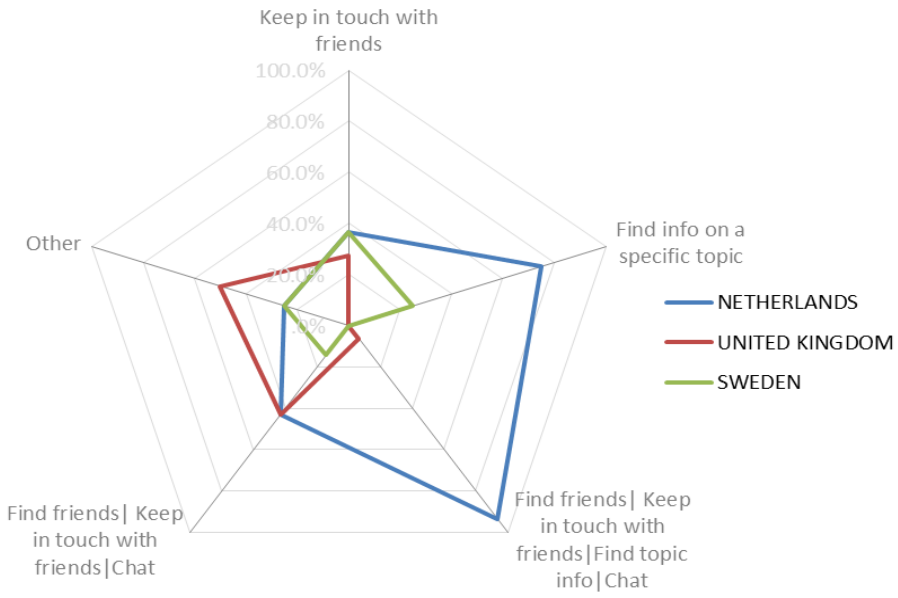

Figure 6: Purpose for using social networks by country

The frequency and motivation for downloading applications (as distinct to use of a social network site) is an issue with relevance to SUNSET in terms of attracting participants towards downloading the SUNSET application initially. The analysis of frequency of downloads by gender (Figure 7) highlights a clear distinction between male and female participants, with male participants generally far more active in downloading apps. This may have implications for the likelihood of the system engaging all sections of the travelling community and suggests the possibility of some gender related equity issues if this pattern is representative of the wider population. Figure 28, Figure 29 and Figure 30 (Section 11 Appendix) give an overview of the importance of particular aspects in the decision to download an app. Overall, the need to find information on a specific task (Figure 30) was the one which featured as the most highly important from all the choices offered to respondents and this was also highly important to both genders. Responding to a verbal recommendation (Figure 8) was the reason with greatest gender differences, whereby the male respondents felt this was far more important than the female respondents.

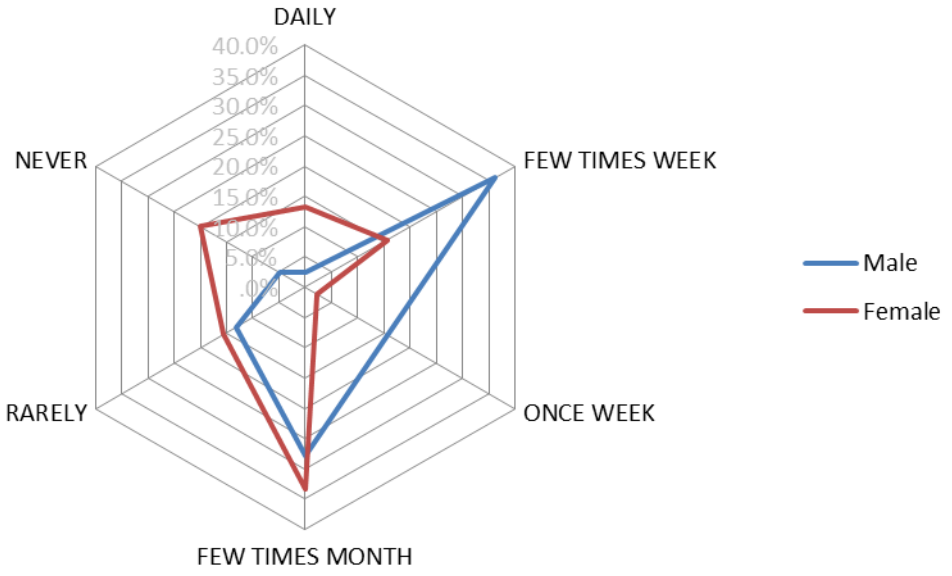

Figure 7: frequency of downloading apps by gender

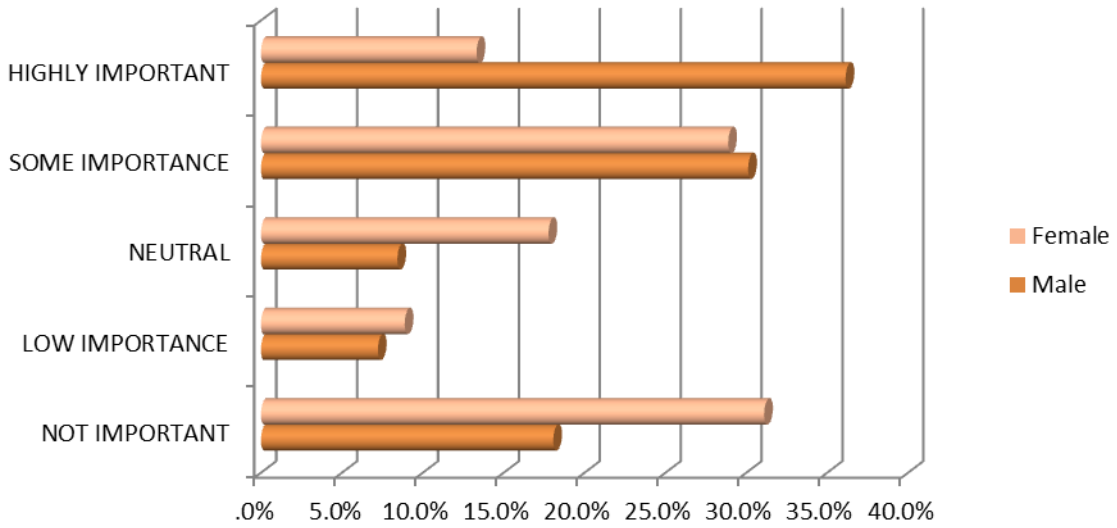

Figure 8: importance of verbal recommendation in downloading an app

As the main objectives of the SUNSET research are to engender behavioural change in order to meet personal and transport system goals, a series of questions were asked relating to use of different modes of transport and the factors of importance in making a trip. The findings from this can inform the design of the system and in particular the types of incentives that might encourage behavioural change. Respondents were asked about their mid-week trips and also their other trips (which are likely to be of a less habitual nature). The summary in this report focuses on the mid-week trips although for the research of the project overall factors relating to both types of trip are of interest.

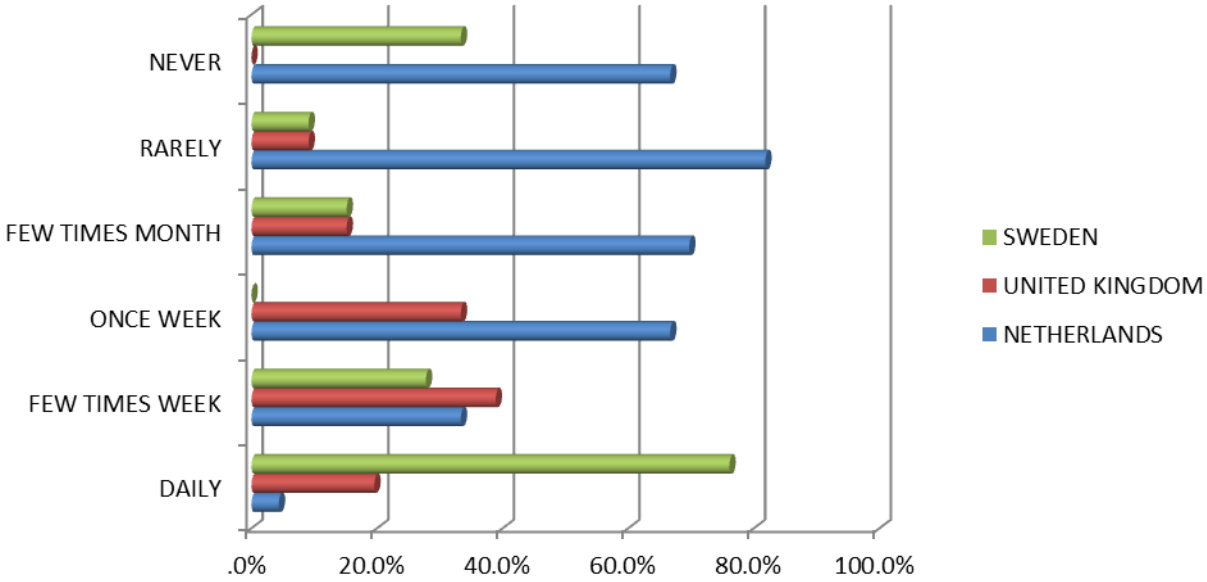

Figure 9: use of public transport for mid week for mid-week travel

Figure 9 highlights some striking differences in the use of public transport between the three countries in which a living lab will take place. Respondents from Sweden were very high proportion of the users of public transport on a daily basis. Respondents from the Netherlands had distributed behaviour across frequency in terms of public transport use, as did those from the UK. Corresponding figures for the use of non-public transport (Car, bicycle, taxi etc.) are given in Figure 31(Section 11 Appendix) and suggest that respondents from the Netherlands were more likely to use private transport on a daily basis than those from other countries.

Figure 32 to Figure 46 report the findings from questions concerning the importance of particular aspects of the trip to the respondents. These aspects cover distance, cost, health, reliability, comfort, convenience, safety, green-score, and travelling encumbered. An understanding of the relative importance of these factors is an important element in the design process, particularly as there could be significant differences between the perceptions of the research team and those of people in different occupations and lifestyles in reality. The responses have been split by age group and gender to highlight any differences by basic population subgroups. The findings highlight some striking differences within particular age groups on the relative importance of particular trip aspects, so for example within the 21-30 age category distance was a highly important factor. Across the alternative aspects, there was little evidence of gender differences, however as Figure 10 and Figure 54 show there appears to less priority on health and green score for the respondents than other factors including reliability (see appendix)

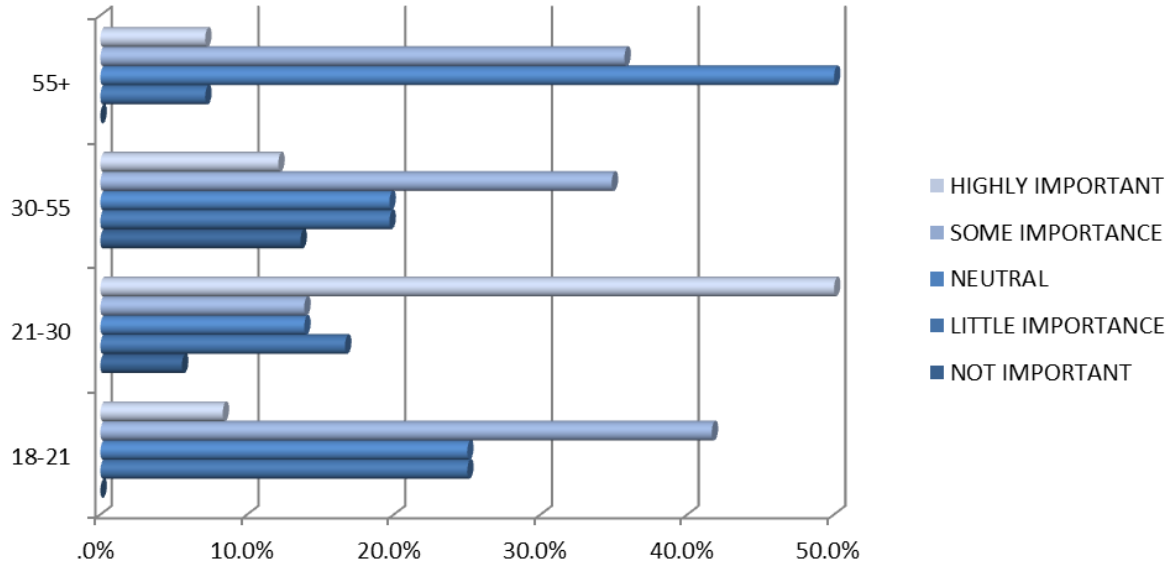

Figure 10: Reg. Trip Health Importance

Respondents were questioned about the kinds of incentives that they believed would be most likely to impact on their transport choices. As anticipated, information about Journey Time appears to be highly important across all age groups, despite its importance increases with age (Figure 11). Another interesting finding concerns differentiations across countries. Figure 12 shows that users in The Netherlands do not consider Journey Time information as important as users in the UK or Sweden do. This may be because of a better service/system in The Netherlands, but any conclusions need to be tested through the Living Labs. Interestingly though, female users rank Journey Time information as more important compared to male ones (Figure 13).

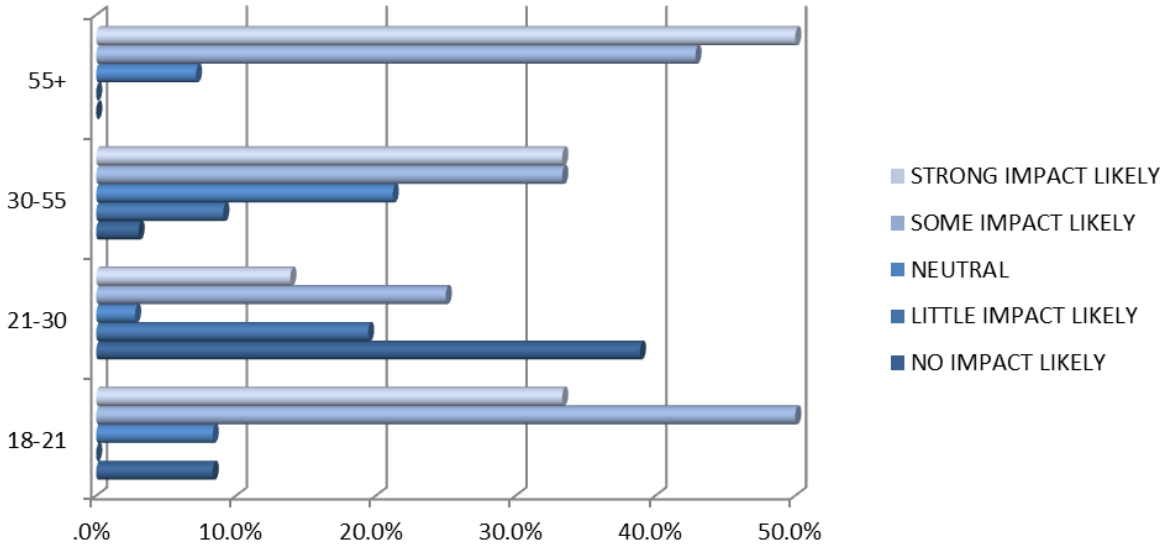

Figure 11: Incentives: Info about journey time (by age-group)

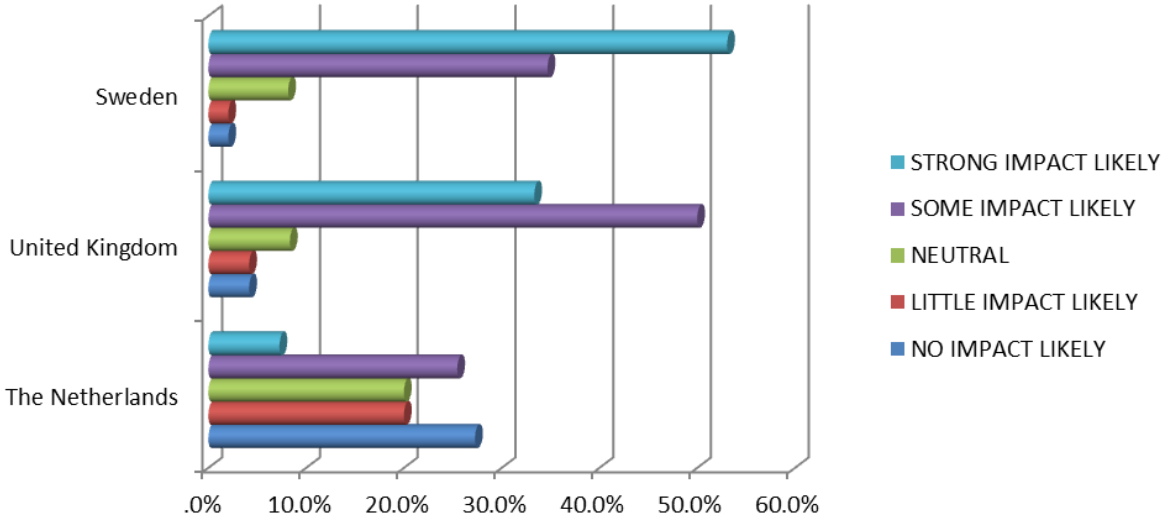

Figure 12: Incentives: Info on Journey Time (by country)

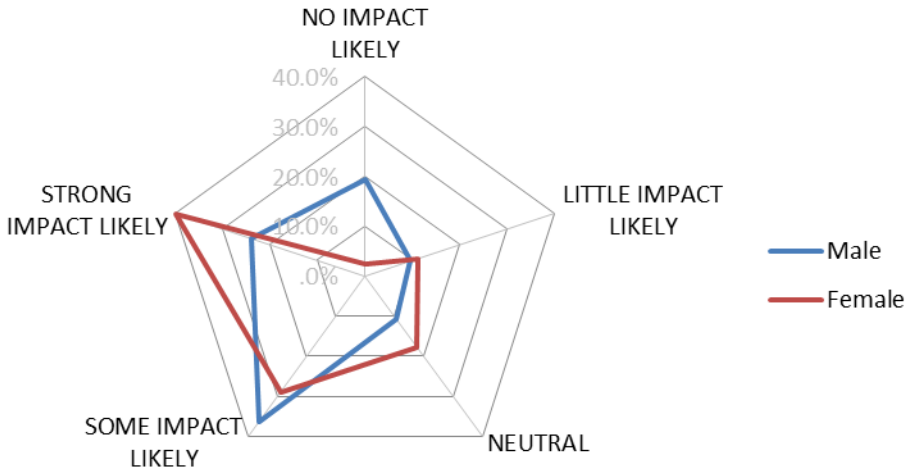

Figure 13: Incentives: Info about journey time (by gender)

Among other incentives, points offered through a game or other types of competition appear to be more attractive to users across most age groups. It is only those aged 21-30 that do not see such incentives as effective. This may be attributed either to low expectations of these users from such games/apps

or due to their lack of time for such games/apps. In contrast, loyalty points do not appear to be an effective incentive for users and this could be due to negative previous experience with other similar schemes. Past travel information is more attractive within elderly users, while health-score ranks quite low for most users, apart those over the age of 55.

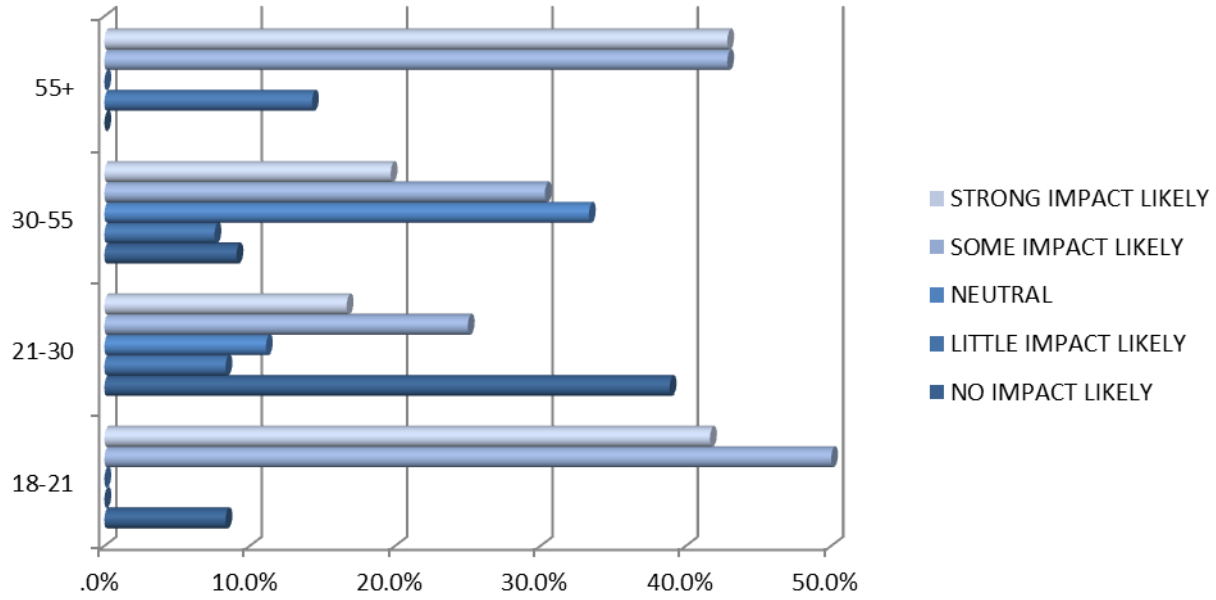

Figure 14: Game points Incentive by age group

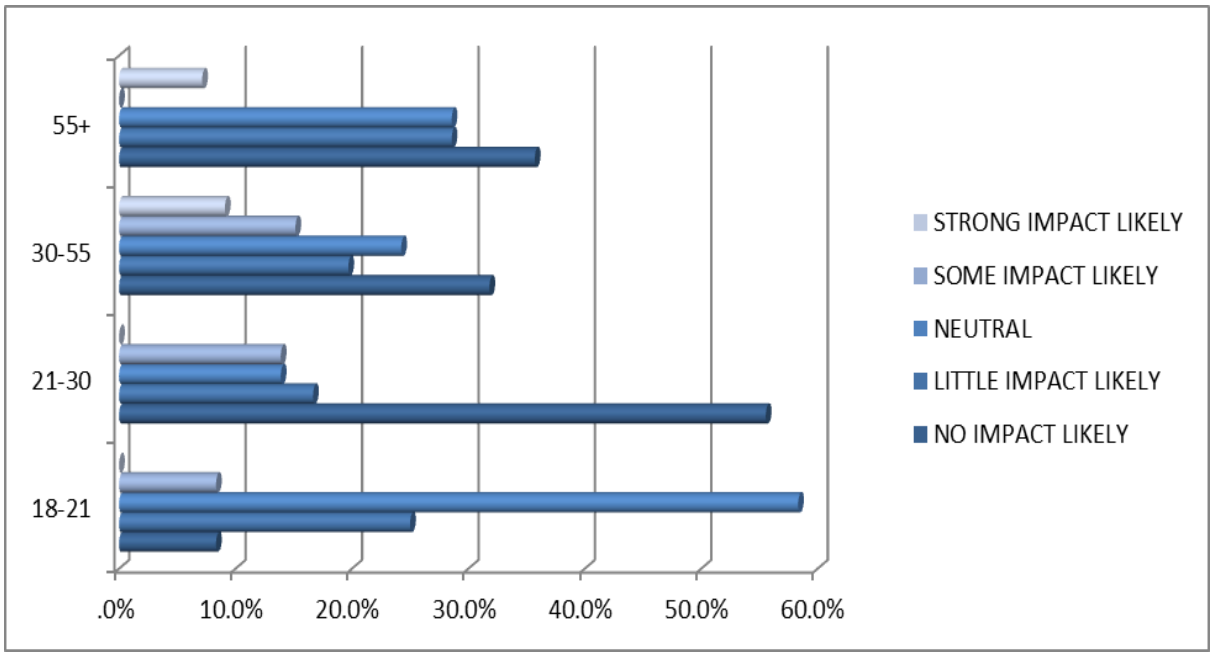

Figure 15: Loyalty points incentive by age group

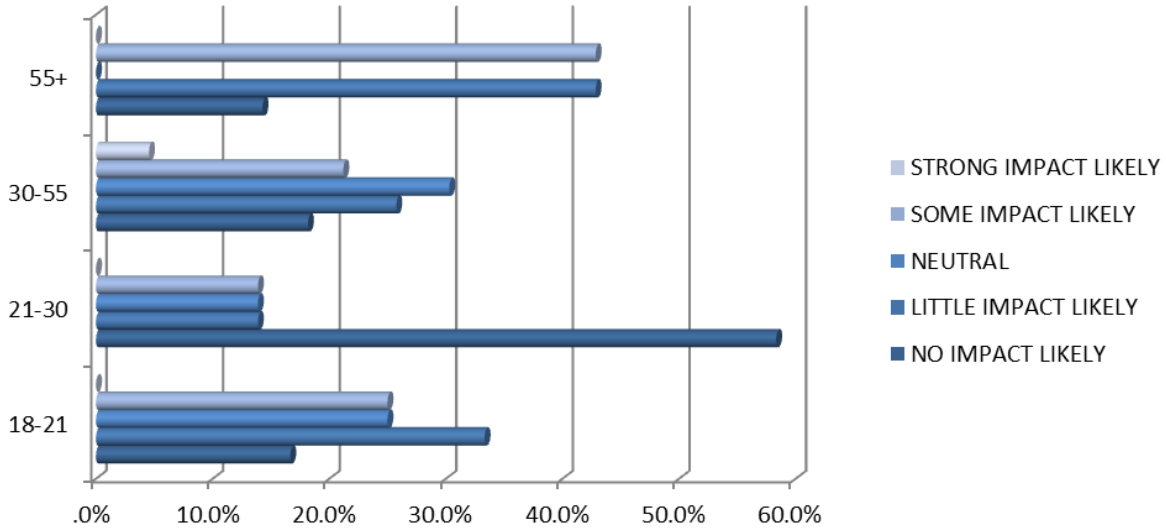

Figure 16: Incentives based on past information by age group.

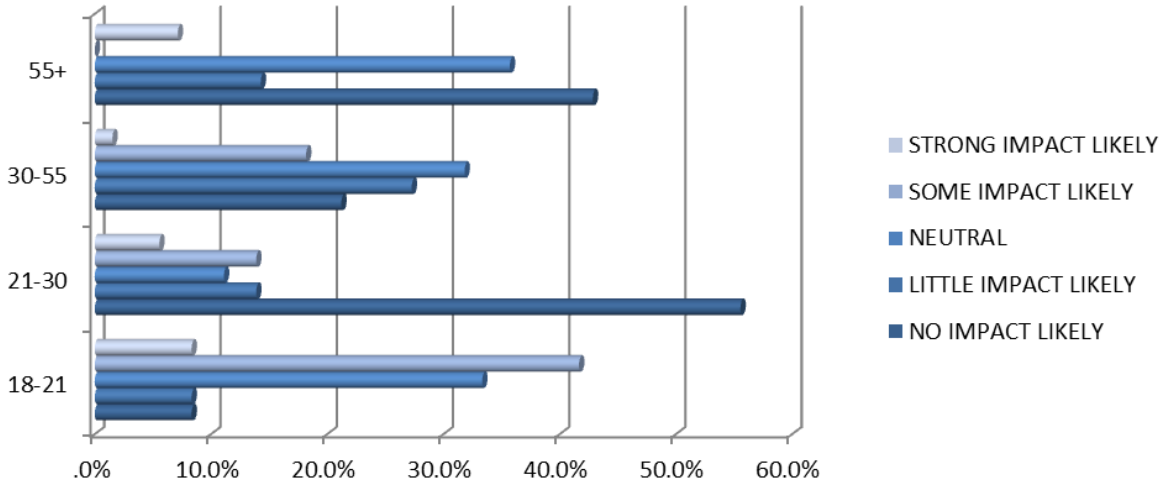

Figure 17: Health score information incentive

5.4 Authority Stake-holder Survey

5.4.1 Purpose, Design and Implementation

The basic purpose of the stakeholder consultation is finding out what the opinion of stakeholders is on the general idea / functionality of the SUNSET-application. The relation with the user consultation and questionnaire is that stakeholders are considered to be high-level users, that want to have an aggregated overview of the performance of (parts of) the traffic system (e.g. traffic controllers at city level). Basically, this consultation is about the requirements for the dashboard, i.e., what functionality, information and aggregation levels are needed in the dashboard to have an added value. By presenting the current functionalities of the SUNSET system and the city

dashboard we tried to get feedback on the functionalities and to find out to what extend the system can contribute to the stakeholder objectives. Because the target group in this case is small and specific we conducted structured interviews to gather the required information on stream (b). The structure of the interviews is as follows:

1. Basic personal and professional information
2. Views on SUNSET concepts and ownership and usage of technology
3. Views on dashboard functionalities
4. Required level of data-aggregation in the city dashboard
5. Additional remarks and suggestions on SUNSET and the city dashboard

5.4.2 Results and Analysis of Stakeholder Survey

A summary of the results of the Stakeholder survey in the form of a structured interview is reported here. The information collected for this survey is reported in Section 15. The stakeholder consultation within the LL Enschede was conducted with the municipality of Enschede as the main road authority. A small group of up to 15 potential stakeholders was initially identified for Enschede but of these only 4 were able to participate in the consultation and to be interviewed. All interviewees (4) were:

- male and in the range of 35 to 55 years of age
- work in the transport sector for a number of years.
- not frequent users of apps on his smartphone or an active member of a social network site.

The professional objectives of the interviewees range from improving accessibility and throughput on municipal level to improving liveability (safety and quality of the urban environment) on neighbourhood and street level. Although it was stated that monitoring and evaluation is important, the actual evaluation is hardly ever done in a structured way. However, traffic data is used in ex ante studies.

The interviewees see little potential for social networks in the transport context. It is stated that a social network site might be useful from the road authority's perspective as a forum for discussion (between traveller and authority) on measures and considerations in the decision making process, and as a tool to distribute news or events.

With reference to the types of incentives the highest potential from a professional point of view is in rewarding and advising the travellers. Adding a gaming aspect is also important in the sense that the presentation of the incentives must be appealing, but most interviewees think that the effect of using games will fade out in time. Only the provision of information is valued to have little potential, because it might lead to an overflow of information. Information on health and CO_2 might have added value. Personalized

advice has higher potential to change behaviour. Backgrounds and considerations that have led to the advice should also be presented. Rewarding travellers for good behaviour has potential when it is the final push in changing towards sustainable mobility behaviour. Only recognition won't be enough, according to the interviewees. With reference to the potential of games, it was stated that the presentation of the incentives in general is important. A game or, more generally speaking, adding 'fun' to the incentives, could be very helpful in presenting the incentives in an appealing way.

With reference to the city dashboard and the provision of data and information on the LL Enschede, we firstly need to state that the interviewees got a brief overview of the concepts and functionalities of the city dashboard. Because the system is still in development and they never used a similar system before, it is difficult to rate the potential and the added value of the SUNSET dashboard. However, the respondents see the provision of more actual (close to real-time) data as a useful addition to the currently available data sources. Moreover, a wider range of data and data sources might improve the accuracy of the calibration of traffic models. Especially traffic-related data from mobile sensors have potential to provide new insights in the traffic system, because origins and destinations, routes and travel times can be deduced from this data.

Traffic-related data should be presented in terms of travel times. Intensities are less important. Some interviewees state that the status of the external factors should be presented as well to be able to better see through problems in unusual situations. In sights in the composition of traffic is only important when it concerns the modal split.

With reference to aggregation levels we distinguished three dimensions: spatial, temporal and social. In spatial sense data and information is valued the highest when presented in terms of main urban routes and streets and to a smaller extent areas and neighbourhoods.

The main temporal aggregation level should be the peak hours in relation to 'the normal situation'. This normal situation can be constructed over a month or a year. Interviewees indicate that they like to have the option to choose a specific temporal aggregation level suitable for each study.
A social aggregation is not considered to be important except for a subdivision of traffic flows into modalities. This lack of interest could stem from the current absence of this information. Because the municipality does not have information on the social contents of traffic flows it is not taken into account in policymaking and therefore is not rated as valuable.

According to the interviewees the SUNSET system can best be used to inform and advise citizens and travellers in unusual situations. The project should focus on providing personalized information in this sense. Furthermore,

combining numerous different data sources could have a large added value for research on the urban traffic system.

6 User Requirements

The user requirements were derived from an analysis of the scenarios as described in Section 6.1.

6.1 How the User Requirements were derived

The process to analyse the scenarios to derive the User requirements is as follows:

- Analyse the scenarios expressed in natural language.
- Analyse the scenarios for functional versus non-functional requirements.
- Analyse the scenario description in order to derive user requirements.
- Review the parts of the complete scenario are all high priority to be developed for phase 1 LL trial or if some parts can be left to the phase 2 trial.
- Review if all major elements of the DoW tasks are used in the scenarios

User requirements were not generated from inputs from external user consultation because the focus there was more on confirming the importance of system features and not on soliciting new requirements for system features from users.

6.2 User Requirements Analysis derived from the Scenarios

First of all it is essential to connect different names and concepts as it is natural when scenarios are created by multiple stake-holders and in natural language that the same concepts may be called by different names - synonyms for some terms concepts may arise (Table 22).

6.2.1 Informal Descriptions using Natural Language Issues

Concept	Where used	Example	Synonym
Goal	US2	Personal profiles easily link with goals from a stakeholder perspective	
Incentive	US13	Sunset offers incentives to users	
Proposition	US14	Business stakeholders send propositions to nearby stakeholders to change their behaviour	Suggestion, Tip, Personal recommendation
Question	US17	SUNSET can pose ultra-short questions on the user's mobile phone regarding mobility	Experience Sample

(Group) Recommendation	US6	A user is awarded a positive mobility recommendation	
Suggestion	US8	At the right time, a user receives a SUNSET mobility suggestion to change behaviour	Proposition, Tip, Personal recommendation

Table 22: key concepts used in the generic scenarios

Note that some of these terms may be used differently in different fields of computer science and science in general. For example, a recommendation is the result of an aggregation of user inputs and hence is anonymised; more specifically this is a group recommendation. This can be distinguished from a sub-type of recommendation where the identity of the recommender may be known – this can be referred to as a personal recommendation.

6.2.2 Explicit requirement versus Implicit Requirement Issues

Quality Function Deployment (QFD) is a quality management technique that translates the needs of customer into technical requirements, see Zultner [1992] quoted in Pressman [1997]. A key point is that users or customers focus on explicitly specifying the functional requirements and if these requirements are supported the customer is satisfied. Expected or implicit requirements may be so fundamental that users do not explicitly state them, e.g., data privacy. However, their absence may be considered by them to create a less usable system, hence system specifiers must still aim to identify these.

The following are considered as candidate implicit requirements supported by the SUNSET system:

- System improves its behaviour the more data it collects and over time (US4)
- Personal data about an individual such as contact details (to send experiential samples to) and information acquired about user's behaviour is held securely (encrypted).
- Access to individual's personal data is defined in a privacy policy and is on a need to know basis
- User's data is anonymised
- The System availability is such that can handle hundreds of simultaneous users transparently.

6.2.3 Implicit Experiential Input from User Interaction

The system may use acquire user input to help evaluate the system in a variety of ways such as explicit off-line feedback from users (via Web questionnaires or face-to-face interviews, on-line (experience sampling) user feedback and implicit feedback via user interactions with the SUNSET App.

Any interaction by the user can provide implicit feedback to evaluate the SUNSET system, e.g.,

- US5: acceptance or not of the recommendations
- US6: rewarding a car pool participant
- US8: acceptance or not of a mobility suggestion
- US13: acceptance or not of a mobility incentive
- US14: acceptance of propositions from nearby users
- US15: participating in ad hoc travel groups

6.2.4 Miscellaneous Issues in Mapping Parts of the Scenario to Use-cases

Note there are many ways the requirements could be categorised; e.g., according to WP, but this latter way is not very understandable by others external to the project. There is not a 1-1 mapping between scenario us-cases to requirements. Some use-cases clearly lead to compound user requirements.

- e.g. UC7 is about providing both trips stats and about real-time traffic information.

There is an overlap between some scenario parts and the use-cases although these may have a different focus. There is often not always a 1-1 mapping from use-case part to user requirement.

- e.g. UC 7 and UC 19.

6.2.5 User Requirements Specification

The user requirements analysis is a semi-formal restructuring of the scenario description and explanation given in Table 23. This requirement is prioritised based upon a review of the requirements by Work-package leaders.

No.	User requirements	Explanation	Priority	WP/T
1.	**Mobility App registration &Download** User registers with SUNSET via its portal and then installs a mobility monitoring application that can run on a mobile phone. This can b) Record location traces c) Classify them into single-modality trips; d) Detect physical movements and activities, e) *Determine air quality***.**	a) Map GPS cords to location context using GIS; need to deal with position inaccuracies where GPS location and route location are slightly different b) Need multiple sensors here, e.g. accelerometers, bus-route info. etc. to classify transport modes, but can we differentiate if a taxi or private car is travelling part of the bus-route? c) This is a complete project in itself, what movement changes are important can be clearly identified? How can activities be defined, classified, identified.	High	T2.1, T4.1

		d) There is no mobility application on a mobile phone. That can monitor air quality for the user. Remove from this part of the requirements? Does the user have any control of what parts of the mobility are monitored and how they are monitored?		
2.	**Social Network Reuse** a) Users on registration can specify their membership and access credentials for others in existing social networks b) Users can elect to re-use a large part of her existing local social networks within the SUNSET/ LL. c) SUNSET can link its social identities to existing social networks d) Social networks neighbours can see each other joining SUNSET on Facebook, and can decides to join too,	c) SUNSET a local identity manager, where social identities can be linked to existing social networks d) Does the system prompt the social neighbours of new users to join?	High	T2.3 T4.2
3	**Mobility Pattern Analysis & View** a) SUNSET system automatically determines and visualises mobility patterns for a user to provide: b) Overview of modality choices, c) Temporal and spatial densities, d) Frequent routes, e) Activity overviews f) Environment indicators g)and allow for manual overwrites to correct derived information with more accurate or specific data	Define what will be provided during, and if the duration of, the 'training phase' is fixed Define which stake-holders can access this information Define how end-users can interact / customise this info? Define how often info. Is uploaded from mobile device and how much info. The mobile device can cache	High	T2.2 T4.1
4	**Improved Mobility Pattern Analysis** This pattern will be continually improve over time a) Locations (destination and other designated way-points by the user/) that characterise trips can be automatically matched with personal places and b) Public places (my office, supermarket stop, or school drop-off)	Define how locations are detected. In simple case they are just end-destinations or goals of trips. For a multi-purpose trip, also need some intermediate ones.	High	T2.2
5	**Trip-based Pattern Analysis**	Patterns are matched across	High	T2.2

	&Recommender a) SUNSET users' trip patterns are matched to each other. b) Recommendations are offered to users based upon the pattern matching	multiple users. The matching depends mostly on b) Start and end location of the detected frequent home-office trips b) The timing of those trips, c) Preferences (modality, smoking, favourite topics, personal recommendations) d) Recommendations will be proposed based upon the matched patterns, e.g., to car pool		T3.3
6	**Trip Recommender Acceptance & Feedback** a) A user can select to receive trips recommendations or not b) A user can check rating information about any service provider making a trip suggestion c) A user can accept trip recommendations from SUNSET d) A User can give feedback about a recommendation, e.g., a positive mobility recommendation e) Positive feedback can be shown on his profile page.	*Note there is an issue here, the scenario talks about recommendations, the discussion talks about incentives – these are not the same* a) Rating information about users is collected b) In SUNSET users can reward and rate everything in their personal sphere that is mobility related: places, vehicles, transport lines, and also users. c) Incentives are a mixture of normative belief, identity, social status, d) Incentives require a relevant audience (people whose opinions matter to John) which has implications for the density of social contact and recruitment methods.	Medium	T2.2 T3.3 T4.1
7	**Real-Time Trip, Historical Trip, Transport choice Info.** a) Users receive historical trip info. That is visualised about their public transport choices, personal traffic jam delays, CO2 emissions, and health indicators for the previous day, week and month. b) Historical trip info. May also after user-configurable filtering and abstraction, get displayed on social networks. c) Historical User Mobility patterns can be classified, e.g., before and after significant mobility changes and characterised including emissions and health indicators d) On entering destination or activity goal info. For current	a) The **mobility profile is visualized** in an attractive way on the SUNSET portal, mobile clients, b) But also on existing social networks. Note; some individual profiles may need filtering before social network use, users may not want all trips to be shown on a social network site, e.g., to see their doctor c) It also shows consequences of personal transport choices, and an easy link to join SUNSET for potential new users. e) Personal profiles could easily link with sustainability goals from stakeholder perspective, e.g. in the UK public health advice is for individuals to aim to take 10,000 steps a week.	High	T3.1, T3.2

	trips, users can receive real-time information about available commute parking spaces, traffic disturbances, approx. travel time by car / public transport to the destination, available bicycles in the area and how much money she have left on her public transport card. e) On entering trip information, user can see the effect towards sustainability goals			
8	**Planned Real-time Trip Info and Recommender** a) If planned trips are degraded based upon real-time traffic info, users are notified before they start, during a journey. b) Alterations to trip proposals can be offered by SUNSET, e.g., for users to work at home	a) This assumes a silent background monitor that observes the situation for all users on their regular trips at this moment of time, and alerts them in case situations deviate from normal. B) Alerting should be direct and personal, e.g. via a mobile app.	High	??
9	**Real-time Trip Info. Confirmation using individual mobility monitoring and traffic sensors** a) Suspected Trip degradation can be determined from a user observing the individual mobility info. Other community members making hardly any progress on these routes to their work b) Individual Trip info. Can be combined with information from roadside sensors if available and visualised by users. c) Furthermore, individuals can manually report on trip degradations on observation	a) Road-side sensors can provide info. b) SUNSET uses extrapolate about current travel/delay times of other users on the regular routes of a user. c) Both personal mobility and roadside sensors have their limitations (limited to main roads or no sufficient temporal coverage), but combining the two alleviates these limitations.	Medium	T4.2 T4.1
10	**Trip Degradation Confirmation using Traffic cameras** Users can access the SUNSET portal before they start a trip to get an automatic link to the most relevant traffic cams for the trip	a) Travel times can also be estimated from webcams observing license plates. Note privacy and security issues, anyone can see your licence plate on these traffic cams. b) And if a webcam is present along the route, it can also be used for visual confirmation.	Medium	T5.1
11	**Trip change based upon Traffic cameras** a) The traffic cams confirm the traffic jams b) When planned trips are	a) This check is not necessary, but users might need information about the sources on which a recommendation is based, to build trust in the	Low	T5.1

	affected, alternative trip plans can be proposed by the system	quality. b) This requires the system to hold more detailed about the trip such as a user goal.		
12	**Group-based aggregated Views of multiple individual Trips** Selected Stake-such as employers who participates in the SUNSET initiative, gets an overview of the travel times of their employees and the trends therein.	a) Not only the user is a stakeholder, but also employers and the local government (item 19), and these stakeholders can be fed with the proper information to take measures improving mobility. b) This requires sufficient contact and spatial densities again, as well as a successful recruitment strategy. The smaller the group, the more important this is, e.g. city level is easier than employer level, which is again easier than place level.	High	T2.3
13	**Trip Change Incentives** a) SUNSET providers can offer incentives to promote specific trips. b) Trips and monitored and Incentives can be matched to the trip info, and offer to travellers based on their mobility info.	a) Incentives can be added to the system by the stakeholders, and are presented and monitored by the SUNSET system, e.g., i) special services or rates, ii) bonuses in the mobility game or iii cash money iv) subsidised transport, e.g., 50% reduction of the price of a new bike, paid by an employer.	High	
14	**Ad hoc Location-specific Mobility Offers** a) Location-specific businesses can register to provide services and incentives b) Service proposals are triggered by route degradation at specified locations	a i)) Stakeholders, such as local shopkeepers, retailers, business owners, road authorities and many more, can register their own incentives into the system. ii) A good incentive should contribute to both the business model of the (which one?) stakeholder and the mobility performance indicators of SUNSET.	Medium	T2.2 T2.3
15	**Ad hoc group Travel Offers** a) traveller can elect to travel specific transport modes because they are informed of the benefits of public transport, e.g., buses offer reduced carbon footprint and use of dedicated bus lines in cities during rush hour b) On entering the bus she is notified by SUNSET that she might join a group of people	bi) Entering shared transport an individual traveller can join an ad-hoc fashion and leave this group after leaving the bus. ii) N.B. In the some cities, e.g., in the UK, you often need to buy the ticket before entering the bus; Buses are privatised, it will reduce profits to allow anyone to join an ad hoc group. iii)These temporary groups can be an incentive to change	Medium	T3.3 T4.3

	sharing their group ticket and thus save money on the ticket fare.	travel behaviour for example by saving money for the ticket fare, or easily grouping people for additional transport in case of severe delays, e.g. finding transport home in case of a blocked train track		
16	**Public transport recognition**: a) When a user enters a PT vehicle, PT instance is identified b) automatic claim if a service falls below threshold. c) use info. of specific PT instances is collected. d) this can be used by other apps such as to target incentives		Medium	T2.2
17	**Experience sampling** a) A short post-trip feedback form can be triggered.		High	T2.1 ??
18	**Sharing Mobility Status Updates** via Social networks a) Group travellers inform others of each other's status: i) during trip planning ii) to meet up at start of trip.	.	Medium	T2.3 T4.2
19	**User-centred monitoring and visualisation of Mobility patterns.** a) The living lab portal offers a number of widgets that can be configured in the SUNSET portal by user, b) Widgets can also be placed wherever he wants (in particular social networks) c) These widgets are updated automatically so that they always represent the latest status, e.g. i) to show mobility patterns, ii) environmental footprint, and iii) progress on personal goals, iv) consequences of mobility such as personal health indicators and emission levels. v) real-time information about available commute parking spaces, vi) traffic disturbances, g) approx. travel time by car h) public transport to the destination, i) available bicycles in the area j) and how much money she has left on her public transport	These widgets can be configured in the SUNSET portal by user, and placed wherever he wants (in particular social networks), and these are updated automatically so that they always represent the latest status. Commonalities are good to increase social communication and use social norms to influence behaviour.	High	T2.4

	card.			
20	**Reuse of SUNSET Widgets in External Applications** a)Users can easily re-use these widgets on personal websites b) And in social networks a user is in, to show to non-community members how the impact on the mobility and environmental problems has been reduced over time. c) users can compare their behaviour with the average or a friend group, and also see progress in these groups	b) that means all this impact information is made public for all to see (including when the impact is less favourable to the subject) c) travellers are grouped but are not yet defined how groups are defined and how travellers belong to groups that may be exclusive or inclusive.	Medium	T5.2
21	**Analysis of Mobility Patterns and Proposals for Mobility Improvements** a) After a longer period of time, SUNSET analyses am individual's travel patterns, b) SUNSET proposes suggestions for improvements saving timings by; i) avoiding delays and by better modality choices, ii) offering directly applicable suggestions for safer, more comfortable iii) showing the environment impact gain when a traveller selects a specific transport mode	a) Time period could be a month or longer, b) provides suggestions such as: better take the bus on this frequent trip, it saves you 5 minutes per day; or: better take this route by car instead of your normal route, it has less accidents[5]; or: better travel with person X on Tuesdays to the office. Inter-urban trips or trips abroad can also be included. The longer the observation period the better the suggestions will be.	Medium	T2.2
22	**Users can offer each other travel tips** Safety is improved by tips and reviews of other SUNSET users, who comment on their favourite routes and travel times, adding personal suggestions.	Personal contact and suggestions of trusted people work best and are facilitated by SUNSET. Comments from total strangers are not facilitated by SUNSET because of safety considerations.	Medium	T4.2

Table 23: User requirements analysis of user scenario

No.	User requirements	Remarks	Priority	WP/T
SS1	**Views of Data aggregated over time and space** a) SS can configure which time	Information is available on place level (road, crossing, region)	High	T2.4 T5.2

[5] There are ethical issues here associated with SUNSET offering travellers advice to "take this route by car instead of your normal route, it has fewer accidents", as described in Table 21: ethical issues are considered in [D8.2].

	and space intervals are viewed in a dashboard			
SS2	**Exceptions & Abnormalities & Opportunities are highlighted** a) SS can configure filters to trigger exceptions and customise how these are highlighted and displayed	The current state of the network can be compared with a theoretical (e.g. max speed vs. current speed) and an average state (e.g. normal modality usage at day, time) Whether the detection of abnormalities and opportunities is fully automatic, or the empirical result of comparing two mobility states (current with average, current with last year, etc.) is still an open question.	Medium	T2.4 T5.2
SS3	**Incentives can be issued in the living lab** a) SS can create new incentives b) incentives can be issued to users	a) conditions (*when* to issue an incentive) need to be specified b) selection of users (*who*, the target group) can be made on fixed characteristics (gender, age), location or certain types of behaviour c) the reward (*what*) can be specified in a number of points to earn, to be exchanged later for material rewards (goodies, reduced prices, services, ...)	High	T2.4 T5.2
SS4	**Use of incentives Views** a) Stats of the no. of times incentives are issued is acquired & displayed	Statistics also on times used, being able to filter on age, gender, mobility conditions (modality, route, accompany, destination, ...)	High	T2.4 T5.2
SS5	**Event-based Experiential sampling** a) Experiential samples can be created and distributed by a SS b) responses can be acquired and analysed	Filter based on location, behaviour, characteristics	High	T2.1 T5.2
SS6	**3rd Parties can Monitor Mobility Patterns** a) Local government can use the monitoring and analysis tool of SUNSET to see the environment impact of the incentives offered in i) a specific user group, ii) to see trends for the accessibility of specific places in the city iii) to see the city-wide progress on the goals and performance indicators, using the real-time information from all living lab community members as input. b) Local government can play with incentives by launching them, observing the impact, and	In short, the city dashboard allows the local government or road authority to 'play' with the mobility choices of the travellers in his city: observe situations that are sub-optimal, design incentives to change behaviour of at least part of the community who is regularly in that situation, observe the effect and impact of those incentives, identify responsive target groups, and re-design /improve/continue with those incentives.	High	T2.2 T5.2

	then discard them if they do not have the desired effect, or scale up if they do. c) user feedback is used to improve the SUNSET living labs over time.			

Table 24: User requirements analysis of stakeholder scenario

6.2.6 Relation of Scenario to SUNSET WPs and Tasks

The list of characteristics defined in Work-Package and task descriptions in the project proposal were cross-checked against the user-requirements defined in Table 23 and Table 24. It is somewhat difficult to do this analysis at the WP level because the main WP objectives do not cover all the characteristics, e.g., the main WP2 objectives do not cover privacy etc. Hence this analysis must be covered at the task level.

N.B. not every system component proposed in the DoW tasks is explicitly used in scenarios as some system requirements are often implied by users rather than being explicitly specified. The following system components from the DoW are not explicit in the scenarios:

- list of data covered by mobility monitoring (WP2 Task T2.1)
- Visualisation of goal-monitoring (WP2 Task T2.2)
- Privacy management that is user-centred (WP2 Task T2.3)
- Central storage of mobility data and provisioning to goal and incentive engines and 3rd applications (WP2 Task T2.4)
- support for well-connected public transport systems, safe & secure urban transport (WP3 Task T3.1)
- individual and system goals (WP3 Task T3.2)

7 System Requirements

This Deliverable provides a snapshot of the ongoing R&D work. The latest version of the system requirements is available from the SUNSET developer network (http://www.tripzoom.eu/sps/) together with the component model, process model and API specifications of all components. This resource can be accessed with user name 'reviewer' and password and is available on request.

7.1 Introduction

System requirements are produced by the technical work packages: Mobility server sub-system (WP2), mobility client sub-system (WP4) and Infrastructure Network & Portal sub-system (WP5).

95 system requirements for the mobility server were identified. This includes 11 for the Personal Mobility Store, 13 for the Mobility Pattern Detector, 9 for the Mobility Pattern Visualizer, 13 for the Incentive Market-Place, 10 for the Experience Sampling Store, 16 for the Relation and Identity Manager, 11 for the Privacy Manager, 5 for the Evaluation Support and 7 for the Infrastructure Network Manager) Most requirements have a strong link with the scenarios, but the list includes still a few technical ones and a few coming from the DoW, without a direct link to the use cases. The mobility server requirements are defined in an Appendix, see section 14.4. It also contains an initial table to check whether all use cases are covered by requirements which identifies also a small number of use cases that are not covered by requirements, this is future work.
14 system requirements were identified for the mobility client (7 from T4.1 + 4 from T4.2 + 3 from T4.3). The mobility client system requirements are defined in more detail in Sections 14.1 to 14.3.
18 system requirements were identified for Work package WP5. This includes: 3 Infrastructure Status Store System ones; 5 Proxy & Authentication System requirements; 7 Living Lab Controls & Evaluation (Dashboard) System requirements and 3 Web Portal (User) System requirements. WP5 system component requirements are defined in more detail in Section 14.5.

All requirements are presented in the template given in Table 25, which basically allows for making the connection with the WP1 use cases in the user scenario (USx) and the stakeholder scenario (SSx), to provide the rationale behind the requirement, and finally, to prioritise them[6] which will in turn guide the development of the entire SUNSET system. The relations of the system components to the user requirements are given via the scenario use-cases

[6] This prioritisation was determined after consultations with work-package leaders within the project. These are the initial estimated priorities. Pragmatically, these prioritisations can change as the SUNSET system matures as LLs mature and as further user feedback is collected.

are specified in Table 26. The template given was used to express the system and technical requirements.

<T>n	**<short name>**
Expert	<Name> (<Partner>),..
Component	{Mobile monitoring application, ..}
Type	{System, Technical}
Description	<describes the content of the requirement>
Source	<where does this requirement come from>
Rationale	<arguments that explain why this requirement is implied by the source>
Priority	{High, Medium, Low}
Remarks	<additional comments>

Table 25: Template to express the system requirements

7.2 Mapping of System Requirements to User Requirements

The user requirements are identified as use-case parts of the generic user scenario (Section4.1). The system requirements are defined in Section 14 where individual system requirements for each system component are related to use-cases. Table 26 gives the mapping of use cases (and indirectly to user requirements) to system requirements whilst Table 27 gives the mapping of system to use cases and hence to user requirements. The reason why the mappings are defined in both directions is that there is not a transitive 1-1 relationship between user and system requirements but potentially a Many-Many mapping.

Scenario ID	User requirements	System requirements	Priority	WP/T
US1	Mobility App registration &Download	T4.1-SR0,T4.1-SR1,T4.1-SR5, PMS.1, PMS.3, PMS.4, PMS.5,	High	T4.1
US2	Social Network Reuse	T4.1-SR0,RIM.1, RIM.2, RIM.3, RIM.5,	High	T4.1
US3	Mobility Pattern Analysis & View	T4.1-SR1, T4.1-SR2, T4.1-SR6, PMS.1, PMS.2, PMS.3, PMS.4, PMS.5, MPD.4, IMP.4, IMP.5, INM.1, INM.2, INM.3, INM.4, INM.5	High	T2.2 T4.1, t5.2
US4	Improved Mobility Pattern Analysis	MPD.1, MPD.4, PMS.2, INM.4, INM.5	High	T2.2, T5.2
US5	Trip-based Pattern Analysis &Recommender	T4.1-SR4	High	T4.1
US6	Trip Recommender Acceptance & Feedback	RIM.7	Medium	T2.3
US7	Real-Time Trip, Historical Trip,	N/A[7]	High	T3.1,

[7] not currently planned to be addressed in the phase 1 system but maybe addressed in the phase 2 system

	Transport choice Info.			T3.2
US8	Planned Real-time Trip Info and Recommender	T4.1-SR4, MPD.3, MPD.8	High	T4.1, T2.2,
US9	Real-time Trip Info. Confirmation using individual mobility monitoring and traffic sensors	MPD.1	Medium	T4.2 T4.1
US10	Trip Degradation Confirmation using Traffic cameras	INM.1, INM.2, INM.3, INM.6	Medium	T5.2
US11	Trip change based upon Traffic cameras	MPD.9, ISS,2	Low	T2.2, T5.2
US12	Group-based aggregated Views of multiple individual Trips	MPD.5, MPV.1, ES.1, ES.2, ÈS.3, ÈS.4, ÈS.5	High	T2.2 T2.3
US13	Trip Change Incentives	T4.3-SR0, T4.3-SR1, T4.3-SR2, PMS.8, IMP.4,	High	T4.3, T2.1, T2.3
US14	Ad hoc Location-specific Mobility Offers	IMP.4	Medium	T2.3
US15	Ad hoc group Travel Offers	T4.1-SR4, MPD.6,MPD.7, RIM.7 RIM.9, RIM.10	Medium	T3.3 T4.3
US16	Public transport recognition:	MPD.6, INM.1, INM.2, INM.3	Medium	T2.2
US17	Experience sampling	PMS.8, ESS.3, ESS.5, ESS.6, ESS.8	High	T2.1 ??
US18	Sharing Mobility Status Updates	T4.2-SR3, MPV.4, ESS.10	Medium	T2.3 T4.2?
US19	User-centred monitoring and visualisation of Mobility patterns.	N/A	High	T2.4
US20	Reuse of SUNSET Widgets in External Applications	MPV.4, RIM.3, RIM.8	Medium	T5.2
US21	Analysis of Mobility Patterns and Proposals for Mobility Improvements	PMS.2, PMS.8, MPD.1, MPD.3	Medium	T2.2
US22	Users can offer each other travel tips	N/A	Medium	T4.2
SS1	Overview of transport movements in the city	PMS.1, PMS.2, PMS.3, PMS.4, PMS.5, MPD.1,MPD.5, MPD.1, MPD.2, MPD.3, MPD.5, ESS.1, ESS.4, ESS.6, ESS.8, ISS.1, ES.1, ES.2, ÈS.3, ÈS.4,ÈS.5, LLC.3, WP.2,		
SS2	Monitor sub-optimal situations	ES.1, ES.2, ÈS.3, ÈS.4, ÈS.5, LLC.7		
SS3	Creates incentives	IMP.2, IMP.4, IMP.5, IMP.9, LLC.6, WP.3		
SS4	Monitors effect of incentive use	MPD.1, MPV.1, MPV.6, ES.1, ES.2 ÈS.3,ÈS.4, ÈS.5, LLC.2, LLC.3, LLC.4, WP.2		
SS5	Issue new experience sampling	ESS.1, ESS.4, ESS.6,ESS.8, LLC.5, WP.1		
SS6	View aggregated data	MPD.5, MPD.6, LLC.1, LLC.2		

	related to policy objectives			

Table 26: Mapping of Use-cases to System components and system requirements (N/A indicates not available)

System Component ID	System requirements	Linked user requirements	Priority	WP/T
Mobile Sensing (MS)	T4.1-SR0 T4.1-SR1 T4.1-SR2 T4.1-SR3 T4.1-SR4 T4.1-SR5 T4.1-SR6	US01, US02 US01, US01, US03, US09 US03 US08, US09 US08,US5-GO,US8-GO,US15-GO US01 US03g,US06d,US09c.US03-EN	High High High Medium Medium High High	T4.1
Mobile Mobility Profile Visualisation (MMPV)	T4.2-SR1 T4.2-SR2 T4.2-SR3 T4.2-SR4	US03 US03 US18 N/A	Medium Medium Medium High	T4.2
Incentive Market Place (IMP)	T4.3-SR0 T4.3-SR1 T4.3-SR2	US13 US13 US13	High High	T4.3
Personal Mobility Store (PMS)	PMS.1 PMS.2 PMS.3 PMS.4 PMS.5 PMS.6 PMS.7 PMS.8 PMS.9 PMS.10 PMS.11	US1, US3, SS1 US3, US4, US21, SS1 US1, US3, SS1 US1, US3, SS1 US1, US3, SS1 Developer Developer US13,US21,US17 WP4-req WP4-req IMP/ESS	High High High Med, Low Medium High High Medium High High High	T2.1
Mobility Pattern Detector (MPD)	MPD.1 MPD.2 MPD.3 MPD.4 MPD.5 MPD.6 MPD.7 MPD.8 MPD.9 MPD.10 MPD.11 MPD.12 MPD.13	US3, US4, US9, US21, SS1, SS4 N/A US8,US21 US3, US4, US7 US12, SS1, SS6 US15, US16, SS6 US15 Developer, US8, US 16 US3, US11 Developer Developer Developer ESS/IMP	High Medium High High High Low High High High Medium Medium Medium High	T2.2
Mobility Pattern Visualizer (MPV)	MPV.1 MPV.2 MPV.3 MPV.4 MPV.5 MPV.6 MPV.7 MPV.8 MPV.9	US3, US12, US19, SS1, SS4 US19, SS1 US7, US19, SS1 US18, US20 US19, SS1 US19, SS1, SS4 Technical Technical Technical	High High High High Medium Medium High Medium High	T2.2
Incentive	IMP.1	Technical	High	T2.3

Market-Place (IMP) DUPLICATE	IMP.2 IMP.3 IMP.4 IMP.5 IMP.6 IMP.7 IMP.8 IMP.9 IMP.10 IMP.11 IMP.12 IMP.13	SS3 Technical US13, US14, SS3 US15, SS3 Technical / WP6-req Technical US15 SS3 / WP4-req Technical Technical Technical / WP4-req DoW Ethical issues	High High Medium Medium Medium Low Medium High Low Low High High	
Experience Sampling Store (ESS)	ESS.1 ESS.2 ESS.3 ESS.4 ESS.5 ESS.6 ESS.7 ESS.8 ESS.9 ESS.10	SS1, SS5 City dashboard US17 SS1, SS5 US17 US17, SS1, SS5 US 17 US17, SS1, SS5 Technical US18	High Medium High High High Medium High Medium High Medium	T2.1
Relation and Identity Manager (RIM)	RIM.1 RIM.2 RIM.3 RIM.4 RIM.5 RIM.6 RIM.7 RIM.8 RIM.9 RIM.10 RIM.11 RIM.12 RIM.13 RIM.14 RIM.15 RIM.16	US2 US2 US2, US20 DoW, task description US2 DoW, task description US6, US15 US20 US15 US15 MPD Technical Technical MPD, ES IMP Technical	High High High High High Medium Medium Medium Medium Medium Medium Medium Medium Medium High High	T2.3
Privacy Manager (PM)	PM.1 PM.2 PM.3 PM.4 PM.5 PM.6 PM.7 PM.8 PM.9 PM.10 PM.11	DoW, Task description DoW, Task description Technical DoW, Task description SS1 Dow Ethical issue DoW Ethical issues DoW Ethical issues DoW Ethical issues DoW Ethical issues Technical	High Medium High High High High High High High High High	T2.3
Evaluation Support (ES)	ES.1 ES.2 ÈS.3 ÈS.4 ÈS.5	US12, SS1, SS2, SS4 US12, SS1, SS2, SS4 US12, SS1, SS2, SS4 US12, SS1, SS2, SS4 US12, SS1, SS2, SS4	High High High High High	T2.41
Infrastructure Network	INM.1 INM.2	US3, US10, US16 US3, US10, US16	High High	T5.2

Manager (INM)	INM.3 INM.4 INM.5 INM.6 INM.7	US3, US10, US16 US3, US4 US3, US4 US10 Technical	High High High Medium Medium	
Infrastructure Status Store (ISS)	ISS.1 ISS.2 ISS.3	SS1 US7, US11 US11	High High High	T5.2
Traffic Pattern Detector (TPD)	TPD.1 TPD.2	N/A N/A	High High	T5.2
Proxy & Authentication (pa)	PA.1 PA.2 PA.3 PA.4 PA.5	DoW, Website[8] PA.1 PA.1 PA.1 US.2	High High N/A High High	T5.2
Living Lab Controls & Evaluation (LLC)	LLC.1 LLC.2 LLC.3 LLC.4 LLC.5 LLC.6 LLC.7:	SS1, SS6 SS1, SS6, SS4 SS1, SS4 SS1, SS4 SS5 SS3 SS2	High Medium High Medium High High High	T5.2
User Web Portal (WP)	WP.1 WP.2 WP.3	SS5 SS1, SS4 SS3	High High High	T5.2

Table 27: Mapping of Use-cases to System components and system requirements

[8] http://www.tripzoom.eu/sps/

8 Conclusions

Indicators & Objective: The design of objectives and their indicators is strongly interlinked with WP3 (objectives) and WP6 (indicators for evaluation). Using the insights of [D3.1] 'Objectives,' section 3, we are able to identify the city user objectives for sustainability which are presented here. These objectives will function as input for WP6 where indicators for evaluation are being designed. All LLs cities have the core objectives and indicators to limit car vehicle use in cities despite the increasing trend, lower carbon emissions and a shift to greater use of public transport. In addition Leeds has specified goals and indicators for road safety. The precise indicators are difficult to compare across LL cities because the indicators may be different and calculated or projected over different time and distance spans etc.

Location Dependencies and Effects on Scenarios: the target user groups vary between LL cities but the focus was mostly on commuters rather than visitors. In Gothenburg the focus is more family commuting rather than on individuals. Enschede and Gothenburg tend to allow easier access to fixed infrastructure traffic sensor data rather than in Leeds. It is important to recognize that the survey gave outcomes by country, not by city and the respondents are therefore not necessarily or exclusively residents of the LL. However, the survey has shown some apparent differences between the countries, for example there is a much higher penetration of pervasive technologies of all types within the Swedish respondents than within those respondents from other countries. It was also indicated that the Swedish respondents are more likely to use a social network to find information on a specific topic than respondents from other countries.

User Scenarios and user requirements generation: The main criteria for the use of the scenarios was to show how the use of the proposed system related to the project goals: to promote the use of sustainability indicators; to support the use of existing social networks of participants and to promote social incentive driven changes in mobility patterns that together influence urban travel behaviour. There are two options how to develop city-based scenarios in SUNSET: to support a generic scenario across all LL cities; or to support each LL to independently specify its own scenarios (Table 12, Table 13); or some hybrid combination of these, e.g., a detailed generic scenario was specified and variations for LLs specified. The hybrid option was chosen because it enables a large common pool of services to be specified that can operate across LLs but adds the flexibility of supporting some LL specific variants. Scenarios were developed for two main types of actors: travellers and local transport authority stakeholders. Scenarios were analysed to highlight how they relate to the SUNSET Project Objectives. They were also analysed to compare and contrast scenarios across LLs. Some differences were identified, e.g., Leeds was not that interested in Ad hoc group Travel Offers etc. User

requirements were not generated from inputs from external user consultation because the focus was more on confirming the importance of system features and not on soliciting new requirements for system features from users.

User consultation: The user survey analyses presented represents the preliminary findings from the initial wave of stakeholder consultation and further data collection and analysis will be undertaken as part of the process of understanding user needs and requirements. The survey of over 130 respondents from a number of countries of residents has already highlighted some significant features for design of the system however. In particular it is clear that there are some differences in terms of use of social networks by country and by gender. Some types of incentive have emerged as being more likely to influence particular sub-groups than others, e.g., information about journey times, points offered through a game or competition is seen as useful for most sub-groups by age but loyalty points seem to be less useful. Different age groups have differences in transport related priorities and factors of importance. These initial findings will be taken forward in the design and implementation of the system.

Stakeholder consultation: The stakeholder consultation within the LL Enschede was conducted with the municipality of Enschede as the main urban transport authority. The sample was too limited at this stage of the project to profile user characteristics. Because the system is still in development and they not yet used a similar system before, it is difficult to rate the potential and the added value of the SUNSET dashboard.

User requirements derivation from scenarios and mapping to system requirements: user scenarios were re-structured from natural language into a list of features that equate to user requirements. The scenario was considered to be comprised of use-cases and these were equated to be sets of user requirements. Two practical issues is that user requirements tended to overlap across use-cases and concept names varied across use-cases. In addition, it was noted that users or customers focus on explicitly specifying the functional requirements and if these requirements are supported the customer is satisfied. Expected or implicit requirements may be so fundamental that users do not explicitly state them, e.g., data privacy. Several crosschecks were performed to crosscheck that use-case requirements were mapped to system requirements and vice versa, to the DoW system specification and to the project main goals.

To conclude, this deliverable has generated user requirements from a scenario analysis and mapped them to system requirements. It has gathered user feedback in two main consultations to show how the main proposed features of the SUNSET system are perceived by two main types of actor, travellers and transport authority stakeholders.

9 References

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10 Appendix: LL Variants of Generic Scenario

10.1.1 Enschede User Scenario

For the primary target groups (commuters in Enschede-West), the core scenario is valid for the Enschede LL. By focussing on a specific area, people have a lot in common concerning routes, working hours, parking availability, etc. Also, by involving employers, multiple employees of the same company (with a high chance of being friends on Facebook) will be involved.

Short bio of scenario character: Chantal is 37 years old, and a mother of 3, working part-time for an international tyre manufacturer. She travels a lot by bike for the shorter inner-city trips, but is easily persuaded to take the car in case of a tiny bit of rain. For the longer trips, she usually prefers the train for those cities having a train station at all. Her office times are flexible, as she shares the care for the kids with her husband. During the weekend they love to spend time walking and geocaching, and in the evening a good movie with a dinner for two. They almost have to take the car because they have to be in time for the babysitter, but luckily, her husband is a stereotype in his love for sports cars.

No.	Enschede User Scenario	Enschede explanations & limitations
US1	Chantal began by simply installing a **mobility monitoring** application that can run on her mobile phone.	Getting in touch with SUNSET is initially something that happens using the employer as a gateway, namely these employers which committed to the Twente Mobiel initiative want to deploy mobility management within their organisation.
US2	Chantal is a member of the SUNSET living lab for 3 weeks now. She was able to **re-use** a large part of her existing **local social networks** within the living lab. Her neighbour sees her joining SUNSET on Facebook, and decides to join too.	Enschede will use social networks to launch an attractive application that spreads through existing relations in social networks

US3	Within 2 weeks the SUNSET system has automatically determined an initial mobility pattern for Chantal from her actual travel behaviour in those weeks. 1st version contains a temporal overview of her modality choices (balance between public transport, car, bike, walking) and her frequent routes in the city.	As generic US3
US4	This pattern will be continually improving over time (e.g. with **regular shopping activity** after work),	As generic US4
US5	but already now she may receive first **recommendations from the living lab to carpool** with a colleague she only knows vaguely, who has a matching commuting pattern on Tuesdays and Wednesday.	These recommendations contribute to the Enschede goals, and should stimulate improvements on the indicators about less traffic jams, more public transport usage, and increased safety. These recommendations are issued from the city dashboard and presented to the user in the correct/appropriate mobility context.
US6	She **welcomes the suggestion to share the car** with John, and after some time **Chantal rewards John with a positive mobility recommendation** which is shown on his profile page.	As generic US6
US7	Chantal receives statistics about her public transport choices, personal traffic jam delays, CO2 emissions, and health indicators for the previous day, week and month. She sees that in her last weeks her car kilometres decreased in favour of more cycling and walking, which has a positive effect on both her emissions and health.	As generic US3 but note the previous “same day of the week” is interesting as well as the more normal meaning of the “previous day (of the week)”

US8	One day, a specific Monday, just before she planned to leave, she receives **a SUNSET suggestion to work from home** this morning, because all routes in her personal **commuter pattern are blocked**.	As generic US8. Also, road works will be input for the system to give users suggestions for changing their travel behaviour.
US9	This is **measured by other community members making hardly any progress on these routes** to their work, and that combined with information from road-side sensors, wherever available	As we focus on reaching all employees of the larger Enschede employers, we have significant groups of people all travelling to the same destination, with a substantial overlap in the chosen routes. Hence, we have the opportunity to allow inter-user learning during the morning rush hour.
US10	Chantal uses the SUNSET portal to see **some live webcams on her route**. Getting an automatic link to the most relevant traffic cam	Travel times can also be estimated from webcams observing license plates. And if a webcam is present along the route, it can also be used for visual confirmation.
US11	The webcams confirm the traffic jams and since her agenda allows it, she decides to work at home.	As generic US11
US12	Her employer, who participates in the SUNSET initiative, gets an **anonymised overview** of the travel times of all his employees and the trends therein.	As generic US12

US13	When the following Monday morning rush hours appear to be extremely busy, the SUNSET system offers incentives to Chantal to avoid rush hour on Mondays in the form of special services or rates, bonuses in the mobility game or cash money, depending on the party offering the incentive. Chantal takes the bike this time, because earning bike kilometres in the mobility game provides in the end a 50% reduction of the price of her new bike, paid by her employer.	Possibly, a SUNSET user who buys a bicycle can collect kilometres by using the new bicycle. When enough kilometres are travelled, SUNSET gives them a code they can use as a voucher for reduction on the next maintenance bill. Twente Mobiel offers specific campaigns to promote the e-bike, which might be linked here.
US14	On a Tuesday, when waiting in an unexpected traffic jam, she gets **a proposition** from a nearby business centre to work from there for a reduced tariff, **based on an incentive** of the business centre owner.	Integration in the app would be the best solution. Technical feasibility might result in a reduction code which can be used in the reservation-app of the business centre.
US15	On a Wednesday, she decides to take a bus to work reducing here carbon footprint and taking advantage of the dedicated bus lines in the city during rush hour. On entering the bus, she becomes part of the ad-hoc group 'travellers on line 3', and after a few trips also of the group 'frequent travellers on line 3', which results in a SUNSET reward.	Getting introduced to fellow passengers, might engage new friendships and therefore benefit personal well-being.
US16	When Chantal enters the bus (or train), the SUNSET application automatically recognizes the vehicle and line number, e.g. bus 2023 running on line 3. By doing so, Chantal can be automatically assisted by filling in the reimbursement form in case of delays or missing checkouts.	Normally these forms are 3 pages long and required information is hard to collect. SUNSET reduces this form filling activity to a mere press of the button, and Chantal receive her reimbursements much more easily. Another use is that incentives can now be targeted explicitly on frequent/occasional travellers of specific bus lines, or train/plane connections.

US17	After she returns home, she gets a few ultra-short questions on her mobile about using the late-evening buses of line 3. In general Chantal is happy with quality and speed of the connection, but she notifies that she already missed the last bus 3 times in the last month (and had to take an expensive taxi instead. It appears that on average 6 people have the same problem every night on that same line. This justifies an extra small-size night bus, which indeed solves the connection problem for Chantal in the following months. Immediate action by the local government and transport provider paid off, at least for Chantal.	The questions can be issued from the city dashboard of living lab control. This is also the place where all answers to the questions were analysed, and used as input to improve the system, to issue new incentives, et cetera.
US18	On Thursday, when Chantal leaves Enschede for a meeting in Amsterdam, she agreed to travel with a colleague by train. The SUNSET mobile app automatically informs the colleague that she is waiting for him in the 1st class compartment on the front-side and that the train leaves within 7 minutes. Luckily he makes it in time, and even brings a coffee for Chantal.	These status updates can contain direct links, e.g. to specific timetables, to vehicle descriptions, or to station maps.
US19	The living lab portal offers a number of widgets, e.g. to show her mobility patterns, environmental footprint, and progress on her personal goals, and the consequences of mobility such as personal health indicators and emission levels.	Widget might also be place-centric, and provide e.g. real-time information about available commute parking spaces, traffic disturbances, approx. travel time by car / public transport to the destination, available bicycles in the area.

US20	She can easily **re-use these widgets on personal websites** and the diverse social networks she is in, to show to non-community members how her impact on the mobility and environmental problems has been reduced over time.	Also a widget is available which sums the results of all (participating) employees, which might be used for a business competition of some sort.
US21	After a longer period of time, SUNSET **analyses her travel patterns**, and comes with suggestions for improvements saving Chantal time by avoiding avoidable delays and better modality choices, but also **offering directly applicable suggestions** for safer, more comfortable or more environmentally friendly transport, such as showing the gain if Chantal would have taken the bike for the shorter trips in good weather conditions.	This is typically an action the user can request in the SUNSET portal: analyse my history, and indicate where I can improve.
US22	**Safety is also improved** by the recommendations and reviews of other SUNSET users, who comment on her favourite routes and travel times, adding personal suggestions.	Using Facebook or other social media as an interface, but in the mean time keeping the information in a structured way so that it can be analysed automatically.

Table 28: Scenario for Enschede

10.1.2 Gothenburg User Scenario

For the primary target group commuters in the Gothenburg region, e.g. Torslanda or Lerum residential area, the core scenario may be valid for the Gothenburg LL (GBG LL), however with some refinements anchored in the situation in Gothenburg. As described in section 2.2 an on-going innovation program (K2020) aims toward shifting the commuters' behaviours to use cars to instead use public transport. Commuters state often state as an argument for using cars that it is the fastest means of transport to and from the work place and that it is the most flexible means of transport compared to the bus. The scenario below is based on the SUNSET core scenario however revised and focused based on the GBG LL situation.

Short bio of scenario character: The scenario is developed around Fredrik 35-40 years of age. He lives with his family (wife and two children 3 and 5) in an

owned house in a residential area outside Gothenburg (e.g. Torslanda or Lerum). He commutes every weekday to and from the City by car. His wife does this too. They have two cars in the household. Fredrik works as a manager and his wife Karin is physician at Sahlgrenska Hospital. Fredrik is the one who on Tuesdays and Thursdays drops of and picks up the children from the kindergarten (at 07:30, 17:00, respectively), on other weekdays his wife does this (same time). They both work full hours. Fredrik and his wife are members of Facebook.

No.	Gothenburg User Scenario	Gothenburg explanations & limitations
US1	Fredrik began by simply installing a mobility monitoring application that can run on his mobile phone.	Fredrik was pointed to the SUNSET applications via the 'help us to improve mobility' button on the RouteNet web site.
US2	Fredrik is a member of the SUNSET GBG LL for 3 weeks now. He was able to re-use a large part of his existing local social networks within the living lab. Her neighbour sees her joining SUNSET on Facebook, and decides to join too.	As generic US2
US3	Within two weeks the SUNSET system has automatically determined an initial mobility pattern for Fredrik from his actual travel behaviour in those weeks to and from the workplace. The first version contains a temporal overview of his modality choices (balance between car and walking) and his frequent routes to and from the city.	As generic US3
US4	This pattern will be continually improved over time (e.g. with **regular shopping activity** after work),	As generic US4

US5	…but already now he may receive first recommendations from the living lab to use public transportation (i.e. bus) on Mondays, Wednesdays and Fridays, when he does not drop of or pick up the kids on kindergarten.	As generic US4 but includes a stronger focus towards public transportation. This does not means that the focus on ride sharing in the core should be replaced in the GOT case. Both could exist. However there is and will be for teen years to come a huge focus on pushing commuters to better utilize existing public transport and leave their car at home. In 2013, a congestion charge will be implemented in GOT that is believed to stimulate a shift from cars to the use of public transportation to and from the inner city. Until 2025 the share of public transportation should be doubled compared to the volume 2006
US6	He welcomes the suggestion to shift to a bus on Wednesdays & Fridays. After some time a number of friends on Facebook, rewards Fredrik with a positive mobility recommendation that is shown on his profile page.	As generic US6
US7	Fredrik receives statistics about his public transport choices, personal traffic jam delays, CO2 emissions, and health indicators for the previous day, week and month. He sees that in the last weeks his car kilometres decreased in favour of more public transport and walking, which has a positive effect on both his emissions and health.	As generic US7

US8	One day, a specific Monday, just before he planned to leave with his car, he receives a SUNSET suggestion to use public transport (e.g. Bus line 234, 65 or 16) this morning, because the route in her personal commuter pattern are heavily congested and it is estimated that taking the bus (e.g.234) will reduce the expected travelling time with at least 20 minutes.	As generic US8; but the silent background must also monitor the public transport resources available.
US9	The traffic congestion is measured by other community members making hardly any progress on these routes to their work, and that combined with information from road-side sensors and real-time data of actual bus times.	As generic US9
US10	Fredrik uses the SUNSET service to see live webcams of his planned route. Getting an automatic link to the most relevant traffic cam	As generic US10
US11	The webcams confirms the traffic jams and since he gained time using the bus he decides to take the bus. He pays the ticket via the SUNSET service and is advised to the nearest bus stop perhaps via a commute parking place.	In the GOT scenario we have to stress that the user (Fredrik) has to go to the job; in the core scenario Fredrik stays at home
US12	Not applicable	Not applicable
US13	When the following Monday morning rush hours appear to be extremely busy, the SUNSET service offers incentives to Fredrik to avoid rush hour on Mondays in the form of special services or rates, bonuses in the mobility game or cash money, depending on the party offering the incentive.	No further comments. The incentives to be applied in GOT must be analysed

US14	On a Monday, when taking the bus to work, he receives a call from the kindergarten telling him that the one of the kinds are sick. Using the SUNSET service he is instantly advised how he can commute from work to the kindergarten and from the kindergarten to home with the use of public transport, and also how to buy SMS-tickets.	Surveys performed on commuters' behaviour in GOT points toward the conclusion that cars are used as they are perceived as more flexible and efficient in comparison to the bus if the planned everyday situation changes. The SUNSET service must be proven valuable for the user and support him or her to be order to handle changes in during everyday activities.
US15	On a Wednesday, he decides to take a bus to work reducing his carbon footprint & taking advantage of the dedicated bus lines in the city during rush hour. On entering the bus he is notified by SUNSET that he might join a group of people sharing their group ticket and thus save money on the ticket fare.	As generic US15
US16	Fredrik automatically receives information of the line that he travels when he uses the specific means of public transportation (or he receives a question asking him if he is on a certain route).	In order for this to work automatically the operator must publish route descriptions that the operator currently does not do. If this is not the case in the trial then the user should be able to himself register the route in order for the system to match incentives to specific bus lines and also type of travellers (frequent/occasional)
US17	Not applicable	Not applicable
US18	Not applicable	Not applicable
US19	The living lab portal offers a number of widgets, e.g. to show his mobility patterns, environmental footprint, and progress on his personal goals, and the consequences of mobility such as personal health indicators and emission levels.	As generic US19

US20	He can easily re-use these widgets on personal websites and the diverse social networks she is in, to show to non-community members how her impact on the mobility and environmental problems has been reduced over time.	As generic US20
US21	After a longer period of time, SUNSET analyses his travel patterns, and comes with suggestions for improvements saving Fredrik time by avoiding avoidable delays and better modality choices, but also offering directly applicable suggestions for safer, more comfortable or more environmentally friendly transport, such as showing the gain if Fredrik would have taken the bike for the shorter trips in good weather conditions.	As generic US21
US22	Safety is also improved by the recommendations and reviews of other SUNSET users, who comment on his favourite routes and travel times, adding personal suggestions.	As generic US22

Table 29: Gothenburg Scenario description

10.1.3 Leeds User Scenario

In Leeds the population that we wish to participate in the Living Lab trial are those who are time-poor and/or at a critical life-stage experiencing many stresses and changes to mobility patterns, such as families where both parents are employed (part-time and full-time) and young dependent children or children just starting school or in the first year, or with children who are just about to start being independently mobile, usually this will coincide with starting secondary school. The other criteria we wish to use in recruitment are (a) those living within the North West wedge of Leeds (this includes 6 districts) and a population estimated to be 142000 and (b) existing users of a smart phone, and (c) have a car available. The ongoing aim of the city council is to reduce demand for car travel and resultant C02 emissions to meet UK Govt. targets.

In addition a sample will be recruited from among people who work in the city centre. This sample will be taken from those who are employed by the

‘green employers’ group[9]. Participants will be selected on the basis that they also travel on the A61[10] to commute into work. Participants will be chosen to include those who are existing users of a smart phone, and have a car available. In addition we will recruit to ensure participants are from a range of life-stages including those with and without children.

Short bio of scenario character: The scenario is developed around a fictional caricature designed to highlight some of the criteria which are significant for sample recruitment but are not prescriptive. Jane is over 20 years old, and a mother with two children, working part-time, Tuesday and Wednesday in the city centre. She travels mainly by car. Her office times are flexible within core hours. Her partner works full-time. She shares childcare with her partner but she is the main carer. The household has a car available. The family members all have bikes but they rarely use them. The children are both young enough that they have to be looked after and are either in childcare or attend primary school. Jane has a smart phone and a Facebook page.

No.	Leeds User Scenario	Leeds explanations & limitations
US1	Jane began by simply installing a **mobility monitoring** application that can run on her mobile phone.	Recruitment around location of workplace, and use of A61 and S-D criteria. Leeds City Council has offered two webpage sites for recruitment of participants and access to a group of city centre located employers.
US2	Jane is a member of the SUNSET living lab for 3 weeks now. She was able to re-use a large part of her existing local social networks within the living lab. Her friend sees her joining SUNSET on Facebook, and decides to join too.	As generic US3. Recruitment also around social network involvement.

[9] The green employers group is a group of primarily larger employees who either have an obligation under current legislation to develop travel plans due to the size of the organization or who are otherwise committed to a sustainability agenda

[10] The A61 is a primary radial from Leeds city centre to the north of Leeds which is heavily used by commuters from major residential conurbations. Close to the city centre the A61 passes through less wealthy districts where the local authority has prioritized some improvements to PT provision such as increased frequency of buses, improved shelters and dynamic travel information. The A61 serves at least three significant destinations in the form of two schools and a large visitor attraction (historic house) in the outbound direction. The outermost destination is a wealthy town with high car ownership. A premium quality bus service is provided on the route. This is popular with a section of the population which has been historically difficult to convert to PT. something of a ‘subculture’ around the ‘Number 36 bus’ has developed. Other service providers also operate on this route

US3	Within two weeks the SUNSET system has automatically determined an initial mobility pattern for Jane from her actual travel behaviour in those weeks. The first version contains a temporal overview of her modality choices (balance between public transport, car, bike, walking) and her frequent routes in the city.	Data on travel patterns provided by SUNSET system for analysis by SUNSET partners and for viewing by participants. This data needs to be mapped. Analysis requires: spatial and temporal patterns; activities at stops; travel companions; travelling activities and preferences; cost(s); mode use; trip chain patterns. Would also want to survey participants on subjective understandings and activities.
US4	This pattern will be continually improving over time (e.g. with **regular shopping activity** after work),	As generic US4
US5	But already now she may receive first **suggestion** from the living lab which will include weblink to information about public transport from the primary school to the city centre with additional information about return journey times and costs and additional information about the health gains.	Data from personal automatic monitoring coupled with additional information from participant can be used to determine potential recommendations on travelling. Public transport data is available on web.
US6	She welcomes the suggestion to catch the bus and after some time Jane rewards rates the bus journey which is shown on her profile page.	As generic US6.
US7	Jane receives statistics about her public transport choices, personal traffic jam delays, CO2 emissions & health indicators for the previous day, week & month. She sees that last week her car kilometres decreased in favour of more bus use, which has a positive effect on both her emissions and health.	As generic US7

US8	One day, a specific Tuesday, just before she planned to leave, she receives **a SUNSET message indicating that the routes to the city centre are running very slowly and the suggestion to walk to work in the morning and use the bus for the return journey or to work from home for the morning**.	Unlike generic US8 Leeds will not have silent background monitor of system level performance. SUNSET would have to use the information from other users to determine the system performance.
US9	This is **measured by other community members making hardly any progress on these routes** to their work, and that combined with information from road-side sensors, wherever available	Leeds could test the sole use of personal automatic monitoring.
US10	Jane uses the SUNSET portal to see some live webcams on her route. Getting an automatic link to the most relevant traffic cam	Leeds can use the www.leedsliveinfo.com website for confirmation via webcams of travel conditions on main arterials and junctions of the transport network and can also link to monitoring of the strategic network for routes out of Leeds.
US11	The webcams confirm the traffic jams and since her agenda allows it, she decides to work at home.	Reliability of website needs to be tested prior to use in the SUNSET system and to build trust.
US12	Not applicable	Not applicable

US13	When the following Monday morning rush hours appear to be extremely busy, the SUNSET system offers incentives to Jane to avoid rush hour on Mondays. Incentives include gaining 'points' in a loyalty bonus style or in the form of achieving points against her own objectives for mode use and health. Jane parks in a different spot and walks further to the primary school for the journey to and from school and gains extra 'credits'/'points' for walking the children further.	In Leeds will be able to join in with the mobilities points system awarded for travel behaviour and offer actual monetary incentive but only on limited scale depending on allocated and available resource.
US14	Not applicable	Not applicable
US15	Not applicable	Not applicable
US16	Not applicable	Not applicable
US17	Not applicable	Not applicable
US18	Not applicable	Not applicable
US19	The living lab portal **offers a number of widgets, e.g. to show her mobility patterns**, environmental footprint, progress on her personal goals, & consequences of mobility such as personal health indicators & emission levels.	As Generic US19
US20	She can easily **re-use these widgets on personal websites** and the diverse social networks she is in, to show to non-community members how her impact on the mobility and environmental problems has been reduced over time.	Improving on mobility and its negative consequences is a community effort; more participants increase the impact, and (collaborative) progress is the reward for people's effort. In the widgets people can easily compare their behaviour with the average or the friend group, and also see progress in these groups.

US21	After a longer period of time, SUNSET analyses her travel patterns, and comes with suggestions for improvements saving Jane time by avoiding avoidable delays and better modality choices, but also offering directly applicable suggestions for safer, more comfortable or more environmentally friendly transport., such as showing the gain if Jane would have taken the bike for the shorter trips in good weather conditions.	In Leeds can offer information on walking and cycling easily as alternatives to some travel but more difficult to include public transport alternatives due to scarcity of pt real-time information and parking spaces information.
US22	**Safety is also improved** by the recommendations and reviews of other SUNSET users, who **comment on her** favourite routes and travel times, adding **personal suggestions**.	As generic US22

Table 30: Leeds scenario description

11 Appendix: Types of External User Consultation that could be Undertaken by SUNSET

The types of Types of possible external user consultation that could be undertaken by SUNSET are described in detail in Table 31.

WP	Purpose of consultation	Target sample and Sample size	Type of survey	Data collected	Recruitment strategy	Lead partner and Delivery	Cost implications
WP1, WP2	(a) system functionality (what it will provide to travellers & how it may be used)	Travellers who have never used a SUNSET type system. Disaggregate by population subgroups (age, gender, h/hold type etc.), geographic area.	1.Questionnaire or focus group (with presentation, example screens or other materials). The group would be purposefully selected with known characteristics. 2. on-line questionnaire to known target groups & to 'open' community.	1. qualitative feedback on stated preferences & concerns, creative input on design 2. both qualitative & quantitative feedback from on-line questionnaires. Some key characteristics of respondents will be needed to analyse the data. Some data may be	Sample from all three LL as first priority. This will need purposeful sampling using established email lists, websites, major employers or existing cohort contact data. Open sample under (2) will generate	1. Leeds with Enschede, Gothenburg. No of groups, no of people in groups & exact recruitment to be designed. A standard set of focus group materials could be developed then translated/delivered in local language. Focus group materials would need agreement in consortium first. 2. Suggest WP2 takes a lead on developing software for questionnaire, with	1. Development of focus group materials should be within WP budgets. Recruitment & incentivisation costs for participants to be determined. 2. development of content & software for on-line questionnaire should be

				poor quality. Geographic distribution of responses may be unpredictable &/or suboptimal.	data from outside the LL areas.	question content led by Leeds & agreed by consortium.	feasible in project budgets.
		Travellers who have some exposure to a SUNSET type system. Disaggregate by population subgroups (age, gender, h/hold type etc.), geographic area	1. focus group (as above) 2. on-line questionnaire to known target groups (as above)	1. Qualitative feedback on functionality preferences & concerns, creative input on design. Comparison data against existing apps. 2. both qualitative & quantitative feedback on functionality from on-line questionnaires. Comparison data against existing apps.	Sample from Enschede & Gothenburg as first priority i.e. from IZONE & ISET users. This will need purposeful sampling using established websites or existing cohort contact data.	Enschede & Gothenburg with advisory input from Leeds Materials from (1) & (2) above could be adapted to reflect prior exposure to a system. Would also need 'local amendment' for differences between IZONE & ISET.	As above

WP	Purpose of consultation	Target sample & Sample size	Type of Survey	Data collected	Recruitment strategy	Lead partner & Delivery	Cost implications
WP 1, WP 2	(b) Perspectives of high level policy makers e.g. NGO (policy acceptability & support for the system, publicity & awareness raising)	A range of high level NGO, local transport providers, representatives from transnational organizations with a transport portfolio. Ideally some axis of homogeneity within the sample & heterogeneity between. No min or max sample size. Aim to cover three LL regions plus transnational as a min.	Questionnaire or presentation & feedback on key overview questions (feasibility, achievement of objectives etc.)	Qualitative feedback & indicator/scores. This data will have a high degree of subjectivity & be of low precision.	Groups are difficult & expensive to convene for consultation only purposes. Data gathering using meetings & groups convened for other purposes.	Leeds will lead the synthesis of outcomes. All consortium partners can deliver this. It would be possible to generate a 'standard presentation' & circulate in the consortium.	No additional costs, should be feasible within consortium budgets for travel & dissemination.

WP	Purpose of consultation	Target sample & Sample size	Type of Survey	Data collected	Recruitment strategy	Lead partner & Delivery	Cost implications
WP 5 WP 2, WP 1, WP 4	(c)The interface of the application/system (how useable the software interface is)	Traveller groups disaggregate by population subgroups (age, gender, etc.), geographic area. Likely to involve four age bands, both genders, three socio-economic groups, three LL regions. Total sample ideally 100 in each of three regions, but feasible results achievable with less.	1. Would involve testing the user interface with tablet/phone in either individual or group interviews. Would need alternatives to test (preferably with some dynamic function but not necessarily live system). 2. Experience sampling (from WP2 architecture) may also produce information	Largely qualitative responses that would feed directly into interface design.	Could be either individuals or focus groups. Could be same group(s) as (b)	Development of presentational materials by WP2/WP4? Working with Leeds, Gothenburg & Enschede in execution of consultation	Materials to be developed within current WP resources. Consultation costs to be determined, including incentivisation of participants.

WP	Purpose of consultation	Target sample & Sample size	Type of Survey	Data collected	Recruitment strategy	Lead partner & Delivery	Cost implications
WP3	(d) Alternative types of incentives (as part of the design of the incentives & understanding the behavioural responses)	Design of this consultation an inherent function of WP3	Type of survey to be determined by WP3	Data type will be intended to generate modeling outcomes, as determined by WP3	Recruitment can benefit from principles & process established in (b) & (c) as appropriate, but must be design led	Leeds to lead, other WP3 contributors as agreed.	Resources currently within WP but will be better specified by design.

WP	Purpose of consultation	Target sample & Sample size	Type of Survey	Data collected	Recruitment strategy	Lead partner & Delivery	Cost implications
WP 2, WP 3, WP 4, WP 6 WP 7	(e) Testing & evaluation of the SUNSET system as a prototype (to provide a feedback loop on design, functionality, incentives offered)	1) Consortium members for rough prototype. 2) External recruits for beta version. 3) Small sample of LL recruits in early stages of LL	Consultation would involve a preliminary but functioning version of the system. Transport by different modes should be tested. All three LL should be tested as geographic areas. Experience sampling (from WP2 architecture) may also produce information	Qualitative data relating to design & use (most probably by interview or in person feedback, may be possible by on-line survey for these users only or direct experience sampling through the device?). Crude quantitative data to assess evaluation needs (presume this would be by automatic collection through device).	(1) should be readily achievable (2) could use repeat focus group from (b) which would provide more rigorous outputs, alternatively student groups, workplace colleagues etc. (if cost basis determines, but less rigorous outputs) (3) would be part of the design of WP7	Is this a WP2/WP4/WP5 lead? (partners to comment). Other contributors from WP2, WP3, WP6, WP7	Design & production of prototype assumed within current project resources. Cost of recruitment: (1) no cost, (2) & (3) at cost to be determined

WP	Purpose of consultation	Target sample & Sample size	Type of Survey	Data collected	Recruitment strategy	Lead partner & Delivery	Cost implications
WP 7, WP 6	(f) Testing & evaluation of the SUNSET system within the LL	Design of this consultation an inherent function of WP7 & WP6. Should ensure it covers the social network aspect of the system.	Recruitment to LL to be designed by WP7	Data type will be intended to generate outcomes, as determined by WP6	Recruitment should be design led	WP7 partners to lead	Most resources are currently within WPs but others may not be e.g. recruitment. Will be better specified in design.

WP	Purpose of consultation	Target sample & Sample size	Type of Survey	Data collected	Recruitment strategy	Lead partner & Delivery	Cost implications
WP 5, WP 3	(g) Ground truth the business case for a SUNSET type system	Design of this consultation an inherent function of WP5. Focused around businesses & other enterprises that may offer incentives or appreciate the commercial potential of the system.	Type of survey to be determined by WP5	Data type will be intended to inform the development of a business case but also act as a 'reality check', as determined by WP5	Recruitment can benefit from principles & process established in (b) & (c) as appropriate, but must be design led	Leeds to lead? other WP5 contributors as agreed. WP3 may interface	Resources for materials currently within WP. Resources for consultation will be better specified by design.

Table 31: Types of consultation that can be undertaken by SUNSET

12 Appendix: Main User (Traveller) Survey

The SUNSET application is based around the idea that social networks can be a great way for travellers to share information about their journey and benefit from 'live' information from others. It uses a completely new approach by offering personal incentives to encourage a range of different travel options that benefit the traveller whilst making the environment 'greener'. It has a fun element in that travellers can check their progress against individual targets - such as improving their health by their travel choices - and also by competing with others in the social network with SUNSET points for sustainable choices.

You can find out more about SUNSET in our factsheet.

We want to know about the views of a wide group of people so that SUNSET can be designed to work for everyone. Please take some time to let us know what you think and thank you in advance for your time. The questionnaire will take around 20 minutes or so.

Next to some statements there are five boxes. If you completely disagree with the statement, you should mark the first box. Mark the central box if you really are neutral, cannot decide or just cannot make up your mind. Mark the rightmost box if you totally agree with the statement. If you do not want to indicate strong agreement or disagreement but just your general feeling most of the time, use the boxes to the left or right of the centre. Please indicate importance of the provided answer if requested.

Tell us about yourself!

1. Are you male/female?	male female
2. What is your age group?	under 18 18-21 21-30 30-55 55+
3. Which is your country of residence?	Netherlands United Kingdom Sweden Germany other EU country other non-EU country
4. What type of neighbourhood do you live in?	urban suburban rural island other
5. Which of the following mainly applies?	employed home based in full time education other

6. Do you have access to any of the following devices?	mobile phone, without data connection smartphone laptop/netbook PC tablet
-. How often do you use the following devices?	« never --- often »
7. Mobile phone, without data connection	-- ++
8. Smartphone	-- ++
9. Laptop/Netbook	-- ++
10. PC	-- ++
11. Tablet	-- ++

Use of social network sites (Facebook, Twitter, etc)

12. Have you ever used a social network site?	yes - continue with question 15 no do not know
13. Please share your reasons why not (optional)	not sure how to get started find it too complicated worried about sharing information/privacy don't have time other reasons
14. If other reasons, what are they?	
15. Would you use your mobile phone to log in to social networking sites (if your phone has the facility)?	yes no - continue with question 19 maybe
16. What is (or would be) the main purpose in visiting a social network site?	find friends keep up to date with friends find information on a specific topic find shopping offers travel tips real-time chat other
17. If other, please specify	
18. How often do you upload status updates, information, photos or comments?	daily few times per week once a week few times per month

- rarely
- never

Use of mobile applications (apps)

19. How often do you download apps through your smartphone?	daily few times per week once a week few times per month rarely never - continue with question 30
20. How many apps have you installed on your smartphone currently?	0 1-10 10-50 50-100 100+
--. What are the reasons you have chosen to download an app in the past?	« not important --- highly important »
21. Verbal recommendation by a friend, someone at work or similar	-- ++
22. Recommendation through a social network message	-- ++
23. Advert or review eg on TV or in a magazine	-- ++
24. Advert or review on a social network, webpage or similar	-- ++
25. Browsed through an app store or market	-- ++
26. Wanted something for a specific task eg banking	-- ++
27. Please indicate any other reasons you might have	
28. What type of apps do you like to download?	games information socialising hobbies sports music shopping offers travel
29. Please indicate any other types of apps you use regularly	

Some questions about your travel

30. Do you have family or other dependents that you travel with, either usually or occasionally?	no yes - usually travel together

	☐ yes - occasionally travel together
31. Which of the following means of transport does your household possess?	☐ car ☐ motorcycle ☐ moped ☐ scooter ☐ bicycle ☐ other
32. If other, please elaborate	
33. Do you use public transport (bus, train, tram, boat, plane, taxi, other) for travel during a week?	☐ daily ☐ few times per week ☐ once a week ☐ few times per month ☐ rarely ☐ never
34. Do you use the following means of transport within the household (car, motorcycle, moped, scooter, bicycle, other) for travel during a week?	☐ daily ☐ few times per week ☐ once a week ☐ few times per month ☐ rarely ☐ never

The next questions are about your considerations in making your trip. The first set deals with regular trips such as commuting, childcare or regular appointments. The second set of questions concerns about incidental trips, such as tourism and visiting.

--. How important are the following factors to you for your regular journeys/commute?	« not important --- highly important »
35. Distance	-- ☐ ☐ ☐ ☐ ☐ ++
36. Health	-- ☐ ☐ ☐ ☐ ☐ ++
37. Cost	-- ☐ ☐ ☐ ☐ ☐ ++
38. Reliability	-- ☐ ☐ ☐ ☐ ☐ ++
39. Comfort	-- ☐ ☐ ☐ ☐ ☐ ++
40. Convenience	-- ☐ ☐ ☐ ☐ ☐ ++
41. Safety	-- ☐ ☐ ☐ ☐ ☐ ++
42. Travelling in a 'green' sustainable way	-- ☐ ☐ ☐ ☐ ☐ ++
43. Ability to travel easily with family, luggage etc	-- ☐ ☐ ☐ ☐ ☐ ++
44. Freedom to choose departure time	-- ☐ ☐ ☐ ☐ ☐ ++
45. Freedom to influence arrival time	-- ☐ ☐ ☐ ☐ ☐ ++
46. The reliability in your arrival time	-- ☐ ☐ ☐ ☐ ☐ ++
47. Please rank the relative importance of these factors / data for you (1,2,3, where 1 is the most important)	1. none 2. none 3. none

--. How important are the following factors to you for your other travel?	« not important --- highly important »
48. Distance	-- ++
49. Health	-- ++
50. Cost	-- ++
51. Reliability	-- ++
52. Comfort	-- ++
53. Convenience	-- ++
54. Safety	-- ++
55. Travelling in a 'green' sustainable way	-- ++
56. Ability to travel easily with family, luggage etc	-- ++
57. Freedom to choose departure time	-- ++
58. Freedom to influence arrival time	-- ++
59. The reliability of your arrival time	-- ++
60. Please rank the relative importance of these factors / data for you (1,2,3, where 1 is the most important)	1. none 2. none 3. none

Travelling and apps

61. Have you ever used any travel apps?	yes no - continue with question 64
62. If yes, which ones (optional)	Foursquare Waze Facebook Places Cheqqer Yelp TravelWatcher Road navigation apps Hiking apps Public transport apps Petrol pricing apps Parking apps Flight and airport apps Camping and hotel apps other
63. If other, please name them	
--. Which of the following information would be useful for you on a travel application	« not very useful --- extremely useful »

64. Traffic jams on your route	-- ☐ ☐ ☐ ☐ ☐ ++
65. Train / bus / tube delays or cancellations	-- ☐ ☐ ☐ ☐ ☐ ++
66. Parking space availability	-- ☐ ☐ ☐ ☐ ☐ ++
67. Weather information	-- ☐ ☐ ☐ ☐ ☐ ++
68. Expected journey time	-- ☐ ☐ ☐ ☐ ☐ ++
69. Alternative ways to make the journey or comparisons between alternatives	-- ☐ ☐ ☐ ☐ ☐ ++
70. The 'green score' for the journey	-- ☐ ☐ ☐ ☐ ☐ ++
71. Other people who made/make/will make the same journey	-- ☐ ☐ ☐ ☐ ☐ ++
72. Please indicate any other type of information you would consider useful	

--. If the travel information was given through a social network where travellers can post updated information, which of the following statements would you agree or disagree with?	« strongly disagree --- strongly agree »
73. I would be willing to believe the information posted	-- ☐ ☐ ☐ ☐ ☐ ++
74. I would be willing to believe the information posted if there were many similar messages	-- ☐ ☐ ☐ ☐ ☐ ++
75. The information could be far more up to date than that given out otherwise e.g. on the radio	-- ☐ ☐ ☐ ☐ ☐ ++
76. I would be willing to post messages about my own travel experience	-- ☐ ☐ ☐ ☐ ☐ ++
77. There could be problems with everyone changing their route or mode of travel at the same time	-- ☐ ☐ ☐ ☐ ☐ ++
78. Posting messages might help people travel in a more 'green' way e.g. by avoiding congestion	-- ☐ ☐ ☐ ☐ ☐ ++

Information and incentives

--. Would any of the following information or incentives be likely to have an impact on your travel habits or cause you to change the way you travel?	« no impact likely --- strong likelihood of an impact »
79. Information about journey times	-- ☐ ☐ ☐ ☐ ☐ ++
80. Information about health benefits or a 'health score' from travelling differently	-- ☐ ☐ ☐ ☐ ☐ ++
81. Information about the 'green score' of your journey	-- ☐ ☐ ☐ ☐ ☐ ++
82. Information about how you could improve your trips in terms of costs, time and green score, given your travel choices of the last month	-- ☐ ☐ ☐ ☐ ☐ ++
83. A game/competition for points, won by changing the way you travel	-- ☐ ☐ ☐ ☐ ☐ ++
84. Points for a national loyalty scheme which can be exchanged for different goods and services	-- ☐ ☐ ☐ ☐ ☐ ++
85. Discounts on other ways of travelling, e.g. bus or train	-- ☐ ☐ ☐ ☐ ☐ ++
86. Discount vouchers for shopping or local stores	☐ ☐ ☐ ☐ ☐

	-- ++
87. Qualify for (group) discounts by travelling together in a temporary group	-- ++
88. Being part of a social network with people who have similar travel habits	-- ++
89. Becoming the virtual 'mayor' of a road, place or public transport line	-- ++
90. If you became a participant in the SUNSET project, how would you prefer to receive your information?	as a mobile app via a web portal through Facebook or the like as a desktop application

Thank you!

Thank you for helping us by taking part in the questionnaire, a few final questions below.

91. Would you have any specific suggestions for SUNSET developers?	
92. Do you have a relative/friend living or working in the local area to recommend to participate in this survey? If yes, please provide contact details (name and email) here	
93. Would you like to take part in the main SUNSET application conducted in	Enschede Gothenburg Leeds No thanks
94. Do you have a relative/friend to recommend to participate in the main SUNSET application? If yes, please provide contact details (name and email) here	
95. If you would wish to participate in the actual trial of the SUNSET application in your area within the next 12 months, please provide contact details (name and email) here	

All information provided through this questionnaire will be used only to develop the SUNSET application and will not be shared with any other organisation for commercial purposes. Your personal data are protected through national and (EU privacy regulations). If you would like to participate in the actual trial of the SUNSET application and take advantage of its benefits at your area, you may indicate this at the end of this questionnaire. In case you need assistance or have any specific queries about completing the survey, you may contact: Susan Grant-Muller.

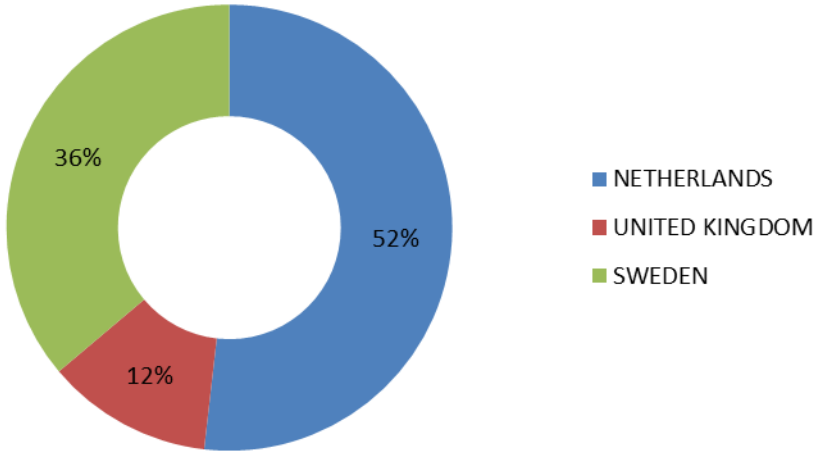


Figure 18: Nationality of Male respondents

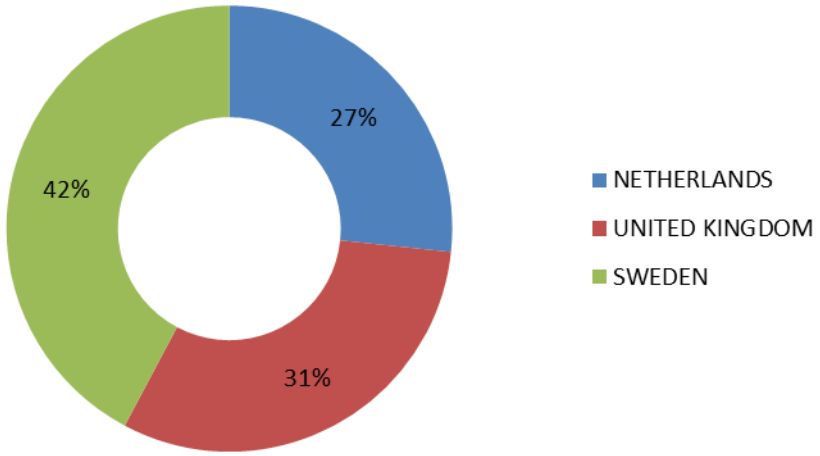


Figure 19: Nationality of Female respondents.

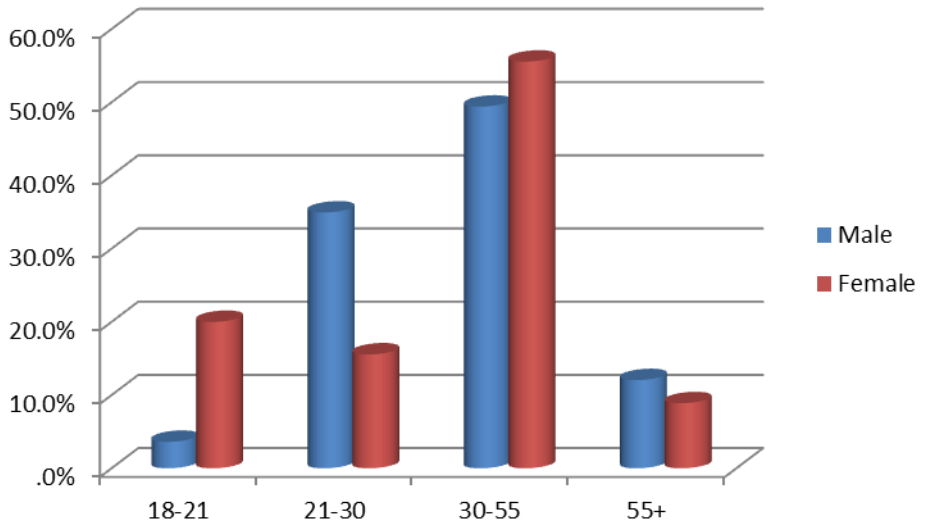


Figure 20: Age distribution of respondents

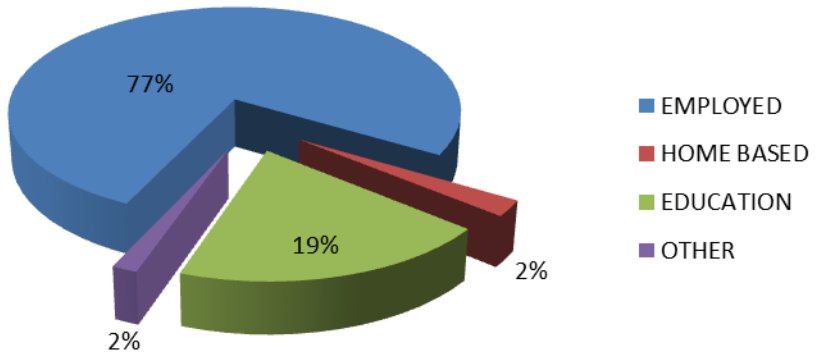


Figure 21: Occupation of respondents

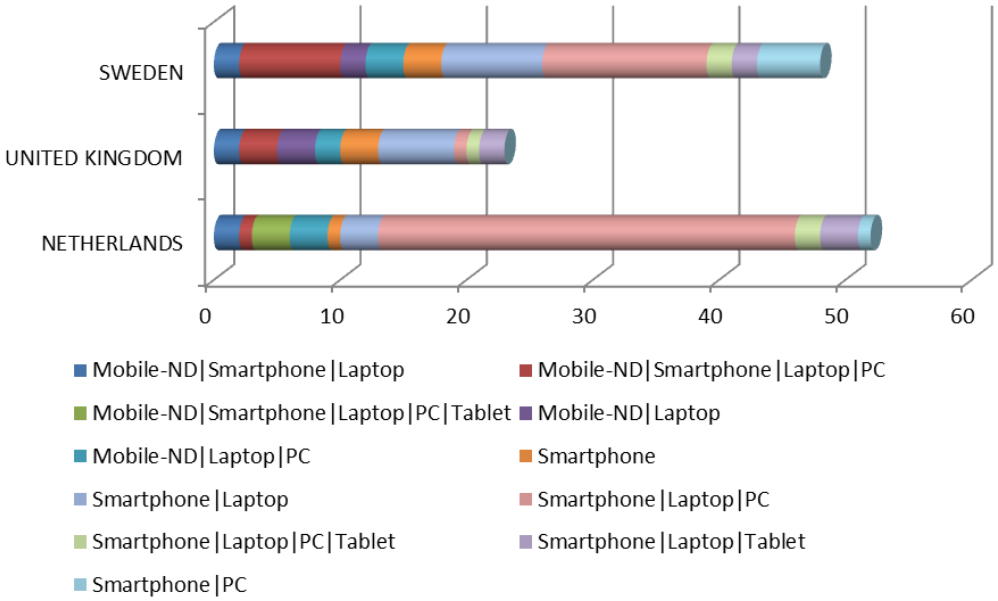


Figure 22: Breakdown of device availability by country

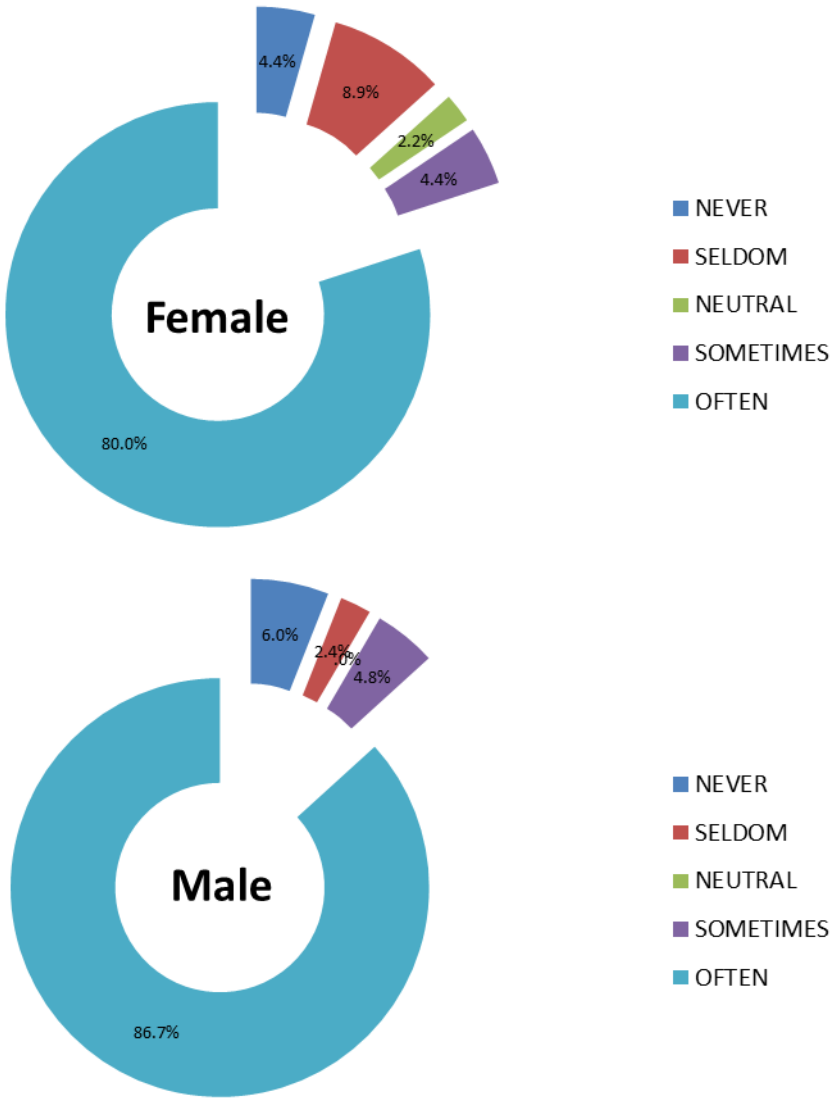


Figure 23: Smart phone use by Gender

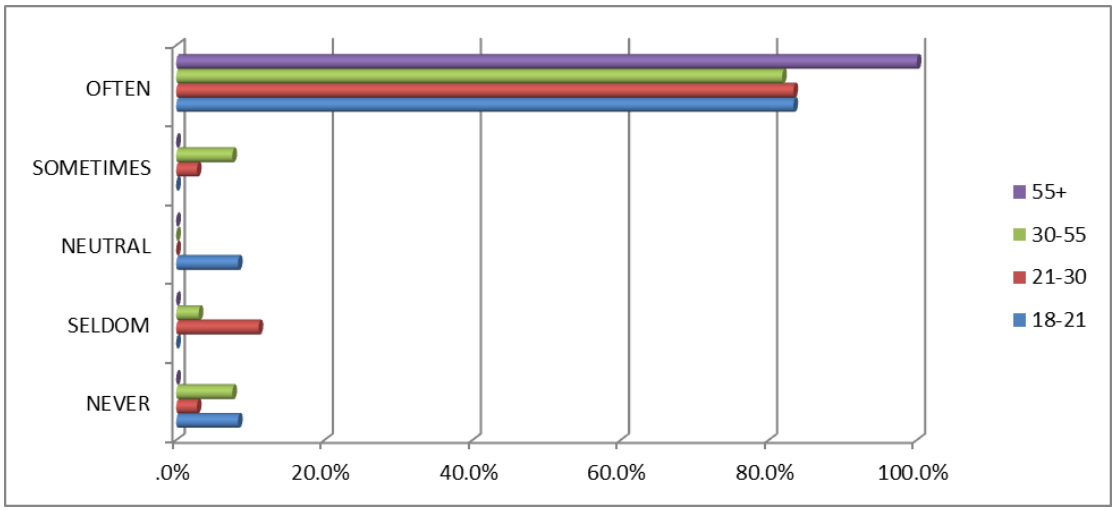


Figure 24: Smart phone use by age

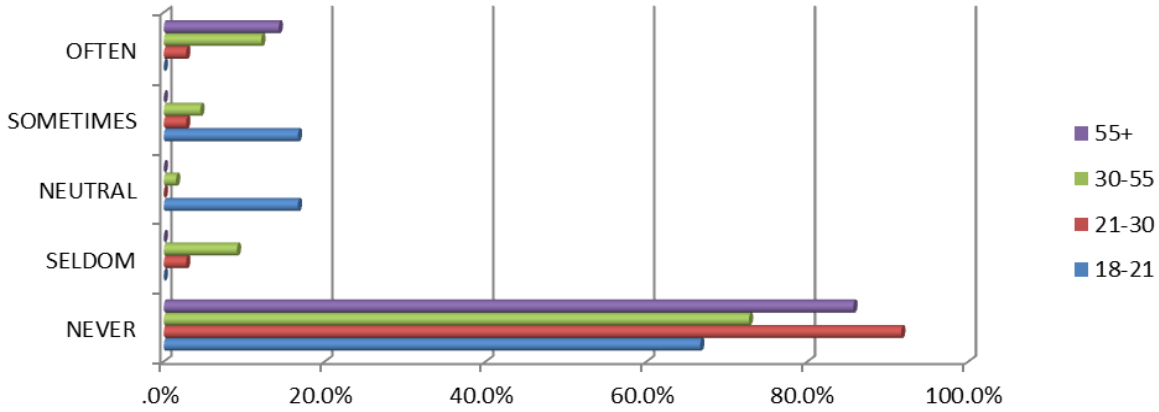


Figure 25: table use by age

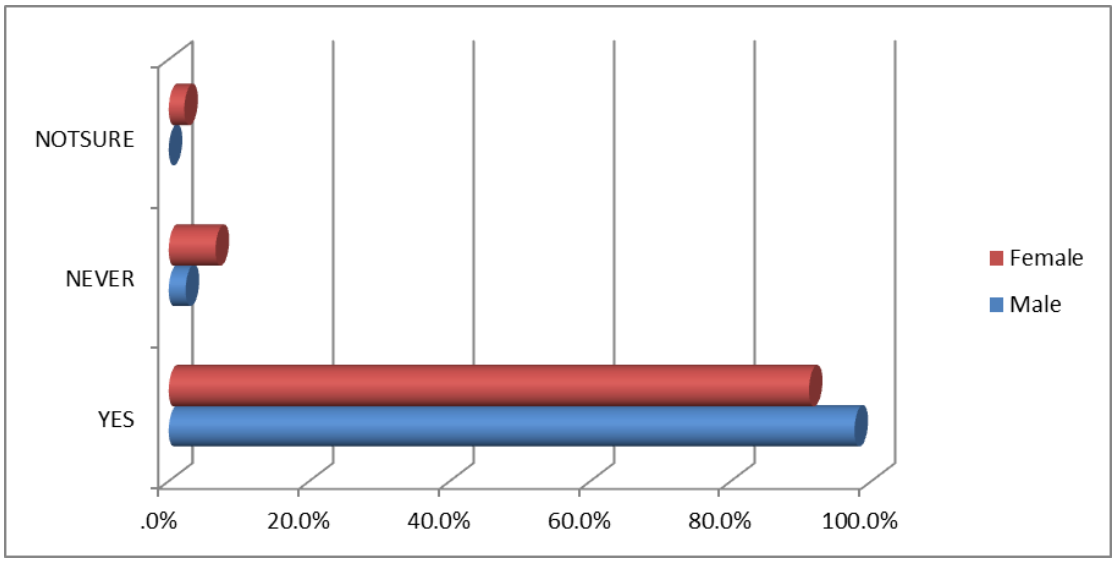


Figure 26: Social Network use by gender

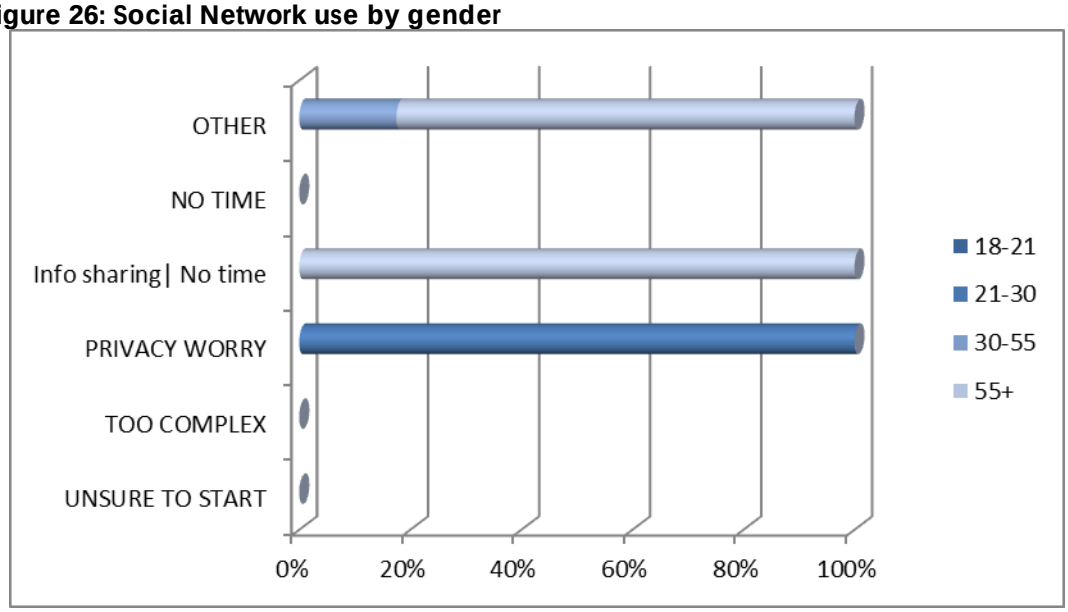


Figure 27: Reasons for not using Social networks

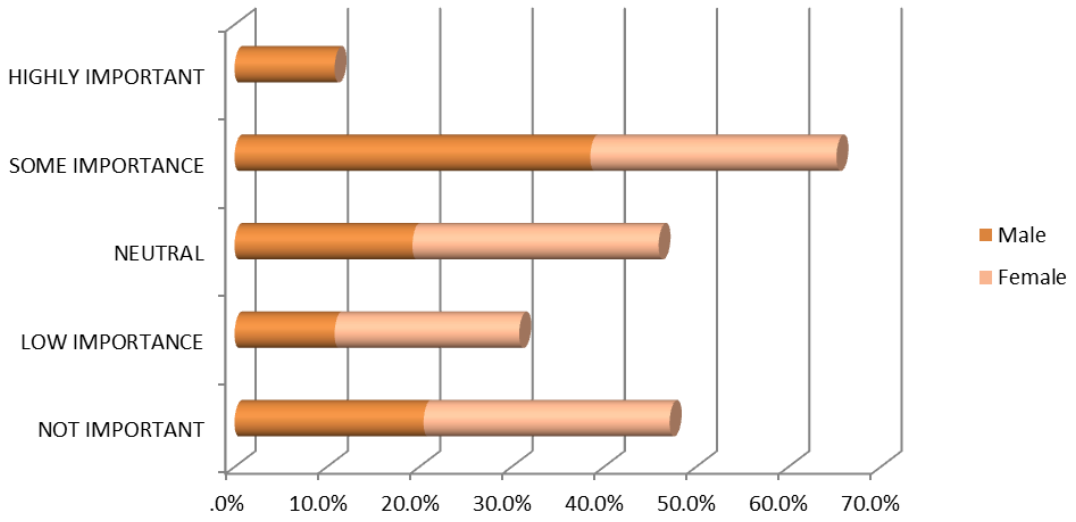


Figure 28: Importance of general advert in decision to download an app

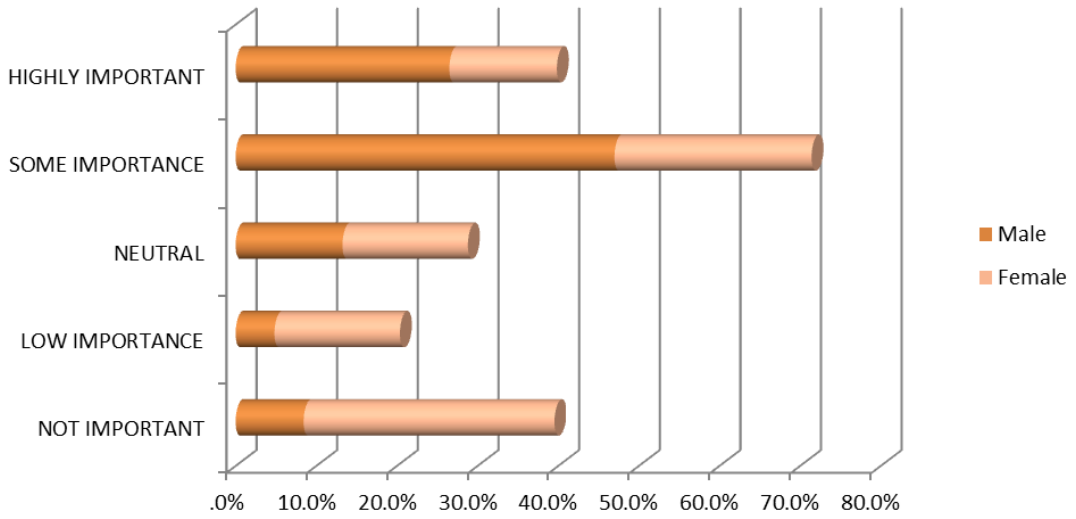


Figure 29: importance of browsing the app store in decision to download an app

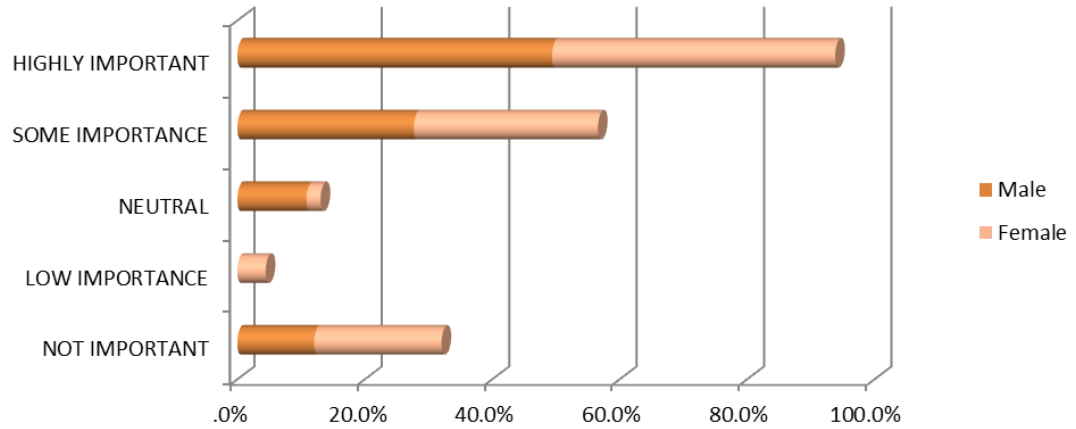


Figure 30: importance of needing an app for a specific task in decision to download

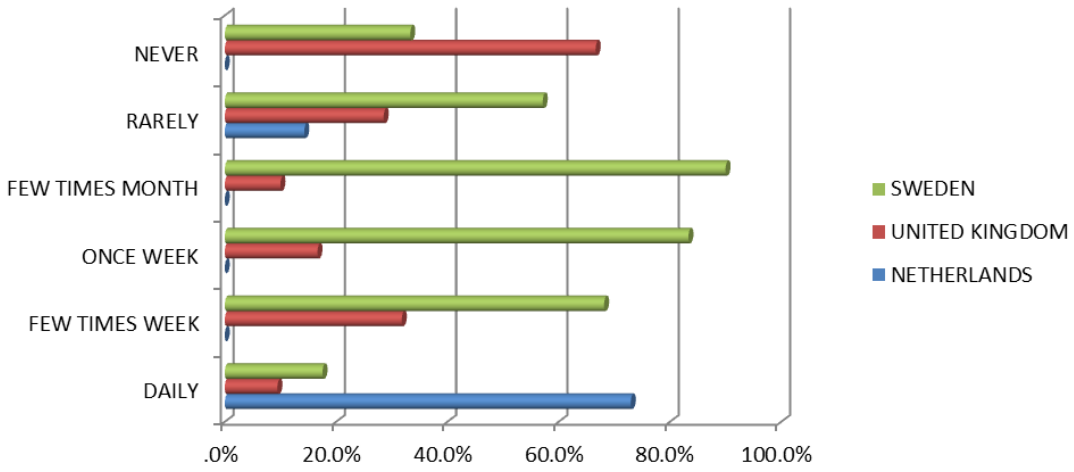


Figure 31: Non-PT use for mid-week travel

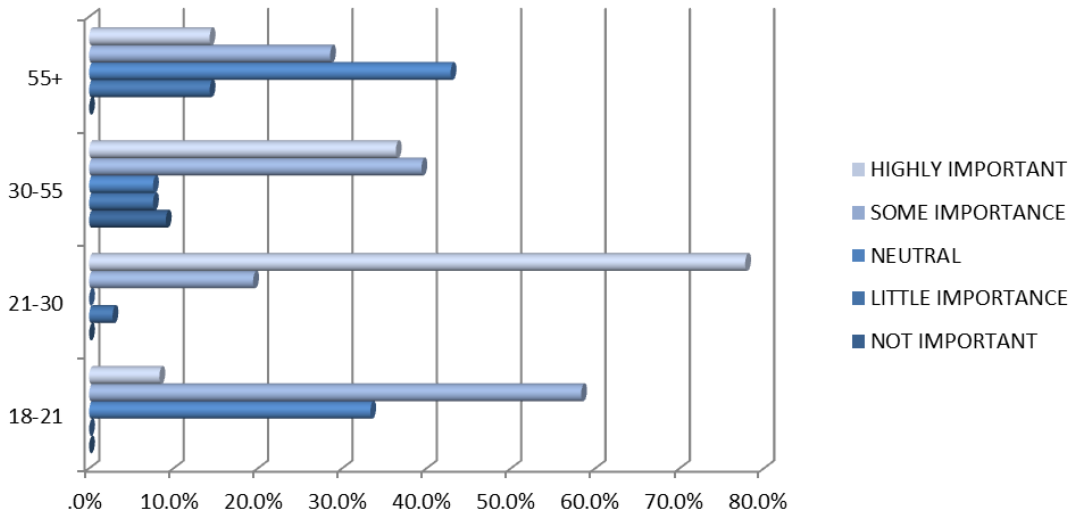


Figure 32: Reg. Trips Distance Importance (by age-group)

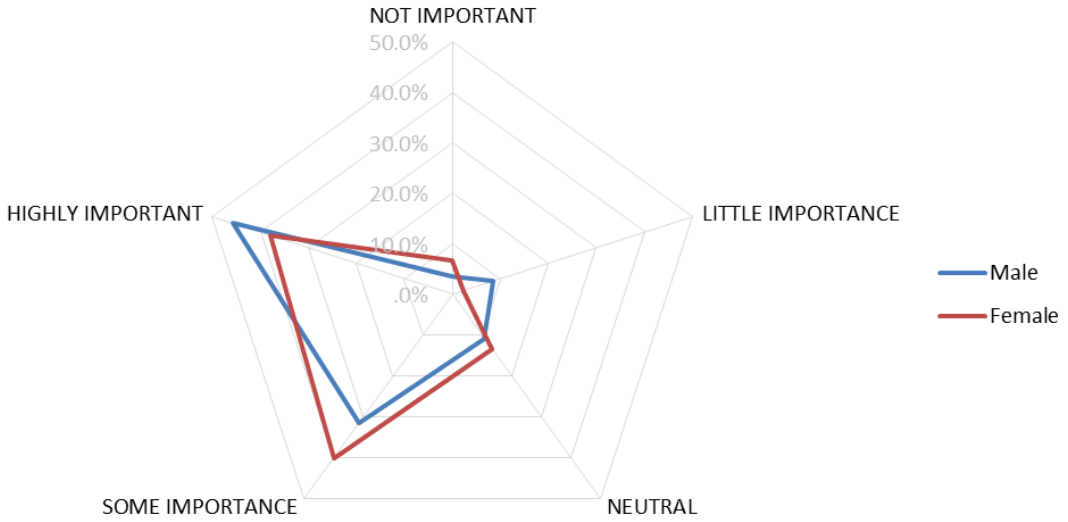


Figure 33: Reg. Trips Distance Importance (by gender)

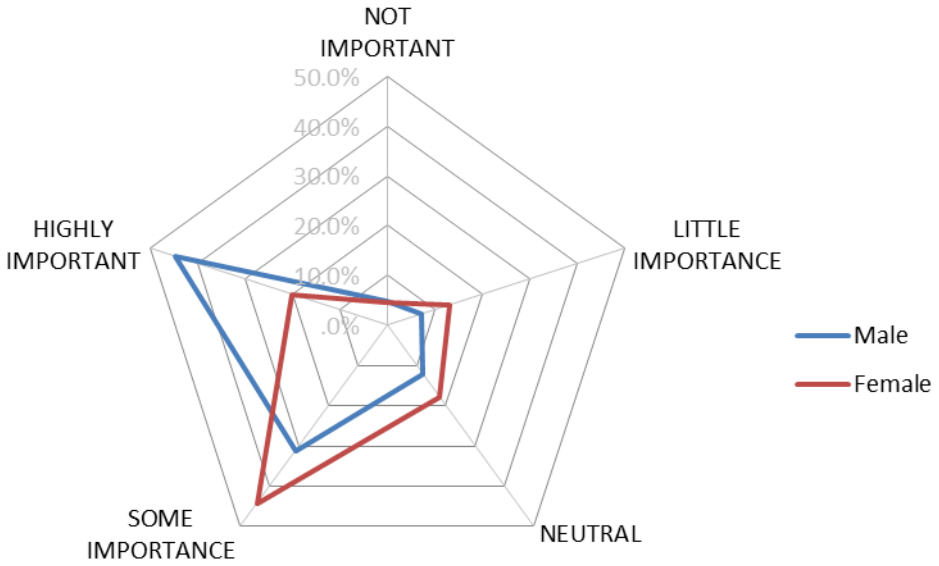


Figure 34: Reg. trip Cost Importance (by gender)

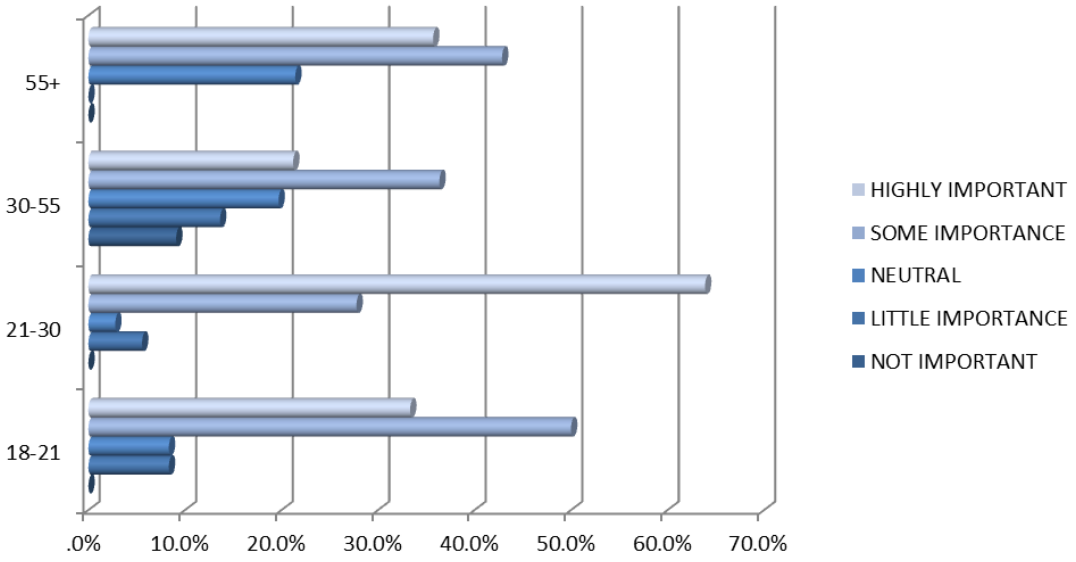


Figure 35: Reg trip Cost Importance (by age-group)

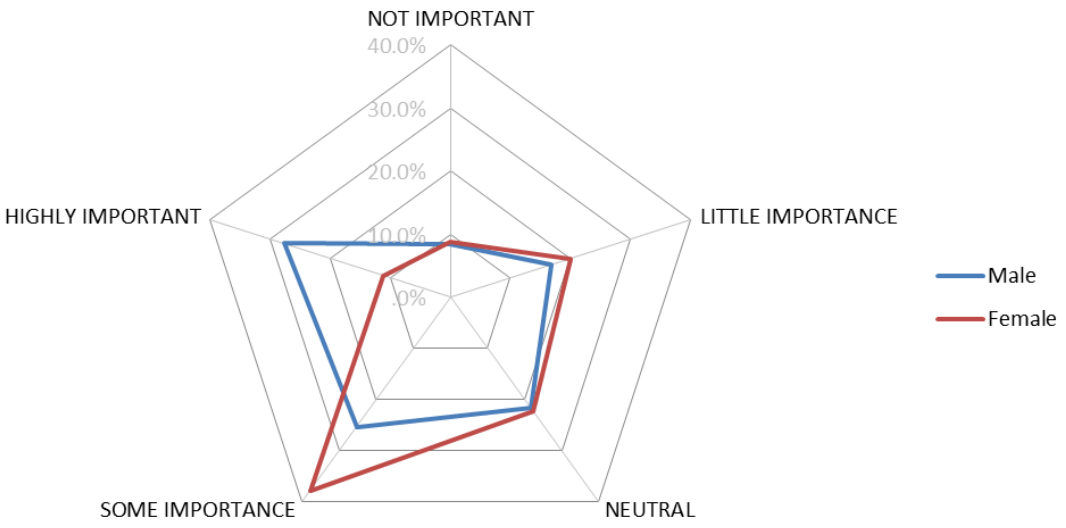


Figure 36: Reg trip Health Importance (by gender)

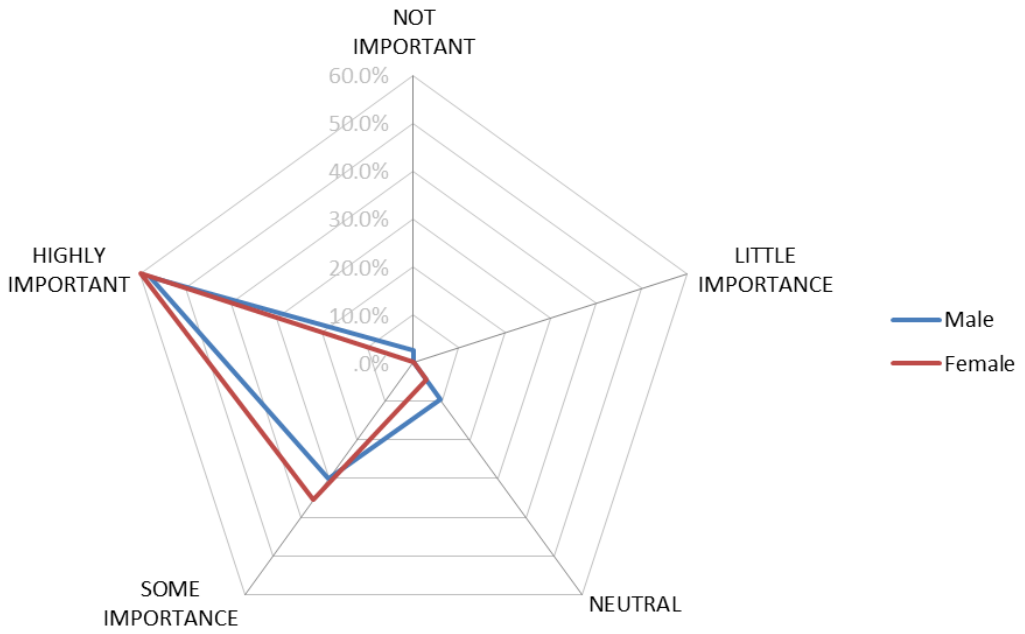


Figure 37: Reg. trip Reliability Importance (by gender)

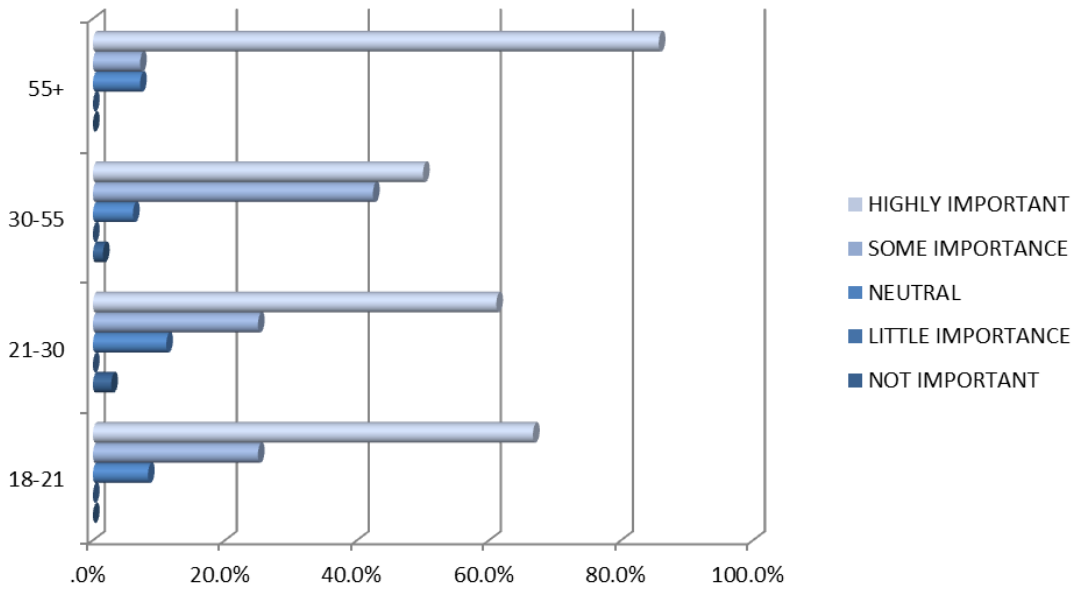


Figure 38: Reg. trip Reliability Importance (by age-group)

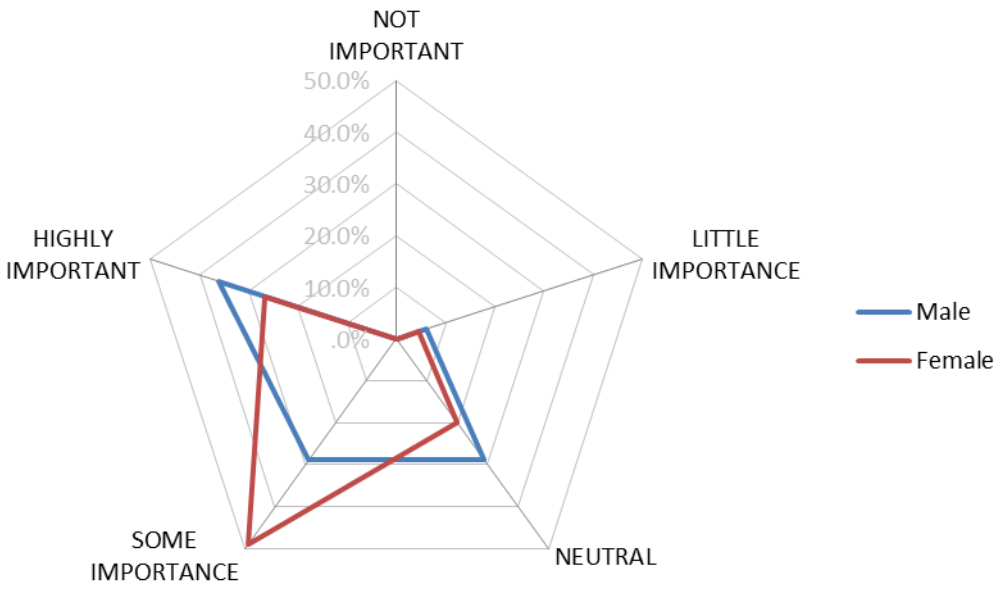


Figure 39: Reg. trip Comfort Importance (by gender)

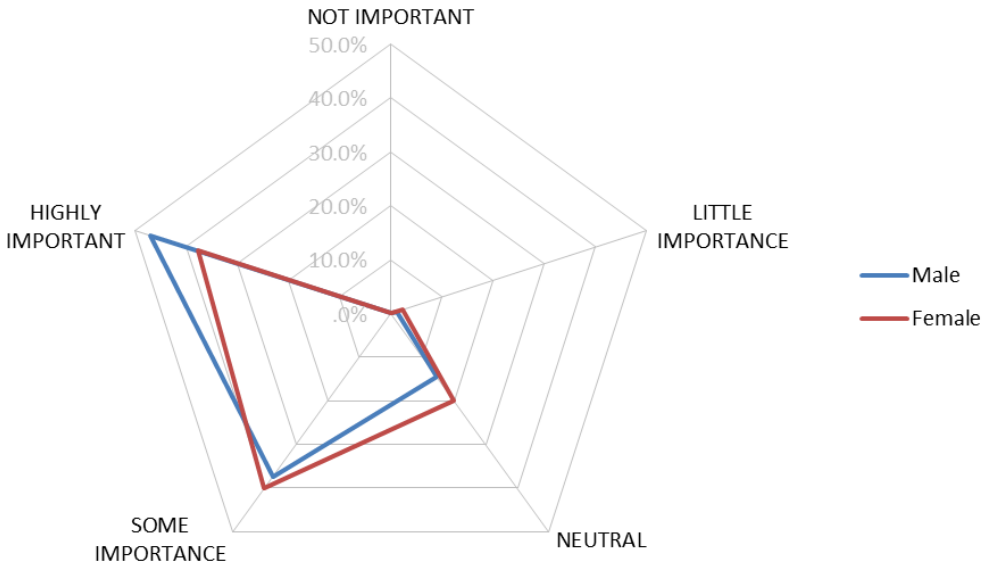


Figure 40: Reg. trip convenience important (by gender)

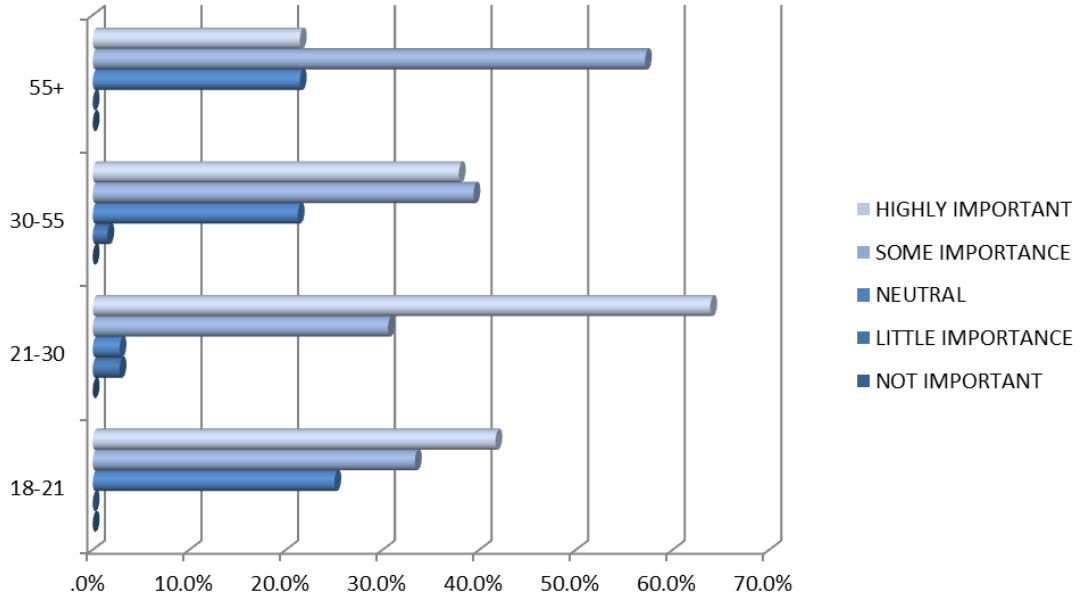


Figure 41: Reg. trip Convenience Importance (by age-group)

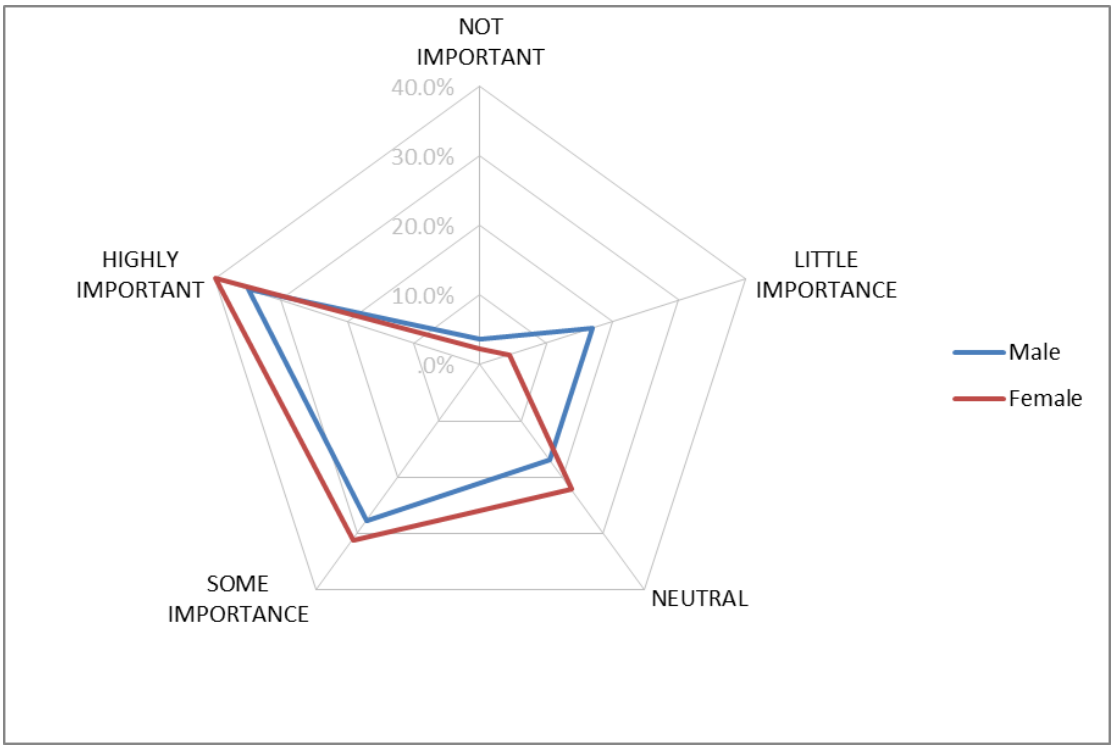


Figure 42: Reg trip safety Importance (by gender)

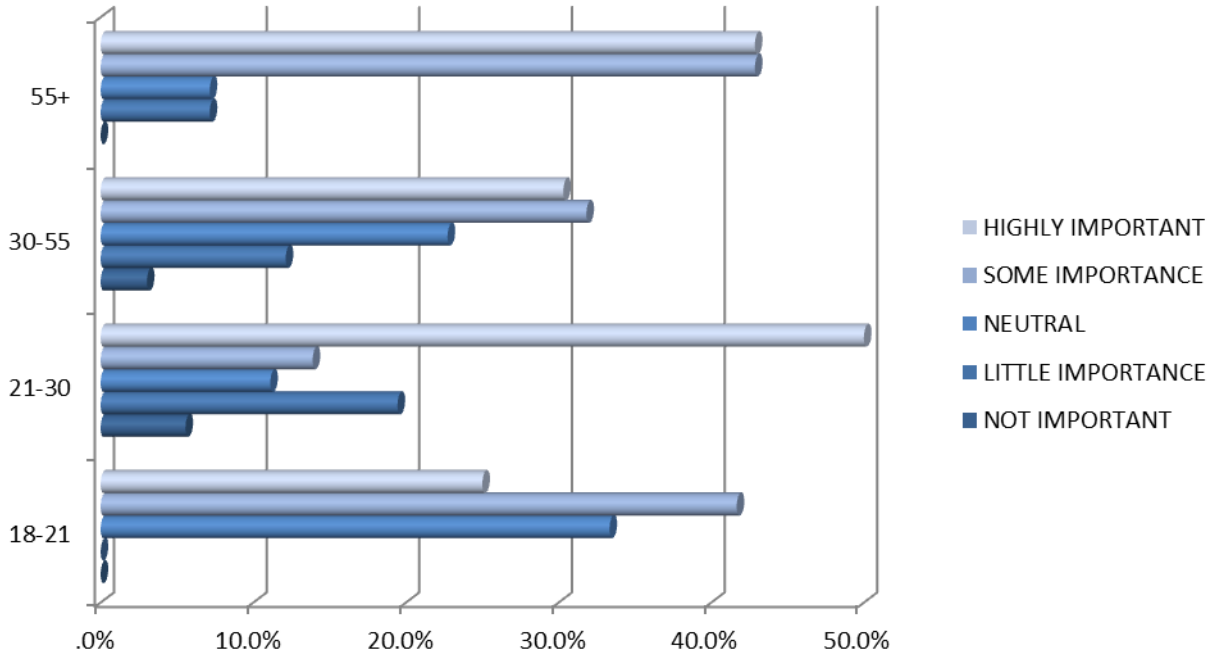


Figure 43: Reg trip safety Importance (by age-group)

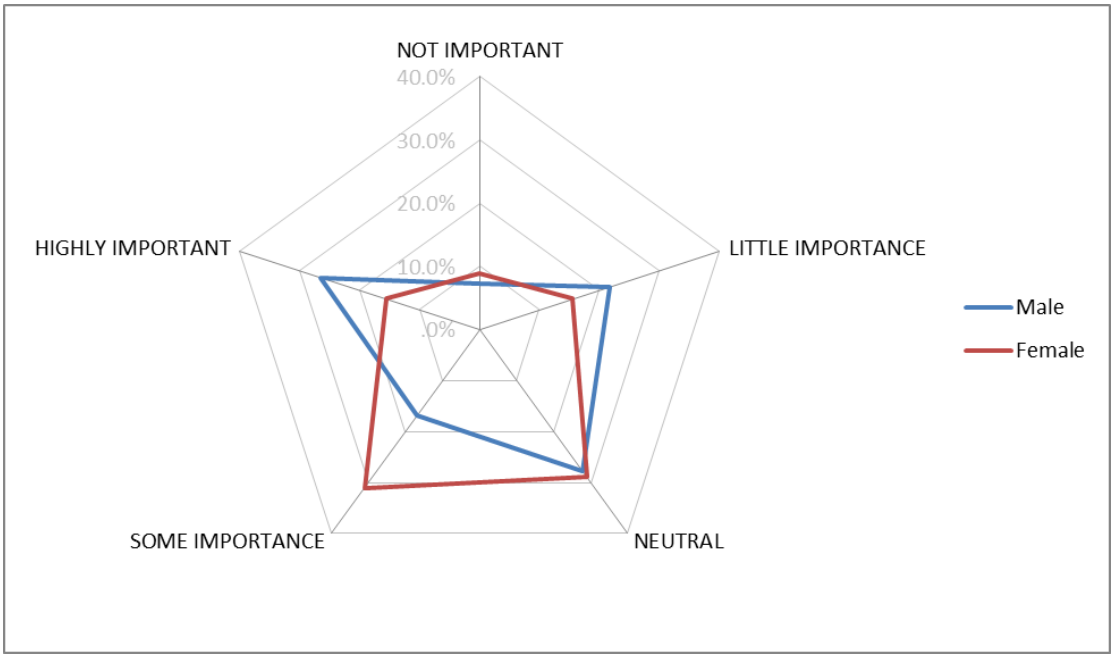


Figure 44: Reg. trip Green Importance (by gender)

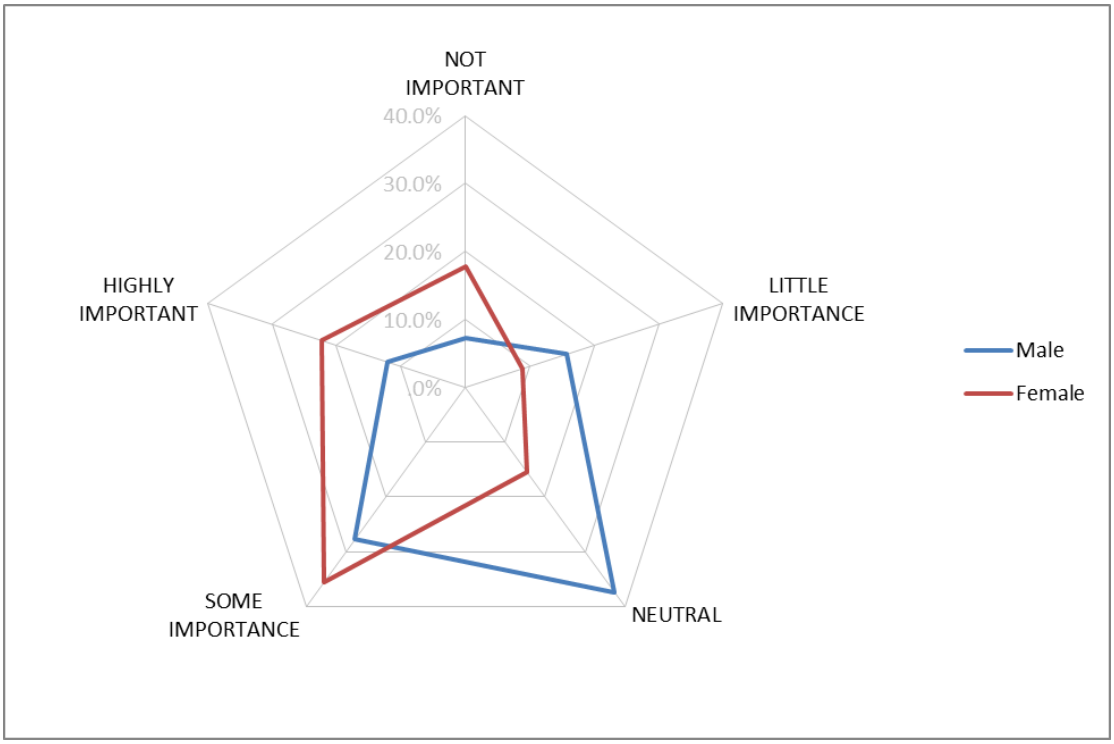


Figure 45: Reg.trip Encumbered Importance (by gender)

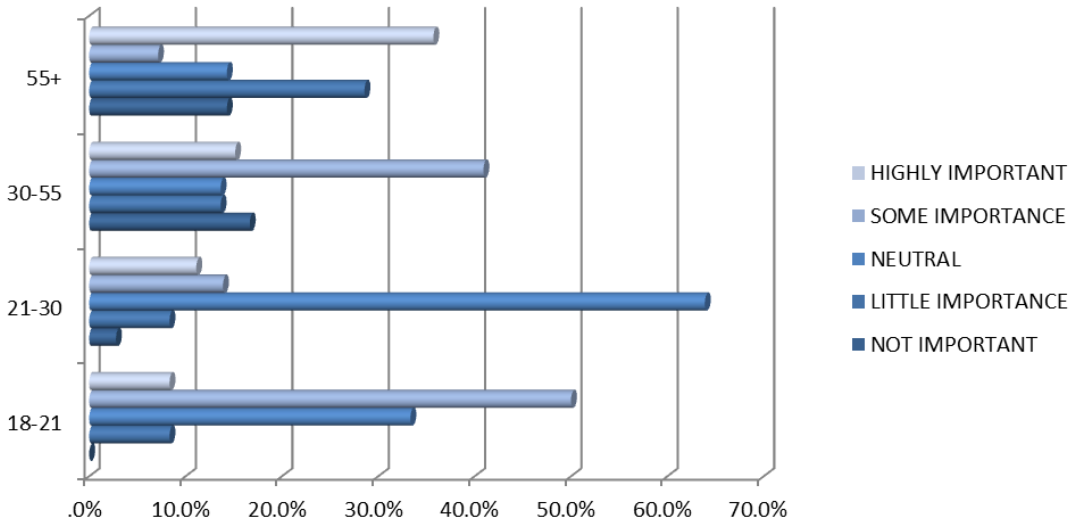


Figure 46: Reg. trip Encumbered Importance (by age-group)

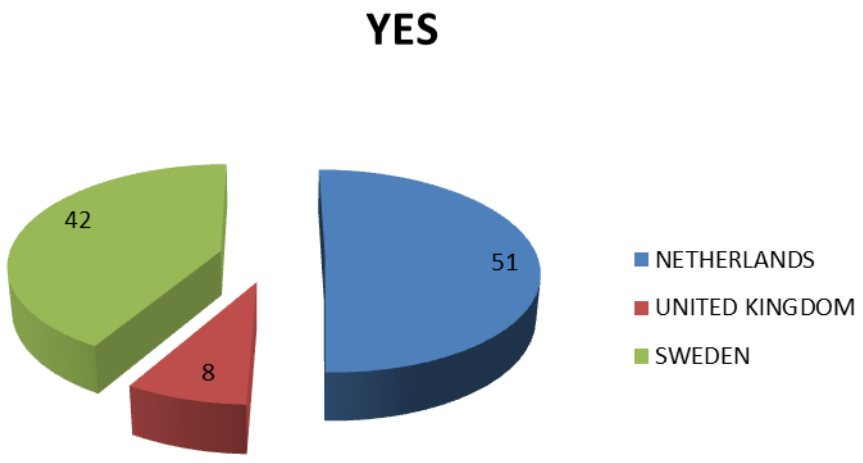


Figure 47: use of travel app by country

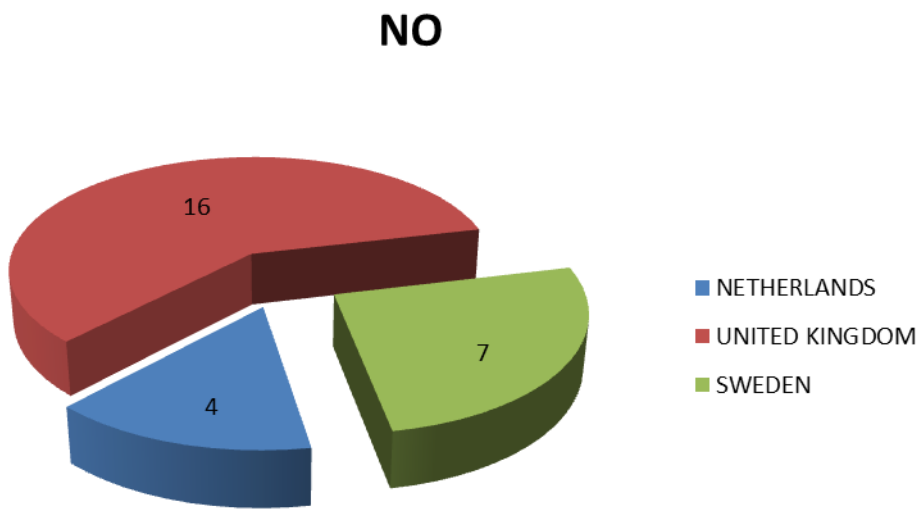


Figure 48: use of travel app by country

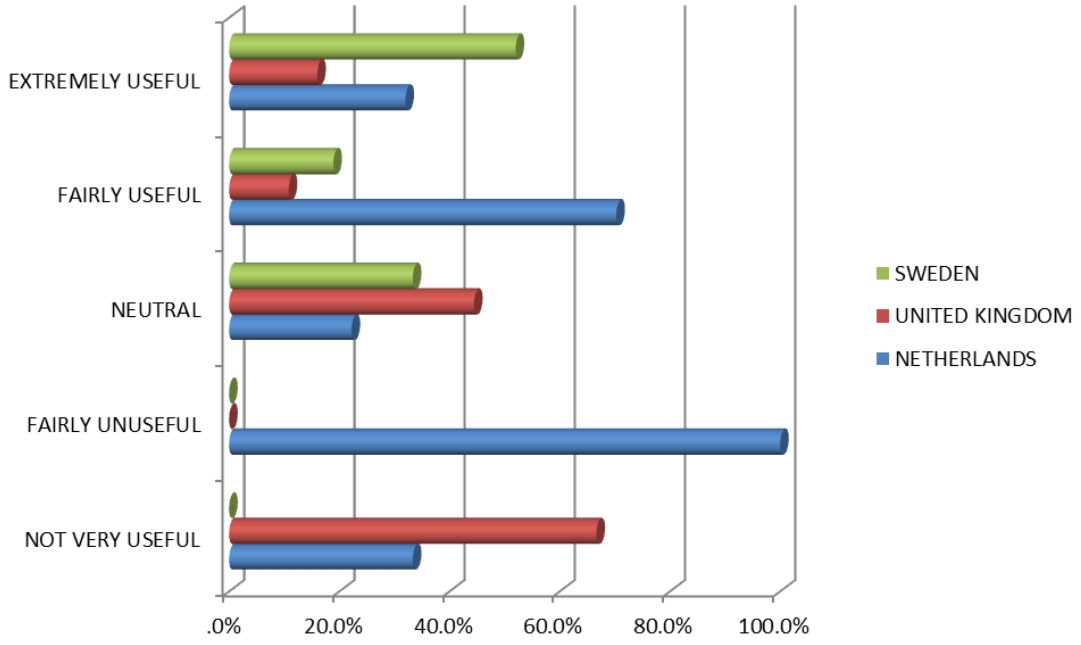


Figure 49: usefulness of traffic jam information

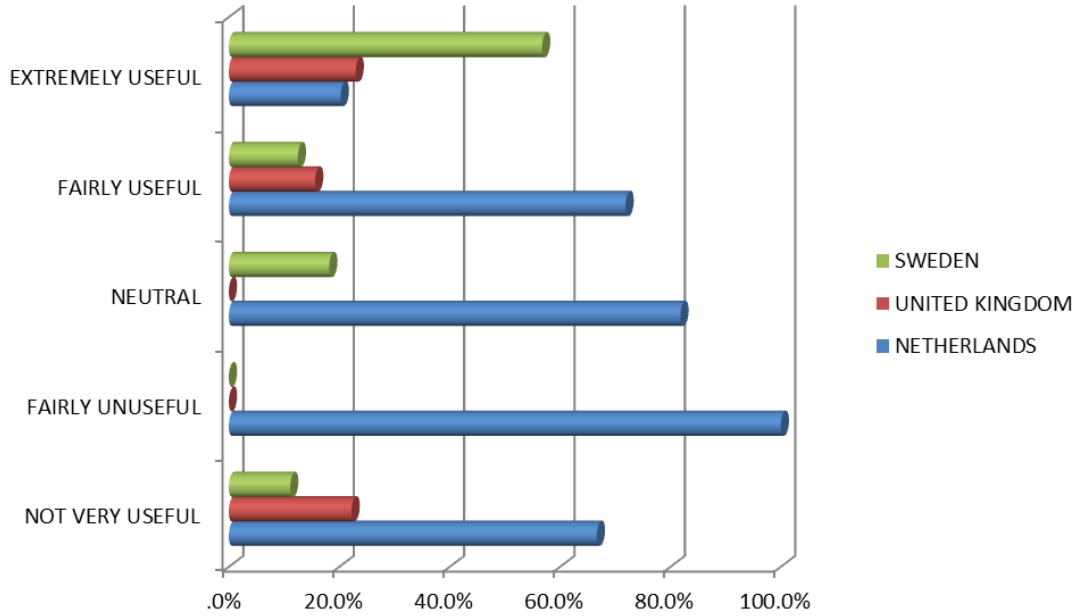


Figure 50 usefulness of PT delays information

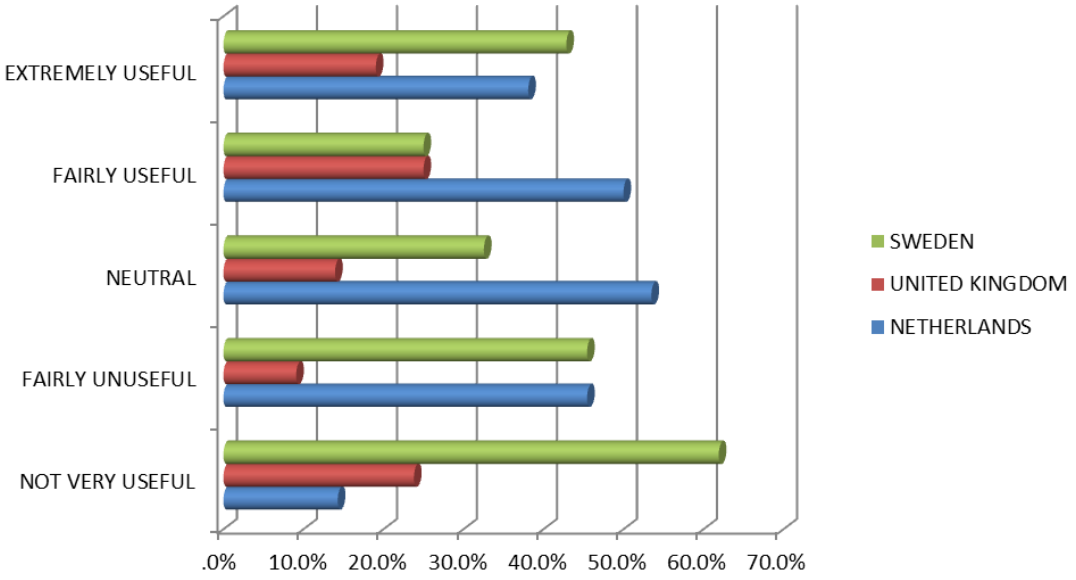


Figure 51: usefulness of parking space availability information

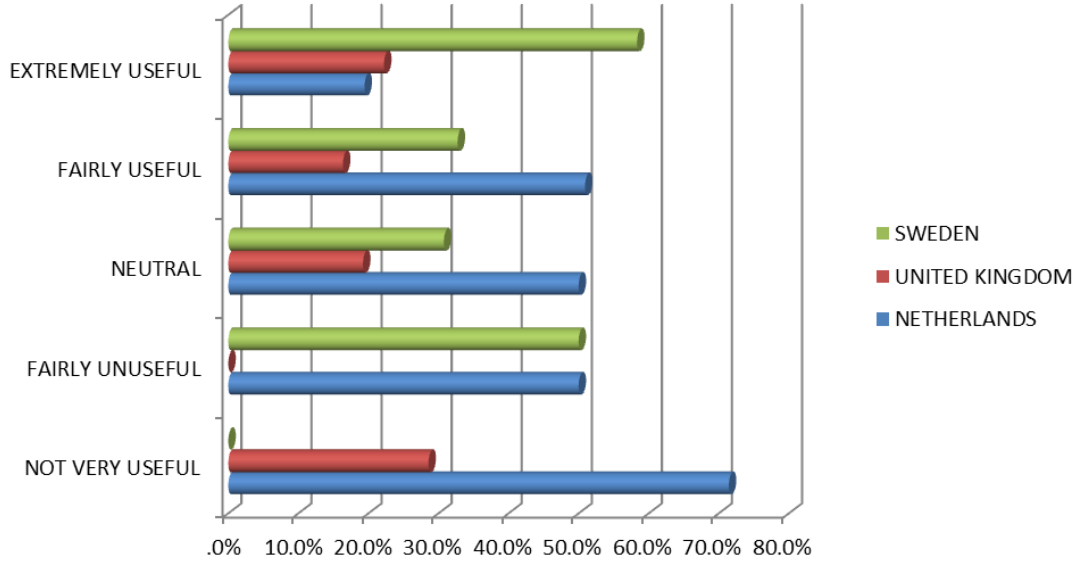


Figure 52: Usefulness of travel alternatives comparison information

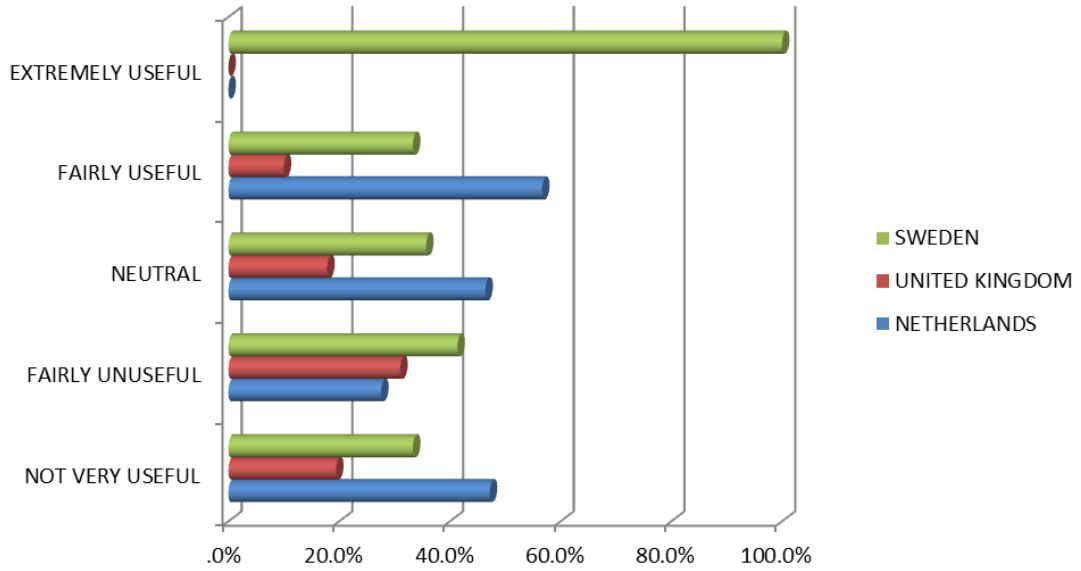


Figure 53: Usefulness of information about other travellers making trip

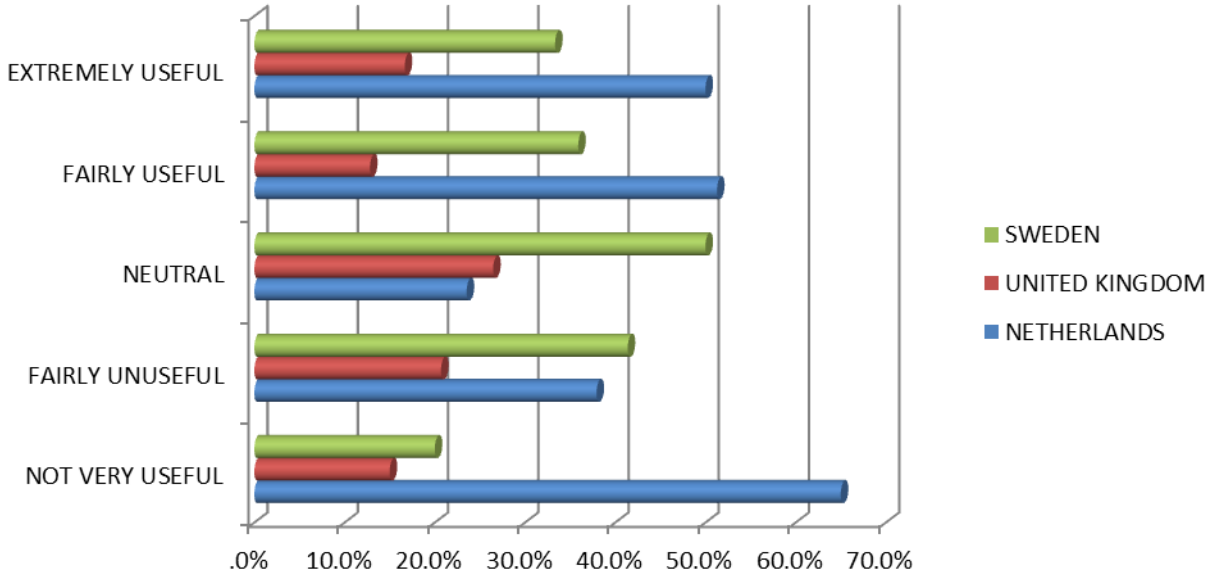


Figure 54: Usefulness of Green score information for trip

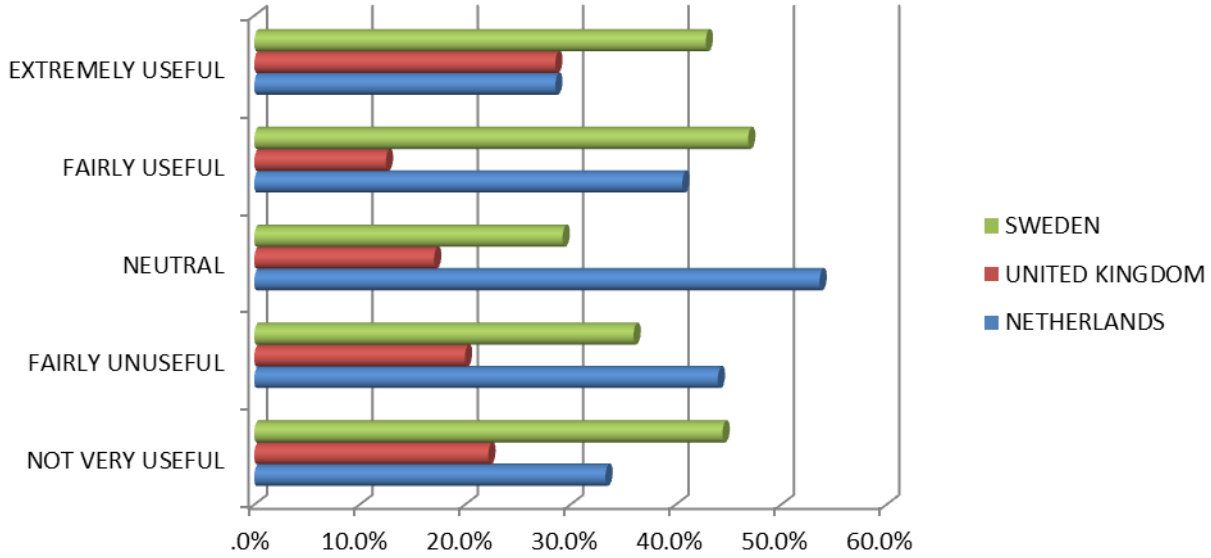


Figure 55: Usefulness of weather information

13 Appendix: Report about Early Consultation of Authority Stake Holders

Some early feedback from stakeholder consultation on SUNSET that took place in Leeds the 1st quarter of the project is reported in Table 32. This details Qualitative stakeholder comments and expounds the implications for the SUNSET system design.

Qualitative stakeholder comments	**Implications for the SUNSET system design**
Transport providers don't want to have a burden of providing extra sensors to the infrastructure, therefore the system should be able to operate with a minimum number of commonly used highway sensors	The system would ideally be developed so that it can be both operate and be (post-hoc) evaluated with minimum sensor information from the existing highway. It could be argued that the system would only be able to function at all with some minimum infrastructure – that is information that would be needed for the commission or city authorities to consider if greater roll out was envisaged. We should define what that would be as an output of the project
There may be an initial impact via the incentives which will wear off after a short while – how can people be offered new incentives over time and who will provide these incentives?	Part of the research of WP3 will be to understand the impact function for different types of incentives. This is an important input to the evaluation method in WP6 and will inform the monitoring timescales. The ability to 'refresh' , adapt or offer new incentives over a longer period should be designed in the system if it is intended as a longer term part of the management of the transport system.
Is it realistic to expect the transport providers or third parties to offer incentives on an on-going basis? Who will pay for these?	Some work is needed both on developing the business case and in being able to present this effectively to third parties and other stakeholders. This is now part of WP5? The credibility of the SUNSET system is linked to the credibility of the business case, which may be a function of the cost and supply source of some types of incentives. As a result a range of incentives with different direct or indirect costs and different providers should be investigated

	in the project.
What about people who don't 'opt-in' to the system by being willing to have their location data linked to the system?	The people who would be 'left out' of the system would be those without the smartphone or those with a device but who did not wish to participate. Some research into how to overcome the barriers to 'opting-in' for those with the smartphone would help in making the business case and also achieveing greater roll out in future. Research into the equity impacts of use of smart technology such as SUNSET is needed for WP6
Will access to databases (at operational/city level) be a barrier to practical implementation?	This may be an issue for particular cities and regions with particular governance or legislative frameworks in place. Examples include highly fragmented ownership/operation models for the transport system, highly regulated data protection environments (privacy laws) or cases of commercial disbenefit to open access. This is an area which it may be difficult to address within the project, but a specification of the database requirements as a minimum level of output would seem feasible.
Aren't there issues of data access given the main service providers don't release their data?	SUNSET doesn't rely on the co-operation of a particular service provider. Data is provided using GPS tracking and individuals consent to their location data being used from the outset. We may need to make sure there is a clear statement on this issue at an appropriate place within the application.
What about confidentiality issues with the use of personal data?	The system only stores data from individuals on a completely voluntary basis, but this question has been raised by a number of stakeholders. The project has a WP/task dedicated to this issue. We may need to make sure there is a clear statement on this issue at an appropriate place within the application.
There are a number of commercial applications developing with similar functionality, how is SUNSET different?	The novelty is in the use of a social network and not just an individual app. There is also novelty in the personalised incentives, which other apps aren't currently offering. We are going to evaluate the efficacy of the system, whilst for other commercial applications this either hasn't been undertaken or is outside the body of public knowledge. The design issue may be in the upfront publicity and also in recruiting to the social networks.

Where is the IPR in SUNSET?	The ordinary traveller will probably not be concerned with IPR. This may be more of a concern for the business model if third parties become involved. The issues around IPR were established at the proposal stage and are not a design issue for the SUNSET system itself.
Doesn't the system require a large number of users to be succesful in practice?	The system has already been designed to work in a flexible way and regardless of the number of users involved. The number of users per se needed for it to be succesful is less of an issue than having a critical mass of users in particular geographic areas, for example along a corridor, at a major destination, using a popular route or segment of the city. A large number of unconnected users would not be as 'succesful' as a smaller number of connected users or those in a focused space. For parts of the transport system that are close to saturation, a change by a relatively small number of travellers can make the difference between freeflow and logjam. This is probably an 'implementation' question for the stakeholder rather than a system design question. However it is related to a similar question around recruitment of users.
It isn't clear how the system will work effectively if the PT system is already saturated – for example if the trains are already full.	This is an implementation question and related to use of the 'dashboard'? different stakeholders will have different transport system or optimisation strategies relating to mode shift, PT supply etc. The purpose of SUNSET is not to optimise the transport system, but rather to provide a platform through which both the transport system operators and the individul travellers use the information provided to make informed decisions. This comment is something to be addressed in the business case rather than affecting the design.
Relationship with the business sector – one to one relationship was seen to be desirable	SUNSET offers a different paradigm to many traditional business models. A one-to-one relationship most probably would not offer the best operating model. SUNSET is based around choices for the individual which would seem to be maximised by participation from a number of third parties more clearly than just one. The design of the system has already taken into the consideration the potential for a number of third parties to be involved.

Issues of footfall – relationship with third parties – diverting people to or away from commercial opportunity	This is a further question for the business model rather than the SUNSET system as an application. The SUNSET system is based around balancing the transport objectives and the individuals travel and other personal objectives. Diverting individuals on a different route for commercial reasons (eg via a particular retailer) would be likely to fall outside those objectives. The system has been designed to work with non-commercial incentives based around information, as well as incentives provided by third parties.
Walking and cycling – where are the incentives and opportunities due to lack of commercial involvement?	The incentives for walking and cycling would be based around information, health benefits for individuals and other non-commercial incentives. There is no further design implication for this.
The software may have the advantage of targetting eg of pollution hotspots	This comment reflects an advantage of the system but doesn't have a specific design requirment. The information on pollution hotspots may be a concern for both the traveller and the system operator. The system has already been designed with the ability to provide this information.

Table 32: Some early feedback from a stakeholder consultation relates qualitative stakeholder comments and the implications for the SUNSET system design

The consultation on the perspectives of Stakeholders on the perceived potential of the SUNSET system contributes to SUNSET's higher level objectives. One of the processes of consultation that has taken place since the outset of the project has concerned the perceived potential of the SUNSET system to achieve higher level transport and other objectives. This consultation essentially comprised feedback on the overall SUNSET concept, rather than on specific issues of design and operation which form the basis for other consultations in the research.

Three groups were used for the consultation, with considerable heterogeneity between the samples but strong within-group homogeneity. These comprised 1) a group of European city-level governmental stakeholders and city operators ('the city pool'), 2) a group of Baltic higher-level policy makers and governmental stakeholders, including some transnational organisations ('the Baltic pool') and 3) a group of student stakeholders from the UK (Leeds) academic community ('the Leeds student pool'). These three groups

broadly represent examples of users, city providers and higher level policy makers.

Both the city pool and Baltic pool comprised representatives from the transport community with a strong awareness of transport problems and intelligent transport alternatives. The Leeds student pool had no prior transport or intelligent transport awareness.

Each group was given a standard presentation and set of information concerning the intending functionality of the SUNSET system and feedback was taken to a standard set of questions on:

- The potential for the SUNSET system to achieve broad transport objectives
- The potential for the SUNSET system to achieve wider societal objectives
- The potential for the SUNSET system to be practically and operationally feasible; and
- The potential financial feasibility of the system.

A summary of the outcomes is given in Figures 56 to 67 below, with grouped responses for each question. The main outcomes were as follows:

- The responses from the Leeds student pool were, in general, less favourable than those from the other consultation pools.
- The Baltic pool were overall most positive in their responses to the potential of the system (across all four questions)
- All consultation pools reflected most doubts about the financial feasibility of the scheme, which may be an unexpected outcome given the possibility of third-party involvement in the system
- Whilst there were mixed responses to the question concerning operational feasibility and achievement of wider social objectives, the responses were most positively inclined towards the ability to achieve transport objectives. This is a welcome outcome as the main goals of SUNSET are framed against the achievement of transport related goals.

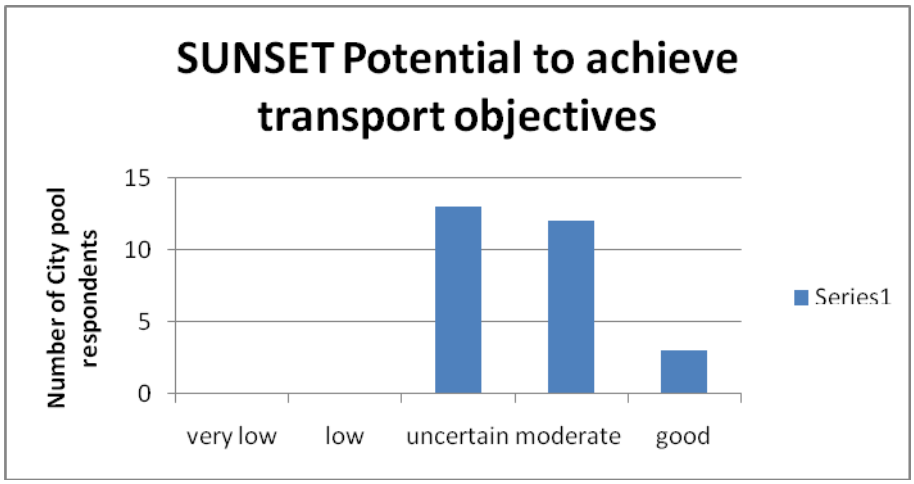


Figure 56: City Pool perceptions on achievement of transport objectives

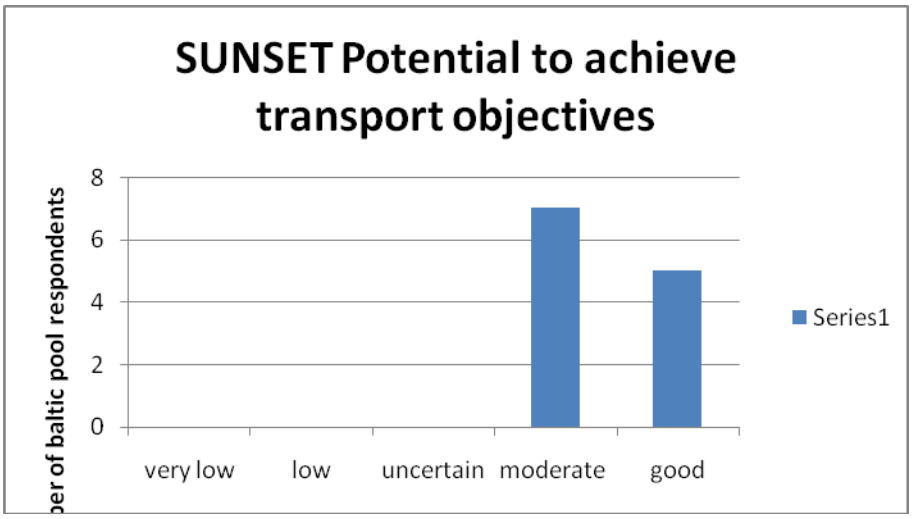


Figure 57: Baltic pool perceptoins on achievement of transport objectives

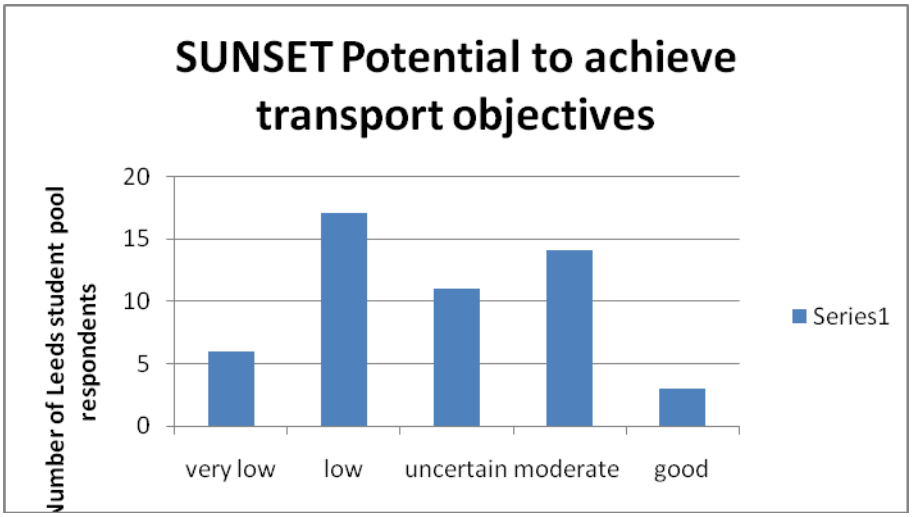


Figure 58: Leeds student pool perceptions on achievement of transport objectives

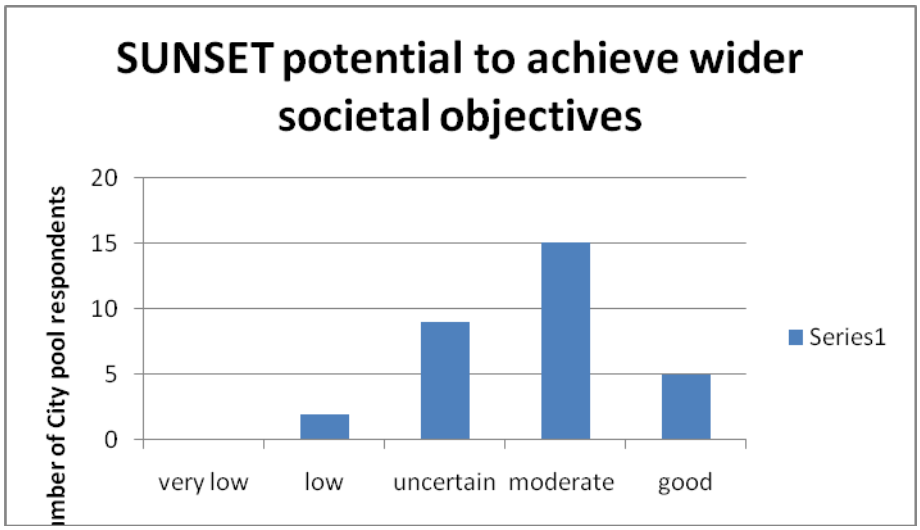


Figure 59: City pool perceptions on achievement of wider societal objectives

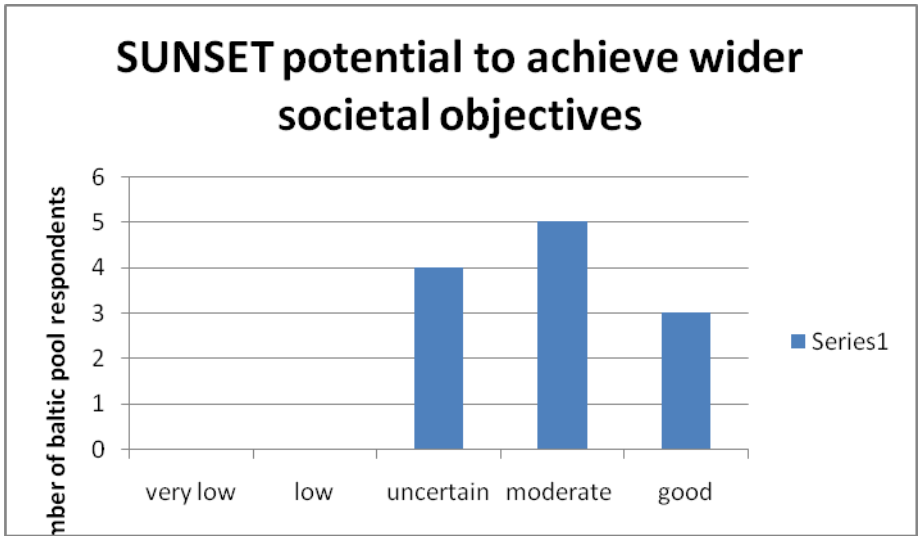


Figure 60: Baltic pool perceptions on achievement of wider societal objectives

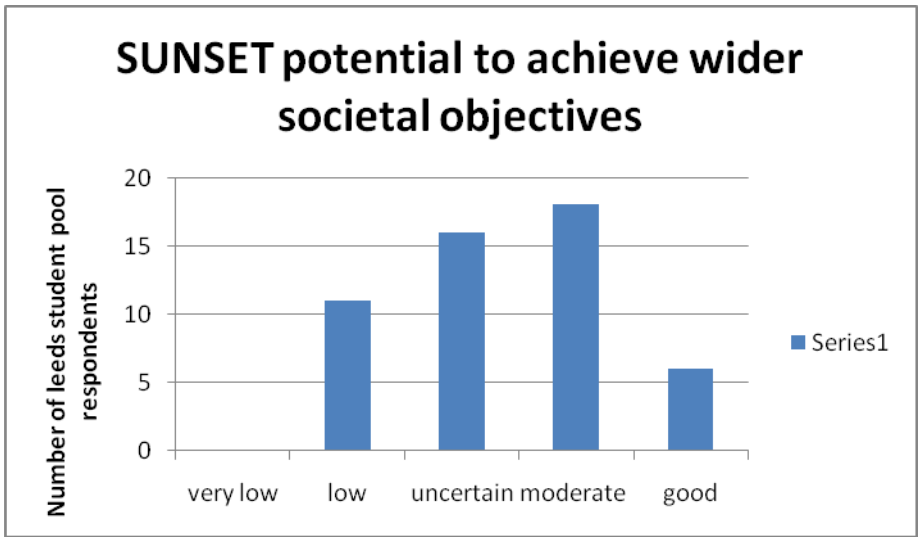


Figure 61: Leeds student pool perceptions on achievement of wider societal objectives

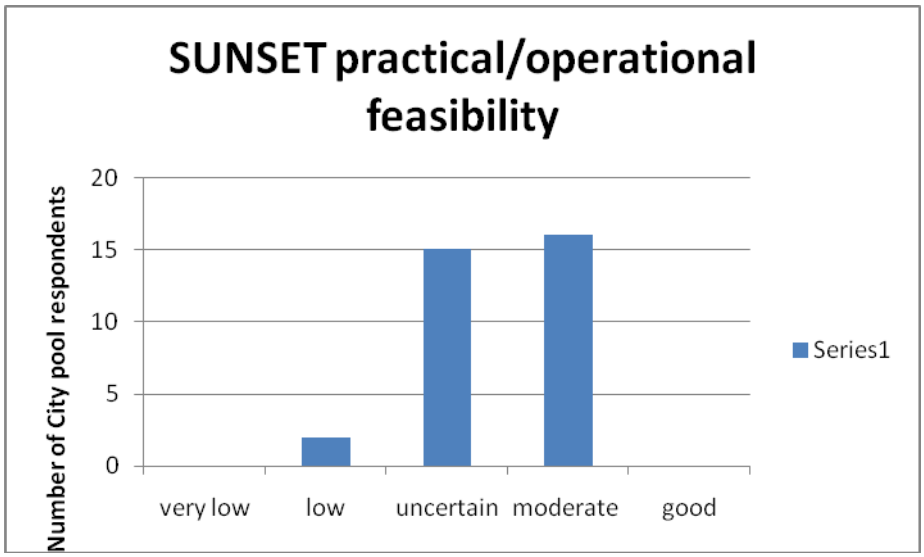


Figure 62: City pool perceptions on operational feasibility

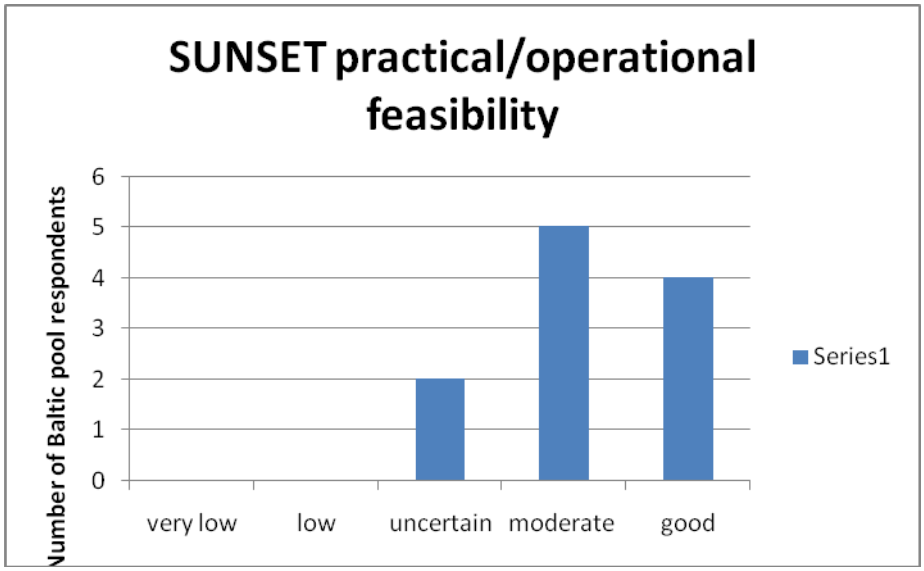


Figure 63: Baltic pool perceptions on operational feasibility

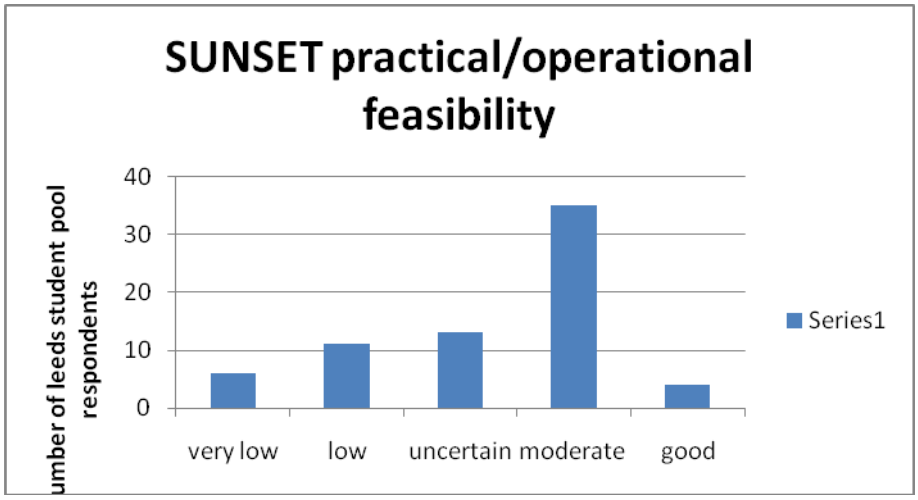


Figure 64: Leeds student pool perceptions on operational feasibility

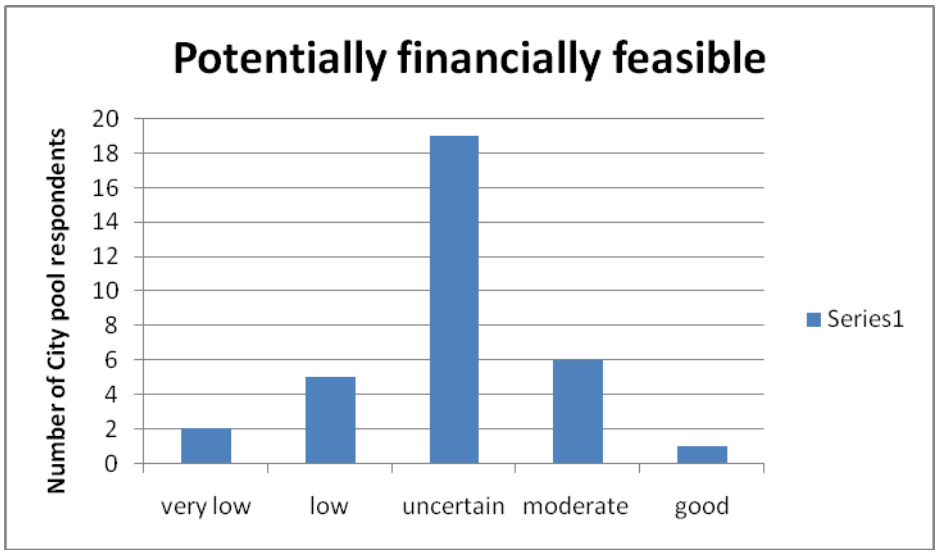


Figure 65: City pool perceptions on financial feasibility

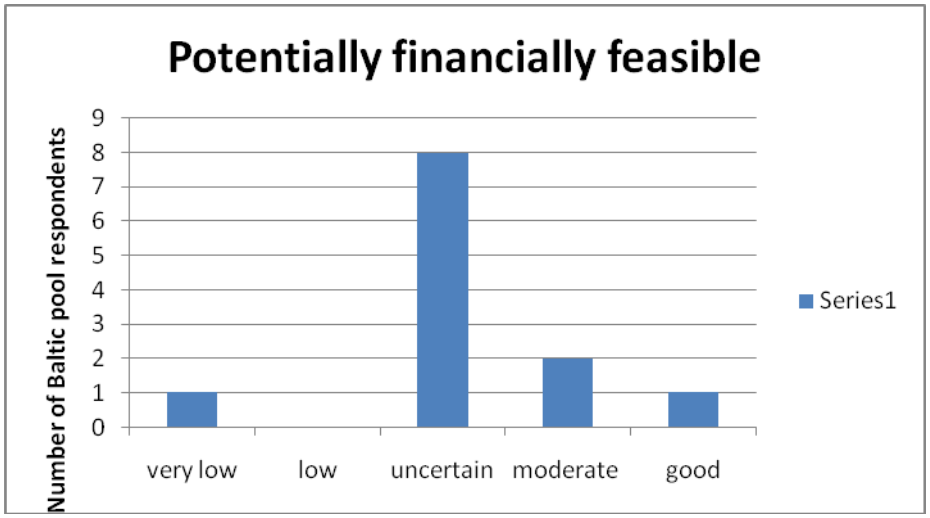


Figure 66 baltic pool perceptions on financial feasibility

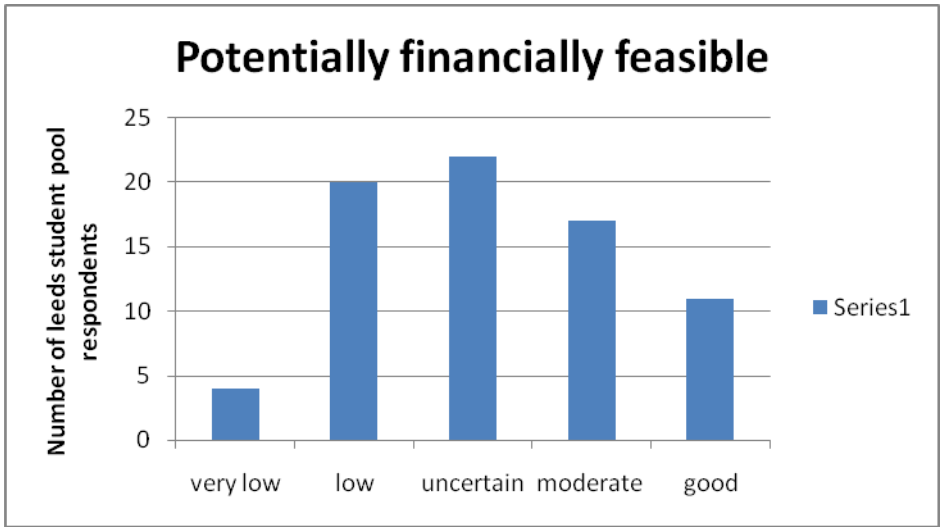


Figure 67 Leeds student pool perceptions on financial feasibility

14 Appendix: System Requirements and their relation to User Requirements

14.1 Mobility Client Requirements: Sensing (WP4)

In the following we list requirements that are relevant for T4.1 "Monitoring Mobile Users". There are two types of requirements. System requirements address system features and requirements that address some technical details. Often system requirements are refinements of system requirements. Requirements are sequentially numbered and prefixed by the task name and the type of requirement. We use the formats T4.1-SR<n> for system, where <n> is the requirement number. Besides the requirement number, each requirement is described by a short name, the experts in the field, the component which it addresses, the type (system or technical), a description, the source were the requirement was extracted from, a rational that explains why this requirement is implied by the source, a priority (high, medium, or low) that indicates how important this requirement is to achieve the project's goals, as well as some remarks.

In the following we list requirements related to the Mobile Monitoring App that were extracted from the WP1 user requirements based on the SUNSET core scenario and its extensions.

T4.1-SR0	**Application Registration**
Expert	Peter Ebben (NOVAY)
Component	Mobile monitoring application? Mobile Sensing?
Type	System
Description	
Source	WP1 user requirements WP1-US01a and WP1-US02a
Rationale	"..installing a mobility monitoring application.." (WP1-CS-2)
Priority	High
Remarks	

T4.1-SR1	**Location Traces Measuring**
Expert	Sebastiaan Raaphorst (LOCNET), Koen Jacobs (LOCNET), Peter Ebben (NOVAY)
Component	Mobile monitoring application? Mobile Sensing?
Type	System
Description	The mobile application should continuously gather location measurements in a way that allows to reconstruct the geographical traces the user took
Source	WP1 user requirements WP1-US01a, WP1-US01b, WP1-US03a, WP1-US09a
Rationale	"..installing a mobility monitoring application.." (WP1-CS-2) and "..the SUNSET system has automatically determined an initial mobility pattern.." (WP1-CS3). This implies that the mobile application should continuously measure positions of the mobile phone in a way that allows reconstructing the users' daily movements without having the user to manually provide any further input.
Priority	High
Remarks	It is expected that the raw location traces measured by the mobile application are refined by some processes like map matching algorithms on the server side

T4.1-SR2	**Modality Detection**
Expert	Sebastiaan Raaphorst (LOCNET), Koen Jacobs (LOCNET), Peter Ebben (NOVAY)
Component	Mobile monitoring application? Mobile Sensing?

Type	System
Description	Location traces have to annotated with the corresponding modality like “by bus” or “by car”.
Source	WP1 user requirement WP1-US03a
Rationale	“..automatically determined an initial mobility pattern..” and “These patterns provide overview of modality choices..” (WP1-CS3/Explanatory text). This implies that the gathered location traces are annotated by modalities.
Priority	Medium
Remarks	While some modalities like cycling could be estimated by taking several sensed data items like the computed speed stemming from the gathered location traces and accelerator measurements into account, it is expected that some server side process can estimate other modalities better (like “by car” if the result of the map matching indicates that the users traces exactly follows a certain highway). This component is linked to the Mobility Pattern Detection component as delivered by T2.1, and thus will require close and real-time interaction with the server side.

T4.1-SR3	**Live Monitoring**
Expert	Sebastiaan Raaphorst (LOCNET), Koen Jacobs (LOCNET), Peter Ebben (NOVAY)
Component	Mobile monitoring application
Type	System
Description	Monitoring results have to be reported almost instantly to a central system component.
Source	WP1 user requirements WP1-US08a and WP1-US09a
Rationale	“..receives a suggestion to work from home..”, “..because all routes in her personal commuter pattern are blocked..”, “this is measured by other community members making hardly any progress on these routes..” (WP1-CS-8/9). This assumes a silent background monitor application that observes the situation for all users on their regular trips at this moment of time, to allow the generation of derivation alarms (computed on the server) on time.
Priority	Medium
Remarks	This requirement implies that the mobile application requires real-time interaction with the server.

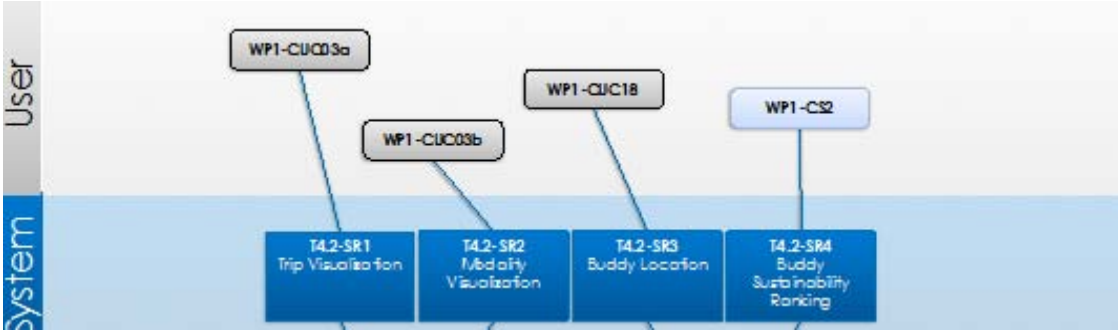
T4.1-SR4	**Notification Support**
Expert	Sebastiaan Raaphorst (LOCNET), Koen Jacobs (LOCNET), Peter Ebben (NOVAY)
Component	Mobile monitoring application
Type	System
Description	The mobile application has to support a notification mechanism such that the server can push information to dedicated users.
Source	WP1 user requirement WP1-US08a as well as the user requirements WP1-US5-GO, WP1USC8-GO and Wp1-US15-GO of the Gothenburg scenario extension.
Rationale	“..receives a suggestion to work from home..” (WP1-CS-8/9). The mobile application needs to be able to gives the user suggestions.
Priority	Medium
Remarks	

T4.1-SR5	**Activity Detection**
Expert	
Component	Mobile monitoring application
Type	System
Description	Activities of users like “biking” or “in a call” have to be detected and pushed to the server.
Source	WP1 user requirement WP1-US01c
Rationale	“..detects physical movements and activities..” (WP1-CS-2)
Priority	High
Remarks	Can be used by the server to decide when to push information to mobile clients

T4.1-SR6	**Manual Experience Sampling**
Expert	
Component	Mobile monitoring application
Type	System
Description	Users shall be able to push feedback messages to nearby users, social networks or the SUNSET portal.
Source	WP1 user requirements WP1-US03g, WP1-US06d, and WP1-US09c as well as the Enschede extension to the core scenario WP1-US03-EN
Rationale	“..Explicit feedback by allowing users to enter feedbacks while they travel or after they arrived at their destination” (annex)
Priority	High
Remarks	Users may be motivated to gain visibility in the system (e.g. acquire new friends), being better ranked by friends.

14.2 Mobile Client Requirements: Social Networks (WP4)

In the following, we list requirements that are relevant for the T4.2 components "Mobile Mobility Profile Visualisation" and "Mobile Buddy List". The following illustrates the dependencies between user, system and technical requirements as defined in the next section.



14.2.1 Requirements Extracted from the WP1 User Requirements

In the following we list requirements related to the Mobile Monitoring App that were extracted from the WP1 user requirements based on the SUNSET core scenario and its extensions.

T4.2- SR1	**Trip Visualization**
Expert	Sebastiaan Raaphorst (LOCNET), Koen Jacobs (LOCNET), Peter Ebben (NOVAY)
Component	Mobile monitoring application / Mobile Mobility Profile Visualisation
Type	System
Description	The mobile application should visualize (recent) trips made by the user. The trips will be ordered showing date, distance and times travelled, departure, destination, and detected modality. On selection, the MVP should provide detailed information about each trip as well as a visualisation of the trace on a map. The application allows overriding the detected modality by the user.
Source	WP1 user requirement WP1-US03a
Rationale	"…visualises mobility patterns for a user"(US-3a) implies that a user should be able to see its mobility pattern, thus being able to access its trips.
Priority	Medium
Remarks	

T4.2-SR2	**Modality Visualization**
Expert	Sebastiaan Raaphorst (LOCNET), Koen Jacobs (LOCNET), Peter Ebben (NOVAY)
Component	Mobile monitoring application / Mobile Mobility Profile Visualisation
Type	System
Description	The mobile application should visualize an overview of the modality footprint of the user. A list based on time / distance / average speed spend per modality will be shown to the users.
Source	WP1 user requirement WP1-US03b
Rationale	"overview of modality choices" implies that the user should be able to see a distribution of the modality choices
Priority	Medium
Remarks	

T4.2-SR3	**Buddy Location**
Expert	Sebastiaan Raaphorst (LOCNET), Koen Jacobs (LOCNET), Peter Ebben (NOVAY)
Component	Mobile monitoring application / Mobile Buddy List
Type	System
Description	The mobile buddy list should provide an overview of the location of friends. The mobile buddy list provides different views of buddies positions based on proximity, modality, destination, highway etc.

Source	WP1 user requirement WP1-US18
Rationale	"Travelling together is synchronized via Social Networks – Group travellers inform others of each other's status"; as the mobile Social Network interface, the Mobile Buddy List has to provide this status information of buddies
Priority	Medium
Remarks	

T4.2-SR4	**Buddy Sustainability Ranking**
Expert	
Component	Mobile monitoring application / Mobile Buddy List
Type	System
Description	The mobile buddy list should provide a ranking of buddies based on, CO2 emission, kilometres travelled by bike, public transport.
Source	WP1 user requirement
Rationale	Competition within the Social Network of buddies (WP1-CS-2) can provide an incentive to users to change behaviour to perform better in certain aspects than their buddies.
Priority	High
Remarks	This can be provided by allowing the users to sort the list of buddies according to some criteria or via the on-demand display of some graphical statistics.

14.3 Mobile Client Requirements: Incentives (WP4)

In the following we list requirements related to the Incentive Market Presenter that were extracted from the WP1 user requirements based on the SUNSET core scenario and its extensions.

T4.3-SR0	**Incentive Market Presenter (Display Shelf)**
Expert	Athen Ma (QMUL)
Component	Incentive Market Presenter
Type	System
Description	This allows users to view the available incentives in the system. Incentives can range from individual to group incentives. Criteria for each incentive will also be displayed.
Source	
Rationale	
Priority	High
Remarks	

T4.3-SR2	**Incentive Market Presenter (Green Mileage Scheme)**
Expert	Athen Ma (QMUL)
Component	Incentive Market Presenter
Type	System
Description	This allows users to subscribe to the SUNSET point collection scheme (e.g. collect "Green Mileage". A user will be able to see his/her current status, and incentives available for redemption. This will also allow the user to redeem his/her incentives.
Source	US13
Rationale	
Priority	High
Remarks	

T4.3-SR3	**Incentive Market Presenter (On-the-go Bonus)**
Expert	Athen Ma (QMUL)
Component	Incentive Market Presenter
Type	System
Description	This will offer "event-triggered" bonus/extra Green Mileage to a user at the right place and time. The trigger will come from T4.1 mobile notification.
Source	US13
Rationale	
Priority	High
Remarks	

14.4 Mobility Server system Requirements (WP2)

The WP2 requirements are grouped per server-side component in the SUNSET system. The inter-component interactions are highlighted in the SUNSET-wide architecture [D5.1].

T2.1	PMS			
Expert	Koen Jacobs (LocatieNet), Johan Koolwaaij (Novay)			
Component	Personal Mobility Store			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
PMS.1	The PMS should collect all raw measurements from the mobile phone	US1, US3, SS1	To minimize sensor data computations on the mobile client, and to support centralized analysis	High
PMS.2	The PMS should perform cleaning, smoothing and enriching all measurements such that the MPD only receives relevant and accurate data	US3, US4, US21, SS1	To alleviate the MPD from dealing with unnecessary/inaccurate measurements	High
PMS.3	Measurements should include location, trips, power usage, network information and other information about the device context	US1, US3, SS1	Minimal set of measurement types to reason about the user's context	High
PMS.4	Measurements may include physical movement, dust intake and air quality	US1, US3, SS1	To reason about the user's environmental impact	Medium / Low
PMS.5	Measurements may include additional information coming from sensing devices attached to human bodies or bikes	US1, US3, SS1	To support external sensors (e.g., ANT+)	Medium
PMS.6	Should offer central error reporting	Developer	Required from a developer perspective	High
PMS.7	Should offer management and monitoring interfaces	Developer	Required from a developer perspective	High
PMS.8	Provides the sensed and smoothed mobility information to other SUNSET components on a real-time basis, allowing them to subscribe to mobility changes.	US13,US21, US17	Required for interaction with MPD, IMP and ESS.	Medium
PMS.9	Provides feedback information towards the mobile sensing application to adjust sampling rate, sensor activation, or required level of detail, as a response to data upload (	WP4-req	Stricter requirements on data quality are posed by the MPD; the PMS only facilitates quality adaptations	High
PMS.10	Should offer a mechanism to trigger the mobile sensing application in case of certain constellation of events	WP4-req	Required to support experience sampling services	High
PMS.11	The PMS should advertise	IMP/ESS	Required to formulate	High

	which mobility information and other contextual data it can serve.		incentives (target groups and conditions) in these terms.	
Remarks	None			

Table 33: Personal Mobility Store System Requirements

T2.2	**MPD**			
Expert	Johan Koolwaaij (Novay), Marko Luther (Docomo)			
Component	Mobility Pattern Detector			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
MPD.1	The MPD should create mobility patterns for persons, places (including routes, and regions) and vehicles	US3, US4, US9, US21, SS1, SS4	These patterns are abstractions and derivatives of the measured mobility data that provide an easy-accessible overview per person, place, et cetera.	High
MPD.2	These patterns should have discrete observation periods, minimally last day, last week, last month and last year	N/A	Required to optimize performance and cache results; this list can be extended in the future.	Medium
MPD.3	Patterns can be context-dependent, with different patterns for different weather conditions, during events or shopping Sundays, or for specific groups of users.	US8,US21	Required to provide personalized incentives, to e.g. all frequent users of a certain road segment, all frequent travellers on bus line 3, or those users who always take the car when it is raining.	High
MPD.4	Personal patterns provide overviews of the mobility choices of users (trips, routes and timings, modality, ...) and the consequences of these choices, in terms of time, money, emissions, delay, et cetera.	US3, US4, US7	To influence behaviour of users' patterns must contain the mobility facts as well as the computed consequences in an easy-to-interpret measure, e.g. delay hours, travel costs, or CO2 emission. A more elaborate description of all algorithms is provided in D2,2	High
MPD.5	Place patterns should contain information or estimates on delay times, intensities and ecological emissions. These patterns can be aggregations and extrapolations of the personal patterns of its inhabitants and visitors, allowing regions (such as different districts in a city) to compare and compete on mobility.	US12, SS1, SS6	A more elaborate description of all algorithms is provided in D2,2	High
MPD.6	Vehicle patterns should contain information on travel and delay times and degree of occupancy, satisfaction of the traveller, et cetera.	US15, US16, SS6	A more elaborate description of all algorithms is provided in D2,2	Low

MPD.7	Persons can be grouped dynamically based on their current situation, and the MPD provides functionality to query for persons based on their modality choices: all regular visitors of place P, all occasional users of modality X in city Y, …	US15	Not only should be patterns be generated by the MPD, they should be queryable on many different cross sections.	High
MPD.8	All patterns can be generated using a batch approach on all user data overnight, and also using a more light-weight approach per user or per trip to obtain initial estimates which can be later improved by the following batch operations.	Developer, US8, US 16	The MPD should offer an incremental approach in improving the data: fast and less-reliable results combined with slower but higher quality results.	High
MPD.9	The MPD should allow the user to provide manual input for certain patterns, to control the outcome of the automatic recognition process, and to adjust these outcomes in case of error.	US3, US11	In order to collect training data, detect errors in algorithms, and to improve data quality.	High
MPD.10	All pattern detection algorithms should provide progress and error logging to file system, and email alerts in case of serious errors or emergencies.	Developer	To monitor behaviour	Medium
MPD.11	The MPD should provide means to influence its behaviour, replace/choose specific algorithms; to start, schedule or redo pattern detection processes;	Developer	To keep the system agile and flexible	Medium
MPD.12	The MPD should provide basic CRUD operations to manage patterns and algorithms, and to override automatically derived patterns by manual user input.	Developer	Apart from the complex methods also convenience methods will be provided for easy accessible but partial/focused functionality.	Medium
MPD.13	The MPD should advertise which mobility information and patterns it can serve, including minimally a list of pattern names and descriptions,	ESS/IMP	Allowing the IMP and ESS to specify in which terms the incentive target groups and conditions can be specified.	High
Remarks	<additional comments>			

Table 34: Mobility Pattern Detector System Requirements

T2.2	**MPV**			
Expert	Martin Wibbels (Novay)			
Component	Mobility Pattern Visualizer (MPV)			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
MPV.1	The MPV should provide an attractive and easy-to-	US3, US12, US19, SS1,	If this is facilitated on the server, it prevents duplicate	High

	interpret visualization of the mobility patterns of persons, places, et cetera.	SS4	implementation in the city dashboard, mobile app, portal, and social networks.	
MPV.2	Generic (pattern-independent) extensions such as showing results in absolute or relative mode, showing averages, and performing linear trend analysis, can be provided by the MPV	US19, SS1	If this is facilitated by the MPV, there is no need to implement this in the MPD in a pattern-dependent fashion.	High
MPV.3	The MPV should be able to display goals (person-centric, place-centric, ...) and the progress on these goals. These goals should come from the requesting component, e.g. the ES for community overviews.	US7, US19, SS1	The visualizations have to combine the measured and derived mobility facts, with a clear indication of the goal and the quantified progress on this goal.	High
MPV.4	The MPV should provide the visualization in such a way that they can be integrated with profiles on existing social networks, at least Facebook	US18, US20	This way visualizations are recognizable, consistent across different components, and implemented only once. The visualizations are implemented as a HTML-based page or snippet that is embedded in e.g. the Facebook profile page (and not a dedicated Facebook application).	High
MPV.5	The MPV should allow for comparison of mobility data between persons or places; more specifically it should allow for a buddy view of mobility data, comparing all buddies of a specific user.	US19, SS1	To be able to interpret the results in relative terms: better/worse than another user, or all users in a specific group, ...	Medium
MPV.6	The MPV should allow for comparison of mobility data between time periods; it should be able to visualize mobility data compared to the same month last year, or month-based data with a year-based or overall average.	US19, SS1, SS4	To be able to interpret the results in relative terms: better/worse than last year, ...	Medium
MPV.7	All visualizations become available in tabular form (text), static graphical form (PNG) or an interactive web page allowing adjustment of control variables, scaling and observed time period.	Technical	To improve the user experience	High
MPV.8	Visualization styling is a community configuration; visualization contents can be adjusted by the user or requestor of the data. Hence all visualizations are recognizable as originating from the SUNSET living labs.	Technical	To improve the user experience	Medium

MPV.9	All visualizations are available in the English language, and may be available in the language of the living lab the user is participating in (English, Dutch, and Swedish).	Technical	To improve the user experience	High
Remarks	<additional comments>			

Table 35: Mobility Pattern Visualizer (MPV) Requirements

T2.4	**IMP**			
Expert	Athen Ma (QMUL), Sander Veenstra (UT)			
Component	Incentive Market-Place			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
IMP.1	Provide system's definition of an incentive in terms of "Who, When, Where and How" so as to Allow providers to publish/update/remove incentives accordingly.	Technical	System's definition on incentives.	High
IMP.2	Provide a bonus point based reward system in which users can subscribe to.	SS3	This will be the platform in which incentives will operate, and it nicely decouples the issuing of incentives from the inning of the rewards.	High
IMP.3	Manage the different types of users of the system: incentive providers and system users.	Technical	This will be defined in the component for general operation.	High
IMP.4	Offer incentives to users by taking into consideration their mobility patterns, identified potential behavioural changes, preferences, circumstances (a car owner or not) and history of incentive scheme participation so as to achieve system's and individual's goals. These offers will be delivered at the right time and place.	US13, US14, SS3	Offer incentives with reference to individuals' travel patterns.	Medium
IMP.5	Identify appropriate incentives for different groups of users to ensure the expected outcome is achieved by encouraging the right kinds of behaviour.	US15, SS3	Offer group incentives.	Medium
IMP.6	Monitor and manage users' participation in incentive schemes and offers by defining suitable participation measures qualitatively and quantitatively. Allow users to feedback their incentive preference (more of this kind, no thanks!).	Technical / WP6-req	Monitoring the successfulness of incentives.	Medium

IMP.7	Handle network economies – more successful offers will lead to more provider and hence more users participating. However, the mechanism used needs to be adaptive to avoid information overload when there is a high volume of take-ups.	Technical	Define an approach to balance between incentive and users.	Low
IMP.8	Incorporate social relationships for group-based incentives to encourage group behaviours.	US15	Use social relationships for group incentives.	Medium
IMP.9	Incentive overview - Provide a portal to advertise available incentives, alert users of those incentives which are applicable to them and notify their bonus point status. Provide visualization of incentive participation rate.	SS3 / WP4-req	Inform users the available incentives.	High
IMP.10	Liaise with MPD/PMS so as to promote incentives	Technical	Inform users the available incentives.	Low
IMP.11	Provide system's rules on incentives. Detect and handle overuse and/or misuse of incentives.	Technical	Generic system's rules.	Low
IMP.12	Define the communication mechanism between the server and client so as to facilitate matching and auctioning processes.	Technical / WP4-req	A defined interface for communication between server and client.	High
IMP.13	Privacy sensitive incentives shall be send only to the particular user involved and not to other persons or authorities.	DoW Ethical issues	The IMP should check this with the PM	High
Remarks	<additional comments>			

Table 36: Incentive Market-Place (IMP) Requirements

T2.1	**ESS**			
Expert	Koen Jacobs (LocatieNet)			
Component	Experience Sampling Store			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
ESS.1	The ESS should allow researchers to register questions for a specific target groups in certain context conditions	SS1, SS5	As a service towards researcher and the city dashboard	High
ESS.2	Should allow for managing target group specifications and re-usable context conditions	City dashboard	As a service towards researcher and the city dashboard	Medium
ESS.3	Should allow mobile application to show answers to posed questions including context conditions	US17	As a service towards the user to review his or her travel motivations	High

	of the answer, and optionally publish specific answers to the user's social network.			
ESS.4	Should allow researchers to get an overview of the answers to experience sampling questions, and make different cross sections relating those answers to the target group, personal profile and mobility behaviour.	SS1, SS5	As a service towards the researcher and the city to analyse the system's impact from the user's perspective	High
ESS.5	Should offer simple to answer questions only, e.g. multiple choice questions, or other closed questions	US17	Required to minimize the interaction with the user	High
ESS.6	It should monitor and store the timing and the conditions of the provided answers.	US17, SS1, SS5	Required to analyse the context conditions in which a question was posed	Medium
ESS.7	Should offer closed questions such that minimal interaction with the user is required	US 17	Required to minimize the interaction with the user (thus the same as ESS.7?)	High
ESS.8	Should store the context in which a question was posed to the user.	US17, SS1, SS5	Looks like ESS.6, but there can be a time gap between posing the question and obtaining the answer.	Medium
ESS.9	Should be triggered by a constellation of events, which will be monitored on the PMS	Technical	And also based on local knowledge on the mobile device (e.g. time-based)	High
ESS.10	The ESS may connect to social networks to publish answer overviews or to pose questions to the user or his buddies.	US18	As an extra channel apart from the mobile, for the less time critical questions	Medium
Remarks	<additional comments>			

Table 37: Experience Sampling Store (ESS) Requirements

T2.3	**RIM**			
Expert	Christian Schaefer (Docomo), Johan Koolwaaij (Novay)			
Component	Relation and Identity Manager			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
RIM.1	Means to identify and authenticate users.	US2	Identity management is a key to Social Networks	High
RIM.2	Use identities from existing social networks, and connect these to the SUNSET identity in such a way that the connection can be altered or terminated by the user.	US2	Identity management is a key to Social Networks	High
RIM.3	Means to map Sunset user identities to social network identities, plus storage of	US2, US20	It is necessary to map the different worlds.	High

	the SNS keys and secret per user to allow interaction with the SNS from different SUNSET components.			
RIM.4	Use existing social networks as a basis for relation management.	DoW, task description	To bootstrap the SUNSET system	High
RIM.5	Re-use existing social network connections.	US2	To bootstrap the SUNSET system	High
RIM.6	Provide semantically rich expression of relationships, with typed relations required for easy privacy management.	DoW, task description	Required for easy privacy directives on group level, and for the ad-hoc relations	Medium
RIM.7	Enable the expression of ad-hoc relationships, where each relation has both a start and an end time, similar relations may follow up on each other, and relations between users and objects are possible as well (user A uses car Z, or user B owns car Z, or user A recommends user C).	US6, US15	Necessary to allow ad-hoc grouping	Medium
RIM.8	Support different social networks for one user.	US20	That is, in principal qua design, not necessarily in implementation	Medium
RIM.9	Support for other relation types not only "friends".	US15	Ad-hoc groups in a bus are usually not based on friendship	Medium
RIM.10	Support for "automatic and temporary relations" (see ad-hoc relations) independent of the user's membership in other SNS.	US15	To persist automatically detected relations, like isTravellingWith, isFrequentUserOf, ...	Medium
RIM.11	Enable ad hoc grouping of users based on personal mobility data, such that a user is part of the Munich group as long as he is in Munich, or part of the train group as long as he is travelling by train, and users can be addressed collectively as a group.	MPD	Required to design incentives for groups with a certain behaviour, and to make the membership of an ad-hoc group explicit.	Medium
RIM.12	The membership of a group has a clear start and end time, and one person can have multiple consecutive membership periods of the same group, which are stored for evaluation purposes.	Technical	Required to design incentives for groups with a certain behaviour, and to make the membership of an ad-hoc group explicit.	Medium
RIM.13	These groups are probably so specific for mobility management that it makes no sense to import all (or connect to) existing group info from social networks, which cover many topics considered out of scope in	Technical	This is a requirement on what not to do	Medium

	SUNSET.			
RIM.14	Components, such as the MPD, can automatically detect ad-hoc groups and relations, and make these persistent in the relation manager.	MPD, ES	To make the membership of ad-hoc groups explicit, and keep the membership history for evaluations.	Medium
RIM.15	Maintain a basic user profile with semi-static information about the user, relevant for correct incentive propositions and living lab evaluations.	IMP	To allow to specify target groups for incentives, e.g. all users aged 35+ with at least one child.	High
RIM.16	Basic CRUD operations to manage and query identities, user profiles, relations, groups. Apart from the complex methods also convenience methods will be provided for easy accessible but partial/focused functionality.	Technical		High
Remarks	<additional comments>			

Table 38: Relation and Identity Manager (RIM) Requirements

T2.3	**PM**			
Expert	Christian Schaefer (Docomo), Paul Holleis (Docomo), Johan Koolwaaij (Novay)			
Component	Privacy Manager			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
PM.1	Means for users to set privacy directives (for other users and third parties) on different types of persona; mobility data	DoW, Task description	To make it easy for the user to grant other users access to personal data.	High
PM.2	Means to represent the user's privacy directives for example in a policy language like XACML.	DoW, Task description	To be compatible with future 3rd party components	Medium
PM.3	Means to enforce the user privacy directives for example by having policy enforcement points at all the data sources or by having a central enforcement point that then grants access to all data sources.	Technical	Open issue here: distributed versus central policy enforcement.	High
PM.4	Allow privacy management for groups of users, using (ah-hoc) groups and relations. This means a user can specify a privacy directive for users in a specific relation to him like "colleagues".	DoW, Task description	To make it easy for the user to grant groups of other users access to personal data.	High
PM.5	Provide means to enable access to anonymised data, specific types of data,	SS1		High

	as well as data instances, such as the user's mobility profile widget for the last year.			
PM.6	Provide means for users to exclude themselves from aggregated and/or anonymised data sets.	Dow Ethical issue	The user needs to be able to control what happens with his data, even though he is no longer identifiable in this data (this is opt-out).	High
PM.7	User has to give explicit consent for data logging in different consent groups of mobility data.	DoW Ethical issues		High
PM.8	User data shall be stored and transferred securely.	DoW Ethical issues		High
PM.9	Users shall be able to view, modify or delete data that the system stores about them.	DoW Ethical issues		High
PM.10	Users shall be able to control with which third party service provider they share which data. (Default is to share with all service providers.)	DoW Ethical issues		High
PM.11	Basic CRUD operations to manage and query privacy directives. Apart from the complex methods also convenience methods will be provided for easy accessible but partial/focused functionality.	Technical		High
Remarks	<additional comments>			

Table 39: Privacy Manager (PM) Requirements

T2.4	**ES**			
Expert	Athen Ma (QMUL), Sander Veenstra (UT)			
Component	Evaluation Support			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
ES.1	Collect data from relevant components so as to support the evaluation process.	US12, SS1, SS2, SS4	Mainly MPV, MPD and TPD	High
ES.2	Gather real-time state of the user. Handle "triggered-based" or measurement specific evaluation criteria.	US12, SS1, SS2, SS4	Mainly from the PMS	High
ÈS.3	Carry out analysis on the collected data according to the defined metrics and indicators in the evaluation methodology. This can be based on historical data over a defined period of time or event driven.	US12, SS1, SS2, SS4	Re-using visualizations from the MPV, but adding the user interaction.	High
ÈS.4	Provide and present data in	US12, SS1,	Re-using visualizations from	High

	the correct format and in a coordinated manner to the dashboard in the different living labs.	SS2, SS4	the MPV, but adding the user interaction.	
ÈS.5	Allow system administrator (Living Labs) to define criteria for data to be collected and analysed as they will be different for the three living labs.	US12, SS1, SS2, SS4	Re-using visualizations from the MPV, but adding the user interaction.	High
Remarks	<additional comments>			

Table 40: Evaluation Support (ES) Requirements

The following table describes how often specific use cases are used as source in the server-side requirements, showing a strong focus on (user-centric and community-centric) mobility overviews and incentives.

Use case	Frequency	Count (Server-side)
US1	xxxx	4
US2	xxxx	4
US3	xxxxx xxxxx xxxx	13
US4	xxxxx	5
US5		0
US6	x	1
US7	xx	2
US8	xx	2
US9	x	1
US10	xxxx	4
US11	x	1
US12	xxxxx xx	7
US13	xx	2
US14	x	1
US15	xxxxx xx	7
US16	xxxxx	5
US17	xxxxx x	6
US18	xx	2
US19	xxxxx	5
US20	xxx	3
US21	xxxx	4
US22		0
SS1	xxxxx xxxxx xxxxx xx	17
SS2	xxxxx	5
SS3	xxxx	4
SS4	xxxxx xxx	8
SS5	xxxx	4
SS6	xx	2

14.5 Infrastructure Network & Portal System Requirements (WP5)

T5.2	**INM**			
Expert	Koen Jacobs (LocatieNet)			
Component	Infrastructure Network Manager (INM)			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
INM.1	The INM should have	US3, US10,	In principle it should cover	High

	knowledge about the transport network, or at least the larger regions around the SUNSET living lab cities	US16	the region in detail and the country in terms of highways and railways.	
INM.2	The INM should include roads, cycling paths, walking paths and public transport connections such as train and bus routes	US3, US10, US16	Required to perform modality detection	High
INM.3	Knowledge should include information about the road segments, the way they are interlinked, and characterizations including intended modalities, maximum speed, road design, and road quality	US3, US10, US16	Required to distinguish between modalities based on segment properties	High
INM.4	The INM should offer functionality to resolve geo-location traces into road segments for the purpose of map matching and pattern detection	US3, US4	Required to reconstruct a trip from a series of measurements	High
INM.5	The INM should offer functionality for reverse geo-coding and mobility-related POI search	US3, US4	Required to (1) provide an interpretable format for geo-locations (e.g. used on the mobile client), and (2) to …	High
INM.6	Offers functionality to collect and maintain traffic-related information such as traffic jams, road works or weather as supplied by external sources (more detailed connectors to road side sensors, such as traffic light delay or traffic intensities on infra segments are provided in WP5)	US10	Required to provide travel advice based on traffic information	Medium
INM.7	May offer functionality to connect to external routing services	Technical	Might be required for map matching, if the internal algorithm for routing falls short, or becomes too complex.	Medium
Remarks	<additional comments>			

Table 41: Infrastructure Network Manager (INM) Requirements

T5.2	**INM**			
Expert	Arjan Peddemors (NOVAY)			
Component	Infrastructure Network Manager (INM)			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
INM.1	Retrieve the definition of infrastructure segments (parts of roads, railways, etc.) incl. the (GPS) location of endpoints	US3-US12, US14-US16, US18-US22, SS1, SS2, SS4	Used for a broad range of services, for instance to display an infrastructure segment on a map	High
INM.2	Get places close to a (GPS) location	US3-US12, US14-US16,	Helps to find places where users reside	Medium

		US18-US22		
INM.3	Retrieve the infrastructure segments close to a (GPS) location	US3-US12, US14-US16, US18-US22	Allows to find the position of a user in the infrastructure network	Medium
INM.4	Get the mapping of a given (GPS) location trace to a list of infrastructure segments.	US3-US12, US14-US16, US19-US22	Allows for the expression of mobility traces in terms of routes through the infrastructure network	High
Remarks				

Table 42: Infrastructure Network Management (IMM) Requirements

T5.2	**ISS**			
Expert				
Component	Infrastructure Status Store			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
ISS.1	ISS should be able to represent traffic incidents	SS1	There should be a way to measure the effect of the SUNSET system to the reduction of traffic congestion.	High
ISS.2	ISS should be able to map traffic incidents to routes	US7, US11	Mapping traffic incidents to the road network is needed to determine if a user's route is obstructed by a jam or other incident.	High
ISS.3	ISS should be able to map POIs (e.g., regarding incentives offers or road cameras) to the network	US11	Mapping POIs to the network is needed to relate location-based services to users	High
Remarks				

Table 43: Infrastructure Status Store (ISS) Requirements

T5.2	**TPD**			
Expert	Koen Jacobs (LOCNET), Sebastiaan Raaphorst (LOCNET)			
Component	Traffic Pattern Detector			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
TPD.1	TPD should be able to map sensor data to OSM network segments	N/A	In order to calculate travel times, the sensor data should be represented in the format of the road network.	High
TPD.2	TPD should be able to perform travel time predictions based on historical information	N/A	Prediction based on statistical analysis of historic sensor data could yield a travel time prediction for given moment in the future.	High
Remarks				

Table 44: Experience Sampling Store (ESS) Requirements

T5.2	Proxy & Authentication			
Expert	Paul Holleis, Marko Luther, DOCOMO			
Component	Proxy & Authentication			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
PA.1	Users must be able to allow applications access to SUNSET components and (partial(data without giving away their credentials	DoW, Workpackage overview WP2	SUNSET and 3rd party apps are central for SUNSET users. However, they should only need to provide their credentials in one central place and have restricted access only to the data they need and are granted access too.	High
PA.2	Means to identify and authenticate users	PA.1	Only authenticated users should be allowed to access	High

			data	
PA.3	Token handling including creation, signing, exchange, and revocation.	PA.1	Tokens are central in storing authentication data	High
PA.4	Consent handling	PA.1	Consents are central in describing to the system and to the user what components is allowed to access which data	High
PA.5	Endpoint for all internal subcomponents of the SUNSET system that, after token verification forwards messages extended by information indicating the authorized entity and the given consents	US.2	Components need an interface through which they can access required data. This interface should check the validity of the request and adorn it with additional information such that components can further decide whether the correct consent has been approved by the user.	High
Remarks				

Table 45: Proxy & Authentication (PA) Requirements

T5.2	**Living Lab Controls & Evaluation (Dashboard)**			
Expert	Zhenchen Wang (QMUL)			
Component	Living Lab Controls & Evaluation			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
LLC.1	Historical and live traffic information display	SS1, SS6	These information is processed on the central server which can effectively reduce the duplication	High
LLC.2	Traffic prediction display	SS1, SS6, SS4	To support policy maker decision making	Medium
LLC.3	Mobility profile display	SS1, SS4	To support policy maker decision making	High
LLC.4	Online user location display	SS1, SS4	To support mobility visualization	Medium
LLC.5	User experience answers display	SS5	To support policy maker decision making and Living lab controller	High
LLC.6	Incentive management	SS3	To support incentive update	High
LLC.7	Group users in terms of mode of transport	SS2	To support policy maker decision making	High
Remarks				

Table 46: Living Lab Controls & Evaluation (LLC) Requirements

T5.2	**Web Portal (User)**			
Expert	Thomas Oshin (QMUL)			
Component	User Web Portal			
Type	System			
Number	**Description**	**Source**	**Rationale**	**Priority**
WP.1	User experience answers should be visualized.	SS5	To support policy maker decision making and Living lab controller	High
WP.2	Show user mobility patterns and visualize	SS1, SS4	To support mobility visualization	High
WP.3	Display user current and historical incentives	SS3	To support incentive update	High
Remarks				

Table 47: User Web Portal (WP) Requirements

15 Appendix: Stake-holder Consultation results

Q #	Sub-question #	Sub-sub-question #	Stimulus	Interviewee #1	Interviewee #2	Interviewee #3	Interviewee #4
Personal information and background							
1	A & B		Age & Gender	All interviewees are male in the age 35 to 55 years			
Professional information and background							
2	A		employer	All interviewees work at the municipality of Enschede			
	B		job description	project manager urban development	Policy advisor accessibility and mobility, researcher and coordinator	Traffic engineer and designer	Senior policy maker
	C	I	time in current job	2 years			
		II	experience with other traffic / policy related jobs	Provincial Government	Consultancy		Consultancy
	D		What are you traffic management	Improve traffic flow, increase road capacity,	Gathering traffic-related information and	Liveability from citizens in relation to externalities	

			objectives	increase traffic safety, improve quality of (urban) environment	providing others with that information	caused by traffic	
	E		To what extent is monitoring and/or evaluation of traffic important in your job?	It is important to estimate effects and success. *However the interviewee claims it is important but does not really have control over the monitoring and evaluation process*	Research mainly from technical background	The interviewee acts upon the 'problems' that the citizens raise and tries to find solutions. Furthermore the interviewee works on improving the accessibility and throughput of the main urban roads Evaluation is not done on facts and figures, but problems are solved if no new complaints occur	
	F		What is your experience with 'soft' traffic measures/incentives				

Views on SUNSET concepts							
3	A	Personal experience with smartphones and social networks					
		I	Do you own a smartphone? Do you use the 'smart part' and for what purpose?	Uses the smartphone for e-mail, agenda. Not for apps	No smartphone	Uses the smartphone for e-mail, agenda. Not for apps	Uses the smartphone for e-mail, agenda, and installed some apps mainly to plan a route
		II	How active are you on social network sites? Do you use SNS in a professional context as well?	Does not use SNS for personal use	Only little	Does not use SNS for personal use	Does not use social networks actively
	B	What is the potential of using social networks in a traffic context?					
		I	What is the added value of providing information via social networks?	Has potential to spread news, especially when many people use it	Direct information has more potential than via a social network		Using a social network as a forum for discussion might be useful for introducing potential incentives and experience

		II	Has a social network added value in a traffic context?	Providing traffic related news on the traffic situation	Only if information is 'pushed' towards users in the social network	Has potential in providing information to citizens on considerations for policy choices. Higher workload in communication for municipality	The most important thing here is that the system offers functionality to the individual The SN can be supportive
	C	what is the potential of using (types of) incentives to change individual behaviour and to reach the objectives (stated by the respondent himself)					
		I	the potential of providing information	Support in route choice will work in terms of congestion and personal wellbeing	Some people will use it to make choices based upon the information	Already too much information, should have a clear additional value	Most potential is in the information on personal health and CO2
		II	the potential of giving advice by system and by other users	When focussed on the individual, it could lead to behaviour change	With the advice the used information and considerations should be presented	Has potential because of the focus. Useful for users	Most effective would be information with an integrated advice (depends heavily on the availability of information)
		III	the potential of rewarding users	People are sensible to rewards and punishments	Rewards have potential, both financial and other. Recognition	People tend to do something when there is something in return	Could be an additional push towards change

					has less potential		
		IV	the potential of games	Possibly but other incentives concerning personal goals (will I get wet when I use the bike now?) are more important	Most potential with younger users, only for a limited time	May work at first but may fade out	The way of presenting the incentives should be appealing, possibly in a game. Performing better than somebody else could be an incentive to join
		V	divide 10 points across the four incentive types mentioned above	i 2 ii 3 iii 4 iv 1	i & ii 5,5 iii 4 iv 0,5	i 1 ii 4 iii 3 iv 2	i 0 ii 2 iii 3 iv 5
Views on dashboard functionalities							
4	A	Current use of tools which assist in monitoring the local traffic situation (competitors for SUNSET city dashboard)					
		I	What data or information do you currently use in your profession (to spot problems and/or to	None	Regional traffic model GIE (geo-information Enschede): - Traffic Counts Data from traffic	Regional traffic model GIE (geo-information Enschede): - Traffic Counts - Cyclorama	

			issue/evaluate solutions/measures)?		lights	(street view) - Aerial views	
		II	How useful is this data/information?		The more data is available the better the traffic model can be calibrated	Information is not always up-to-date. Traffic counts are sometimes 2 years old Traffic model is static instead of dynamic	
		III	what are the limitations of this system?		Information is highly aggregate. Routes through traffic are not taken into account (gravity model is used). OD-relations are hard to check		
		IV	Can SUNSET help to improve the functionality to reduce these limitations?		More insight in relations between origins and destinations and routes might have added value	Real-time information on travel times, but long-term conditions should still be available	
		V	Is it a		Travel times of		

			redundancy if SUNSET includes this functionality or can there be added value by combining it with other features?		individuals has added value Access to data which is already accessible should not be prioritised		
	B	What data/information should be provided by the city dashboard (i.e. a web portal where the transport system of the living lab is visualized) to have an added value to your work					
		I	Intensities and travel times of different modalities?	Travel times are more important, when the ratio between the intensity and capacity is OK.	Travel times are very important, intensities are important if reliable	Travel times are important at the main urban roads. The lower level roads should have info on intensities	
		II	State of external factors like weather, events or unusual situations?	Important in modality choice. Not so much in evaluation	Could be interesting for traffic analysis, especially for planned events in relation to traffic guidance	Especially to be able to detect problems in unusual situation (e.g. bad weather)	
		III	information on the composition of traffic in terms	Could be interesting when evaluating, especially modes	Not directly important, maybe in evaluations	Modal split is important for policy issues. Information on trip	

			of traveller type	of travel.		motive might be useful for dynamic traffic management (i.e. parking guidance system) in Enschede	
		IV	Subjective information from users			Very important to be able to trigger problems	
Desired and required level of data-aggregation							
5	A	What spatial aggregation level of the data would be most useful?					
		I	City-wide … area/quarter … neighbourhood … route … street/intersection … something else	Routes and intersections are most important because of travel time losses and emissions	Neighbourhoods and routes are the most important levels	Mainly the main urban routes and residential streets	
		II	divide 10 points over the previous aggregation levels (i.e. listed in 5ai) based on				

			usefulness				
	B	What temporal aggregation level of the data would be most useful?					
		I	Year … season … month … week … day … part of day … peak hours … hour … real-time	Peak hours are important in relation to off-peak	Current situation in relation to the average. The average could be an average peak hour or month and the current situation is real-time	Peak hours are the most important because problems mainly occur in peak hours. Averages in years or season are however still important	
		II	divide 10 points over the previous aggregation levels (i.e. listed in 5bi) based on usefulness				
		III	Based on events			Recurring events like FC Twente (football) should be possible	
	C	What social aggregation level of the data would be most useful?					
		I	Based on person or household			Throughput on routes should be good, no matter	

			type			who uses the routes	
		II	Based on modality type *(e.g. Car, bike, walking, PT, other)*			Modal split is important	
		III	Based on trip motive *(e.g. Business, home-work, recreational, shopping, other)*			Recreational is not to important (not in peak hours)	
		IV	divide 10 points over the previous aggregation levels (i.e. i, ii and iii) based on usefulness				
Additional suggestion or functionality gaps							
6	What types of problems or opportunities could the SUNSET system respond to or solve?			Advise in case of road works and rerouting, especially in non-regular situation.	Approaching specific groups		

		Should also provide information on effects of traffic measures (like in a traffic model) Provision of traffic information to citizens			
	What types of problems would the SUNSET system and the city dashboard be most useful for?	Traffic and transport analyses based on data gathered in SUNSET			
	Do you have any suggestions for the city dashboard or the SUNSET project in general that would improve the system or the dashboard?		The project should focus on providing personalized information	More actual data, combining different data sources could be valuable	