D4.1 Pilot Evaluation Framework

ZLC

Deliverable

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1 Executive Summary

The adoption of new urban mobility solutions requires defining policies to reach the city - targets (e.g. reduce environmental impact) without worsening other variables (e.g. accidents).

This adoption depends on the different city-stakeholders' levels of acceptance. On the one hand, the service operators need these policies to ensure the operational feasibility and financial sustainability of the solution; on the other hand, the city aims to get the maximal social and environmental benefit while incurring the minimal cost. Finally, the citizens determine adoption success. They represent both, either end-users who benefit from the service or those who suffer the disadvantages (e.g. cyclist vs pedestrians).

Policy-makers play an essential role when catalysing all the stakeholder's requirements by the correct definition of the policies that fit better with the specific area-case idiosyncrasy. However, they emerge fast and with little room for them to react. Cities require enhancing the decision-making process with a correct policy evaluation framework that guides the process and relies on evidence.

The SPROUT pilots will introduce new mobility solutions and draw the city-specific policy response. The pilots' implementation and evaluation framework provide cities with guidance to set the policy-response and ensure successful adoption. SPROUT divides this process into three steps:

First, pilots will test in practice the emerging mobility solution (T4.3), introducing it into a limited scale "*real ecosystem*[1]" and collecting data to assess the operators' operational feasibility and financial sustainability, and the sustainability impact. From these data, cities will identify policies that, being modified or removed, will enhance the results. When facing this process, some questions arise, "how to measure operators' sustainability and operational feasibility, and the sustainability impact of the new mobility solution? "how to use this information to identify the policies which should be modified or removed?".

Second, with the T4.3 resulting list of policies with negative impacts, the list of existing alternative responses defined by T3.3, and with the compiled stakeholders' preferences identified in T2.4, pilots will evaluate and prioritize policies to incorporate in T4.4. But, "how to evaluate and prioritize the policies?".

Third, from the list of prioritized responses, pilots' policy-makers will agree on which ones to implement at a limited scale. Pilots will assess their implementation feasibility and user acceptance to validate the set of alternative policies (T4.5). With the results, first layer cities will draw the city-specific policy response. Final questions to undertake are: "how to define and assess the implementation feasibility?"; "and the

[1] Real ecosystem refers to Living Lab: A living lab is a user-centred, open-innovation ecosystem, often operating in a territorial context (e.g. city, agglomeration, region, campus), integrating concurrent research and innovation processes within a public-private-people partnership- (Wikipedia)

user acceptance?"; "how to use the results for defining the final city-specific policy response?"

Based on the FESTA methodology and with detailed descriptions of the assessment methods to use, the SPROUT evaluation framework provides pilots with a comprehensive and essential guide to conduct the three tasks smoothly. The application of the framework will result in the city-specific policy response, ensuring the successful adoption of the new mobility solution.

2 Introduction

2.1 Aim of the deliverable

The objective of this deliverable is to define an ex-post evaluation framework (EF) that considers just the incremental benefits and costs, and relies on the specific actors' improvements experienced compared with the situation without the new mobility solution. This evaluation framework will be the base for T4.2 (M11-M12). The pilots will use this document as a reference to give detailed specifications of the implementation plan and the testing activities for the three remaining WP4 tasks:

- T4.3 (M13-M16): sustainability assessment of the pilots' impacts. In this task, users and operators will assess the mobility solution itself.
- T4.4 (M17-M18): formulation and prioritization. In this task, pilots' stakeholders will agree with the list of alternative responses that may enhance the adoption of the mobility solution.
- T4.5 (M18-M20): City-specific policy response for harnessing the impact of new mobility solution. In this task, the city as a whole (policymakers, operators, users) will assess different policy alternatives.

The evaluation framework is structured according to the FESTA methodology (see Annex 1). It includes guidance to cover cutting issues such as the implementation plan definition, stakeholder identification and involvement, ethical and legal issues, the communication strategy, and the identification of any possible issue or limitation that could appear when running and testing the pilots by performing the risk management. In addition, it helps the pilots to define the indicators for the assessment and the analysis methods to be used in T4.3, T4.4, and T4.5. The framework also gives guidance of some of the methods and indicators they may use (as per SPROUT DoA):

- For the operators' financial and economic feasibility, it describes the Cost-Benefit-Analysis Methodology.
- For the sustainability impact, it provides pilots with the most comprehensive method for calculating mobility cost externalities.
- Considering the SPROUT mobility systems as digital mobility solutions as they have some information or communication technological component; the operational feasibility will be assessed following the 'Product Quality Model' and the 'Quality in Use Model' of ISO/IEC 25010.
- This EF also explains a multicriteria analysis decision method that pilots will use for supporting decision making covering different stakeholders views and criteria (multi-actor multi-criteria analysis [MAMCA])).

Finally, although not requested for this T4.1, it includes a list of indicators for assessing the pilots' implementation feasibility and user acceptance.

2.2 How this deliverable relates to other deliverables

This is an essential input to prepare the implementation of the 6 pilots under task 4.2 – "*Detailed specifications of pilots' implementation*" conducted during M11 and M12. It will provide the pilots with an evaluation framework that includes a generic implementation plan they will adapt accordingly to their idiosyncrasy, but following and considering key steps. It will help to identify the relevant stakeholders for running and testing the pilots. Finally, it presents the common methods they will use for collecting data and perform the analysis.

2.3 Task Participants and sharing of contributions

The participants for this deliverable are ZLC as the leader of the task, VUB and CERTH. VUB, as the WP2 and WP3 leader, supported the development of this evaluation framework. They also provided the input for describing the existing CIVITAS tools and support for identifying stakeholders' groups. CERTH as the main technical coordinator validated the correct definition of the adapted evaluation framework and provided input for the operational feasibility. ZLC described the framework for measuring the sustainability impact and the operators' financial and economical sustainability. It also adapted the FESTA methodology to cover all the pilots' tasks under WP4 (T4.2, T4.3, T4.4, T4.5).

2.4 Structure of Deliverable

The section that follows (Section 3) first describes the SPROUT evaluation framework (EF). It explains how the WP4 running & testing activities in Task4.3, Task 4.4, and Task4.5 will be prepared and executed following FESTA foundations (as per DoA) for succeeding in conducting Field Operational Tests. According to the proposed FESTA methodology, the EF gives guidelines to define cross-cutting issues that affect the three WP4 pilots' tasks; it presents further details for leading FESTA preparing phase, referencing the methods and the indicators the three tasks will use in performing the assessment. This section also describes the activities that the three tasks will implement during the FESTA using and analysis phases. Section 4 contains the explanations of the methods and indicators referenced previously. It states the information to collect from the use cases or through other means emphasizing the need to specify who will provide it and the possible limitations.

3 SPROUT Implementation and Evaluation Framework

The SPROUT pilots or first layer cities are "*real ecosystems*[1]*"* that will introduce new mobility solutions and draw the city-specific policy response to ensure the successful adoption and wide acceptance. The SPROUT project has divided this process into three tasks (Task 4.3, Task 4.4, and Task 4.5) with different objectives, tests, and assessment methods. The successful running and testing of the pilots require the definition of the evaluation framework and an implementation plan during the setup phase (T4.2).

This section defines the SPROUT evaluation framework that pilots will use as a guide for the pilots' setup in T4.2. It relies on FESTA methodology (see Annex 1) and comprises three main phases (Figure 1).

The first phase or "*preparing phase"* corresponds to Task 4.2 (M11-M12). It provides pilots with guidelines to plan and design the specific tests' requirements for Task 4.3 (M13-M16), Task 4.4 (M17-M18) and Task 4.5 (M18-M20) in parallel. According to FESTA methodology, it also gives guidance for the cross-cutting issues or transversal and common aspects of the three tasks: implementation plan, stakeholder involvement, ethical and legal issues, communication strategy, and risk management. The second phase or "*using phase*" refers to the execution of the specific test, the collection of data, and the calculation of performance indicators. The third phase or "*analysis phase*" uses the test specific second phase outputs to deliver the task-specific outcomes, learnings, and findings.

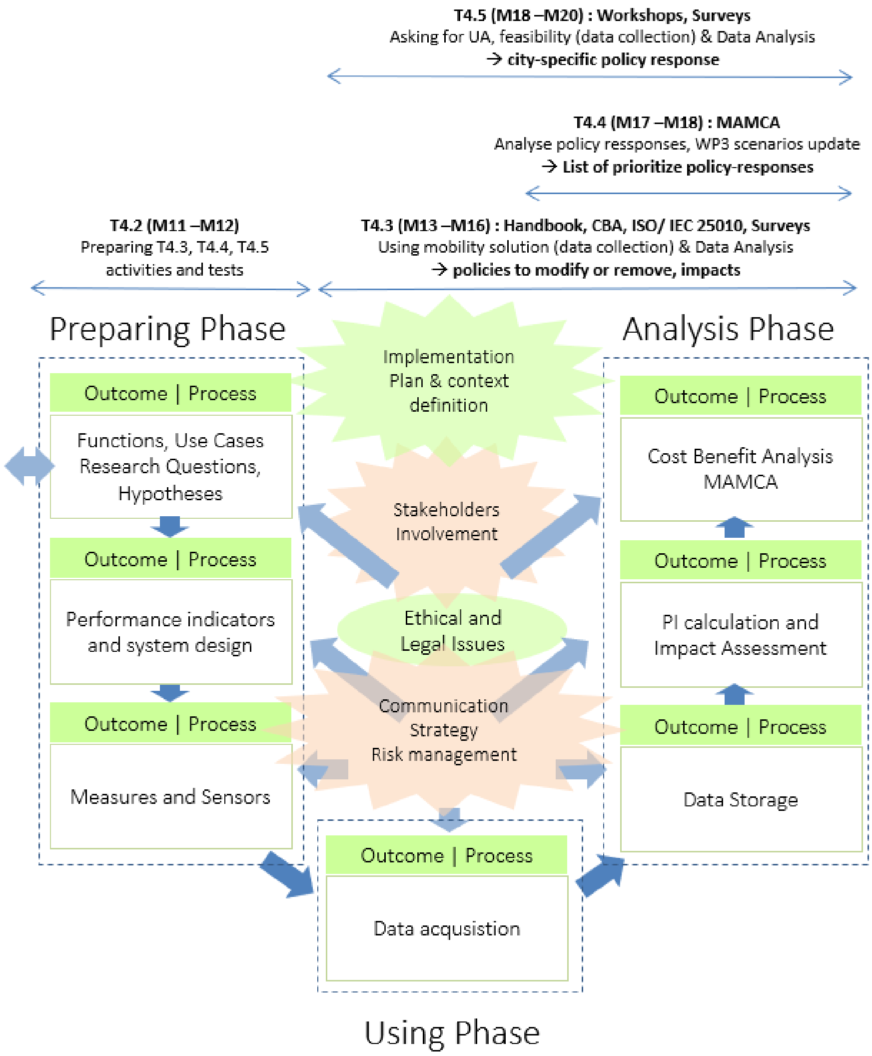

Figure 1. SPROUT evaluation framework.

3.1 Phase 1: Preparing-phase

The preparing phase provides pilots with guidelines to prepare "*T4.2 Detailed specifications of pilots' implementation*". It describes how to plan all the activities and tests required to implement and evaluate the demonstrators.

3.1.1 Cross-cutting issues

This section provides guidance to the pilots to define the FESTA methodology cross-cutting issues or transversal aspects that need to consider all the activities that will take place during Task 4.3, Task 4.4, and Task 4.5. These aspects will require revisiting and updating when running the tasks and comprise the implementation plan & context description, the ethical and legal issues, stakeholders' involvement, risk identification and mitigation strategies, and the communication strategy.

a) Pilots use case description

Pilots will give more details to describe their context. Below there is a list of some information that pilots could provide to enrich their description.

- Description of the urban mobility solution and how it will be introduced;
- Details about the area where the pilot will be tested to contextualize the pilot (e.g. location, population density, commercial activities, residence area);
- Reasons why the pilots selected this specific location;
- The policy framework that affects the pilot implementation, why and how (positively, negatively)

b) Implementation Plan

Pilots will define an implementation plan that includes all the activities of T4.3, T4.4 and T4.5. They will specify the timeline to run the tests, compile data, and analyse the results. Figure 2 shows a generic diagram with the minimal set of activities that pilots may use and adapt.

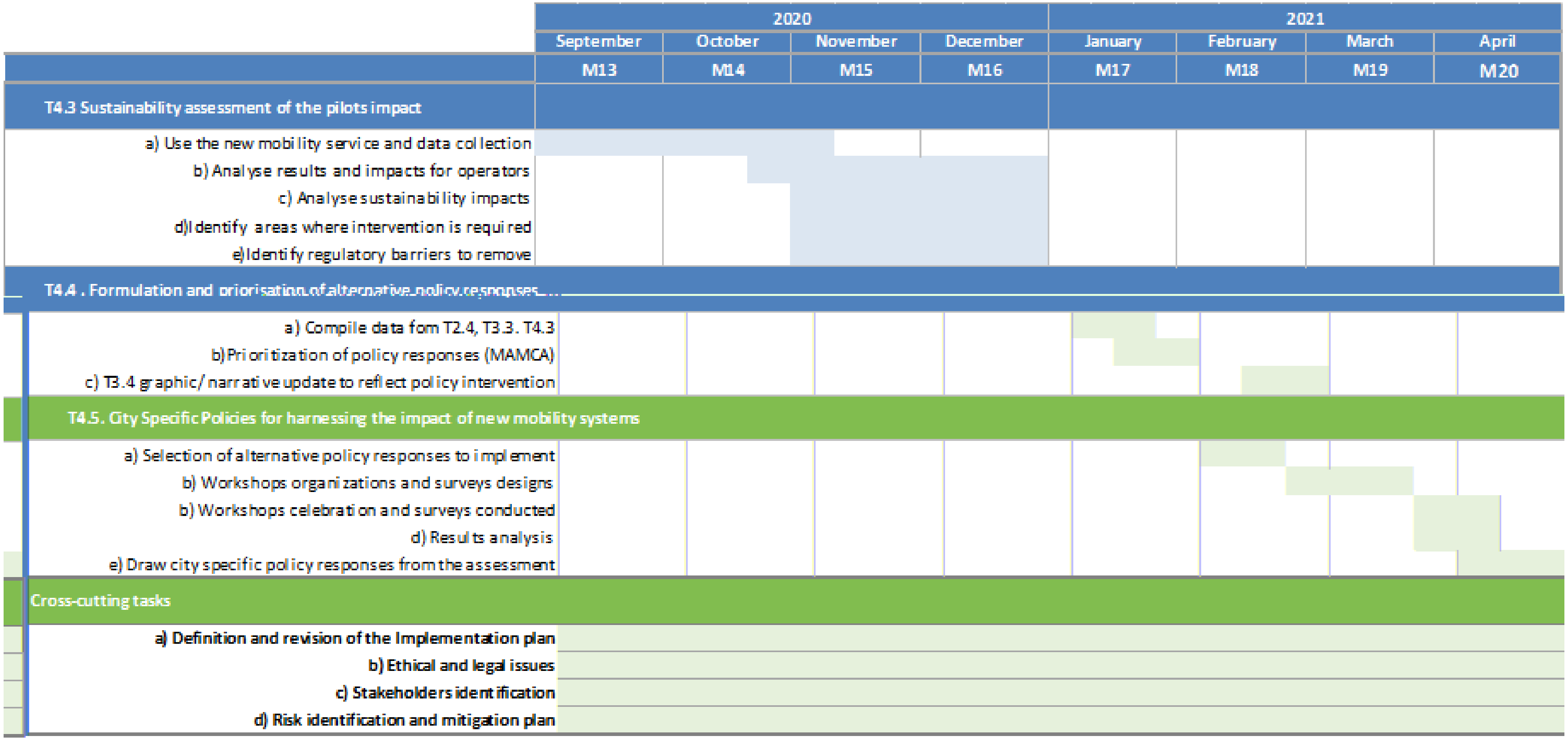

Figure 2. WP4 Pilots activities and timeline.

c) Legal and Ethical Issues

SPROUT pilots twill collect data from respondents from European countries and China.

Regarding the activities carried out in China, NSCIIC is the coordinator of the Ningbo pilot. NBUT is also involved in the setting up, testing and validation activities. Both beneficiaries signed a declaration of compliance with the EU General Data Protection Regulation (see SPROUT's deliverable 1.2).

Cooperation in SPROUT activities is entirely voluntary at all stages and must be based on adequate information about the general purpose and nature of the project. For this purpose, the ***Project Informed Consent Form*** will be handed out to all potential participants in the pilots (details can be found in deliverable 1.2).

For all activities in the project, it is planned to use fully ***rational adults*** that can understand and consent to their involvement in the project. This means that they will be ***in a position to understand their role in the project.***

To be able to pay special attention to the needs of ***vulnerable groups*** and users with ***different cultural backgrounds*** considering ***gender issues*** and embed those special needs into its proposed city-led policy response, the project might need to collect ***vulnerable-groups, different cultural backgrounds, gender data***. For such data, (and also if other sensitive data should be collected for the purpose of the project), the SPROUT Coordinator would request the Ethics committee for its formal approval before their collection. In any case, details on the procedures and criteria that will be used to identify/recruit research participants will be provided.

The rights of data subjects are described in D1.2.

During the pilots running and testing phase, it is possible that the SPROUT team will gain access to **data** that was collected **before the start of the project**, by an organisation who is **not a member of the consortium.** In this event, the SPROUT partner who receives this data must ensure that there is **no information** contained in the data that **could be used to identify individual citizens.**

Similarly, as when interacting with **human participants**, **informed consent** must be obtained when acquiring pre-existing data from external sources. This procedure is not necessary when data has been explicitly released to the public domain, or released under clearly stated conditions that include the intended usage within the SPROUT project.

The SPROUT project participates in the Open Research Data Pilot proposed by the Commission to ensure that the project data and results are FAIR (findable, accessible, interoperable and reusable). Details can be found in the Data Management Plan of SPROUT, which provides details on how personal data is handled in the project (D9.4).

The SPROUT coordinator, ZLC, will be the data controller for the project. According to its privacy policy[2], the data controller can be reached at privacy@zlc.edu.es.

d) Stakeholders identification and involvement

An important step to setting up and evaluating each 1st-layer city pilot is identifying the stakeholders that will be involved in the pilots. As part of T2.1, 'Urban mobility transition inventory', they already selected relevant stakeholders to include in the various steps of the project (e.g. the scenario writing workshops as part of T3.1, 'City-specific urban mobility scenarios', or setting up and evaluating the pilots in WP4). This same overview, in the table below, can be used by pilot representatives if they feel that they need to include more, or different stakeholders in the next steps of the project.

These stakeholders will be involved in all or most of the testing and running activities of T4.3, T4.4 and T4.5. In T4.3, the mobility solutions will be tested in practice and data collected for assessing operator's feasibility and sustainability and identifying policy negative effects related to the sustainability impacts, that being removed or modified would enhance the results. In T4.4, pilots will evaluate the alternative policy responses that will be developed. For this purpose, the stakeholders will be grouped based on previous research on MAMCA in transport and mobility, with the option to define additional stakeholders that were not included in the T2.1 list. Finally, in T4.5, some of these stakeholders will participate in local workshops and fill some surveys to assess alternative policy responses operational feasibility and user acceptance. Their responses will be analysed to draw the final city-specific policy response.

Table 1. shows the stakeholders already identified in the T2.1 and additional ones that could be essential for running and testing the mobility solution. Within these additional stakeholders, the list includes vulnerable groups, as their specific needs have to be considered into the proposed city-led policy response. Although not all stakeholder groups will be necessarily represented in all cities and participate in all task, this table will help pilots to identify and engage the ones needed. It will also help to specify their involvement and have an overall picture of the stakeholder's pilot's role during the whole WP4 phase in T4.2.

Table 1. Pilots stakeholder's identification and involvement.

Type of stakeholder	Name of specific local stakeholder organisation	Involvement
Public administration		
Governmental bodies responsible for transport planning, public works, infrastructure, environment, public space, on local, regional and	To be determined by each city individually (TBD).	Task 4.3, Task 4.4, Task 4.5

[2] https://www.zlc.edu.es/privacy-policy/

metropolitan levels.		
Public Services		
Police	TBD	Task 4.3, Task 4.4, Task 4.5
Emergency services	TBD	Task 4.3
Conventional public transport operators		
Operators of local transport (local bus, tram, (sub)urban rail, ferry, metro)	TBD	Task 4.3, Task 4.4, Task 4.5
Operators of national or regional transport services (train, long-distance bus)	TBD	Task 4.3, Task 4.4, Task 4.5
Conventional taxi companies	TBD	Task 4.3, Task 4.4, Task 4.5
'New mobility' providers		
Shared mobility operators that provide shared cars, (e-)bikes, scooters, motorbikes	TBD	Task 4.3, Task 4.4, Task 4.5
- Peer-to-peer platforms that provide a platform for individuals to share vehicles or provide services (e.g. ride-sharing): - Carpooling (e.g. Blablacar) - peer-to-peer car rental (e.g. CarAmigo)	TBD	Task 4.3, Task 4.4, Task 4.5
Platform-based taxi services (Uber, Lyft)	TBD	

Data/Tech companies		
Wayfinding and route planning providers (e.g. Google Maps, Waze, TomTom, JoynJoyn)	TBD	T4.3
Mobility as a Service provider (e.g. Citymapper)	TBD	T4.3
Providers of smart technology for traffic management (e.g. Intelligent traffic management, smart parking and traffic monitoring service providers such as Kapsch, Siemens etc.)	TBD	T4.3
Energy providers		
Petrol station owners	TBD	T4.3
Electricity providers	TBD	T4.3
Providers of electric vehicle charging points	TBD	T4.3
Potential Stakeholders		
Travellers' associations	TBD	T4.3
Public transport passengers' associations	TBD	T4.3
Drivers' associations	TBD	T4.3
Cyclists' and pedestrians' associations	TBD	T4.3
Other associations related to basic needs to satisfy through the mobility (I.e. food association, mental disease association, disable associations)	TBD	T4.3
Potential Users as representatives of vulnerable groups		

Elderly people *Lack of confidence using digital tools. Reduced mobility.*	TBD	T4.3
People with physical disabilities *Physical barriers to use mobility solutions.* *Reduced mobility or vision.*	TBD	T4.3
Potential Users – Residents		
Civil society organisations representing residents (e.g. neighbourhood committees)	TBD	T4.3
Potential Users - Local businesses		
Federations of business owners (e.g. chamber of commerce)	TBD	T4.3
Urban Logistics		
TBD		T4.3
Vehicle manufacturers (when relevant locally)		
TBD		T4.3
Residents		
TBD		T4.3
Local businesses		
TBD		T4.3

e) Risk identification and mitigation plan

This step is essential for pilots to foresee possible risks before starting a new phase and define a contingency and mitigation plan. This information will also help the pilots and project coordinators to follow-up on these issues and react such as the limitations that may be faced regarding the information to be collected and the results of the assessment. It includes COVID-19 as one of the possible risks.

Table 2. Risks, contingency and mitigation actions (including COVID-19).

Task#.#	Risk description	Contingency action	Mitigation Action
Task4.3	Delays (COVID-19)	Try to anticipate all the paperwork	Alternative testing area; Scenarios simulation
T4.3, T4.4, T4.5	Lack of stakeholders engagement	Provide them with incentives to participate	Broadcast a new request to involve new representatives; bring experts from forums.

f) Communication strategy and channels

Table 3 shows a proposal for the pilots to draft the communication plan. It enables the pilot team to communicate effectively with the rest of the SPROUT project members, team, and other stakeholders. It sets clear guidelines for how the information will be shared, as well as who's responsible for and needs to be looped in on each project communication.

The pilots' specific communication plan will include the WP4 follow-up meetings and monitoring reports; project monitoring meetings and dissemination activities. The first two rows in Table 3 refer to the WP4 follow activities. About the first, the pilots' coordinator will request them to report the state of the activities planned into their specific Gantt chart every week using a monitoring report will be distributed before starting T4.3 (M13). About the second, he/she will set-up bi-weekly WP4 follow-up calls since M10 with the following purposes:

- to monitor the progress of the pilots,
- to facilitate pilots to exchange information and experiences faced during the pilot's implementation and evaluation phase (e.g., data collection)
- other WPs leaders or participants will be invited to attend the follow-up meetings. If they required participating, they will ask the WP4 coordinator for a slot in the agenda.

Third and fourth rows concern to the SPROUT projects meeting takes place every 6 months and any dissemination activity they expect to participate until the end of the project or after the project. The last two rows represent a couple of examples the pilots may use.

Table 3. Communication strategy and channels.

Communication	Method	Frequency	Goal	Owner	Audience
Pilot Status Report	Email	Weekly	Review pilot status and discuss potential issues or delays	Pilot leader	Pilot team + ZLC's coordinator
WP4 follow-up	Meeting (Conference)	Bi-Weekly	Review pilot status and share experiences with the rest of the pilots	Pilot leader	Pilots' leaders +ZLC's coordinator + CERTH
General Assembly	Meeting (F2F/online when not possible)	6-months	Present project deliverables, gather feedback and discuss next steps	Project Coord.	SPROUT team
Dissemination activities	-	-	Dissemination activities		
Team stand-up	Meeting	Weekly	Discuss what each team member did the week before, what they will do during the week and any blockers	Pilot leader	Pilot team
Pilot review	All milestones		Present pilot, deliverables, gather feedback and to discuss next steps	Pilot leader	Pilot team

3.1.2 Task 4.3: sustainability assessment of the pilots' impacts

The evaluation framework *preparing phase* follows a chain of steps further detailed below. They help to identify the performance indicators and define the acquisition and analysis methods (see Figure 1) along with the stakeholders involved. It requires a clear understanding of the task description and objectives.

a) Description of the task and objectives

The objective is to test in practice the assumption that the identified emerging mobility solutions that are the core of the project: (1) are feasible and sustainable, in other words, that they are not just a fad to disappear in the short term; (2) can benefit from a policy response, either in terms of enhancing their sustainability or in terms of mitigating negative impacts. The work to be undertaken will include (see implementation plan):

Testing the new mobility solutions and assessing their operational feasibility and financial sustainability from the operators' point of view;

- Assessing the economic, environmental and social impacts of new mobility solutions and identifying areas where policy intervention will be required due to negative impacts;
- Assessing policy-related and regulatory barriers during the implementation of the pilots that being removed would enhance their economic, environmental and social impacts

b) Research questions

From the task description and objectives stated above, this section identifies T4.3 generic research questions pilots may adopt. During task 4.2, pilots can include other pilot-case specific research question.

- *"how to measure operators' sustainability and operational feasibility?";*
- *"how to assess the environmental, social, and economic impact?";*
- *"how to use this information to identify where policy intervention will be required due to negative impacts?"*
- *"how to use this information to identify where policy-related and regulatory barriers that being removed would enhance their economic, environmental, and social impacts?"*

c) Performance indicators, data collection methods, stakeholders involved

Responding to the questions above requires pilots to test "*the mobility solution"* and measure performance through the definition of performance indicators, data collection and analysis methods, and stakeholders involved.

For measuring ***the operator's financial sustainability***, operators will follow the Cost-Benefit Analysis method (CBA). The Financial Net Value Present (FNVP) and the Economic Net Value Present (ENVP) are the most recommended quantitative indicators to assess the economic and financial sustainability. Section 4.1 further details about the CBA to perform operator's sustainability.

For the ***economic, environmental, and social impact***, this evaluation framework proposes pilots to use the latest version of the European External Transport Cost Handbook published in 2019. The Handbook provides pilots with a set of indicators that reflect the external cost of transport. It comprises climate change, well-to-tank, air-pollution, accidents, noise, and traffic congestion (see section 4.2).

Since all SPROUT mobility solutions have some digital component (Table 4), the SPROUT pilots will adopt and adapt the ISO/ IEC 25010 to measure the product's quality and quality in use related to the ***operational feasibility*** (see section 4.3).

Table 4. SPROUT pilots' digital components.

Pilot 1 (Valencia)	Digital parcel-lockers; digital booking and payment systems; connected users to the public transport services
P2 (Kalisz)	Sensors for parking managing and mobile apps for booking places
P3 (Budapest)	New digital sharing mobility services such as dock-less bike sharing systems
P4 (Padua)	Use of autonomous vehicles for freight and passengers mobility
P5 (Tel Aviv)	Use of sensors and images processors to monitor and adapt traffic lights to the vulnerable users' needs at intersections
P6 (Ningbo)	Use of big data for hyper-local logistics.

The ***identification of*** the ***overall policy gaps and barriers*** is the result of a complex decision making that will be facilitated by the indicators calculated as explained in this document. Task 4.3 leaders will guide pilots in this process.

3.1.3 Task 4.4: formulation and prioritization of alternative policy responses

a) Description of the task and objectives

During this task, the project team will develop a *"list of alternative policy responses"* per pilot to respond to T4.3 overall gaps and barriers. This list of alternative policy responses will consider:

- The adaptation of current policy elements/instruments (e.g. SUMP);
- The integration of urban mobility policies with other policies such as urban planning, social policy (e.g. vulnerable & different cultural background groups), gender-sensitive policies, employment policy (e.g. concerning on-demand logistics), financing policy;
- Policies to help urban mobility innovators overcome regulatory obstacles (e.g. innovative deals).

The work to be undertaken will include (see implementation plan):

- Prioritization of alternative policy responses considering stakeholders identified preferences;
- Select the policy responses with a higher degree of consensus that will be brought to Task 4.5;
- Assess the impact of these policies on the WP3 scenarios;
- Update T3.4 scenario narrative and graphics reflecting the policy interventions.

b) Research questions

From the task description and objectives stated above, this section identifies T4.4 generic research questions pilots may adopt. During task 4.2, pilots can include other pilot-case specific research questions.

> *"how to prioritize the policies considering stakeholders' preferences?"*
> *"how to select the policy response with a higher degree of consensus?*

c) Performance indicators, data collection methods, stakeholders involved

The T4.4 description in the DoA already states the research method that pilots will use to respond to the research questions above. This method is the multi-actor, multi-criteria analysis (MAMCA). It allows prioritizing the policy responses considering stakeholders' preferences identified in T2.4. This method will show the synergies and conflicts between the stakeholder groups and determine the level of consensus of each alternative. Those with a higher degree of consensus will be the input for T4.5. Section 4.5.1 further details the method and provides a tool to conduct the analysis.

3.1.4 Task 4.5: City-specific policy responses for harnessing the impact of new mobility solutions

a) Description of the task

In this task, pilots assume that an appropriate urban policy response can be implemented to harness the benefits of the emerging mobility solutions and mitigate its potential negative impacts. Local stakeholders and policy makers will agree on the prioritised policy responses to introduce on a limited scale (limited in terms of time and geographical scale) in the pilots' cities, and to assess the "*implementation feasibility and user acceptance"*. The results will help to draw the final city-specific policy responses.

b) Research questions

From the task description and objectives stated above, this section identifies T4.5 generic research questions pilots may adopt. During task 4.2, pilots can include other pilot-case specific research questions., but first, we need to define what the implementation feasibility is. The SPROUT project has considered this term as a combination of several dimensions (legal, financial, and operational). Now, some of the research questions below:

> *"Legal dimension: Can the city, considering the existing legal framework, implement the specific policy?*
> *"Financial dimension: Can the city cover any implementation costs of the policy?*
> *Operational & Sustainability: Has the city the required resources to support the implementation and continuation of the policy?*
> *"Can the city improve user acceptance?"*

c) Performance indicators, data collection methods, stakeholders involved

During this final task, pilots will focus on the *policy assessment* measuring the implementation feasibility to the citywide level as the combination of several dimensions (legal, operational, financial) and the user acceptance. The indicators will be collected from the operators, policymakers,

3.3.3 Task 4.5: City-specific policy responses for harnessing the impact of new mobility solutions

This analysis phase starts once *T4.5 using phase* has finished and the data is collected. During this final period, the pilots analyse the compiled data to draw the city-specific policy response with the task leader support**.**

4 Impact assessment methods and existing tools

This chapter describes the methods that SPROUT pilots will use to test the mobility solutions. A list of the resulting recommended indicators can be found in Annexe 2 and Annexe 3.

4.1 Overall financial and economic KPIs

4.1.1 Guidance for using CBA and data collection

For the assessment of financial and economic aspects of the pilots', a methodology based on Cost-Benefit Analysis (CBA) will be used. CBA represents a dynamic analysis for comparison of financial and economic inflows and outflows of a project.

For the purpose of the CBA in this Task, EU structured framework will be followed[3]. During CBA work, some steps will be handled on a lower level of detail depending on the level of specification of a certain Pilot. This framework includes (Figure 3.):

1. Context analysis and appraisal objectives;
2. Clear identification of pilot;
3. Feasibility and options analysis;
4. Financial analysis;
5. Economic analysis;
6. Risk assessment.

All steps of the framework are described in Figure 3, Figure 3 CBA framework for pilot evaluation where the two first ones are already addressed by the FESTA pilots use case description and stakeholders involvement steps (section 3.1.1).

[3] https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

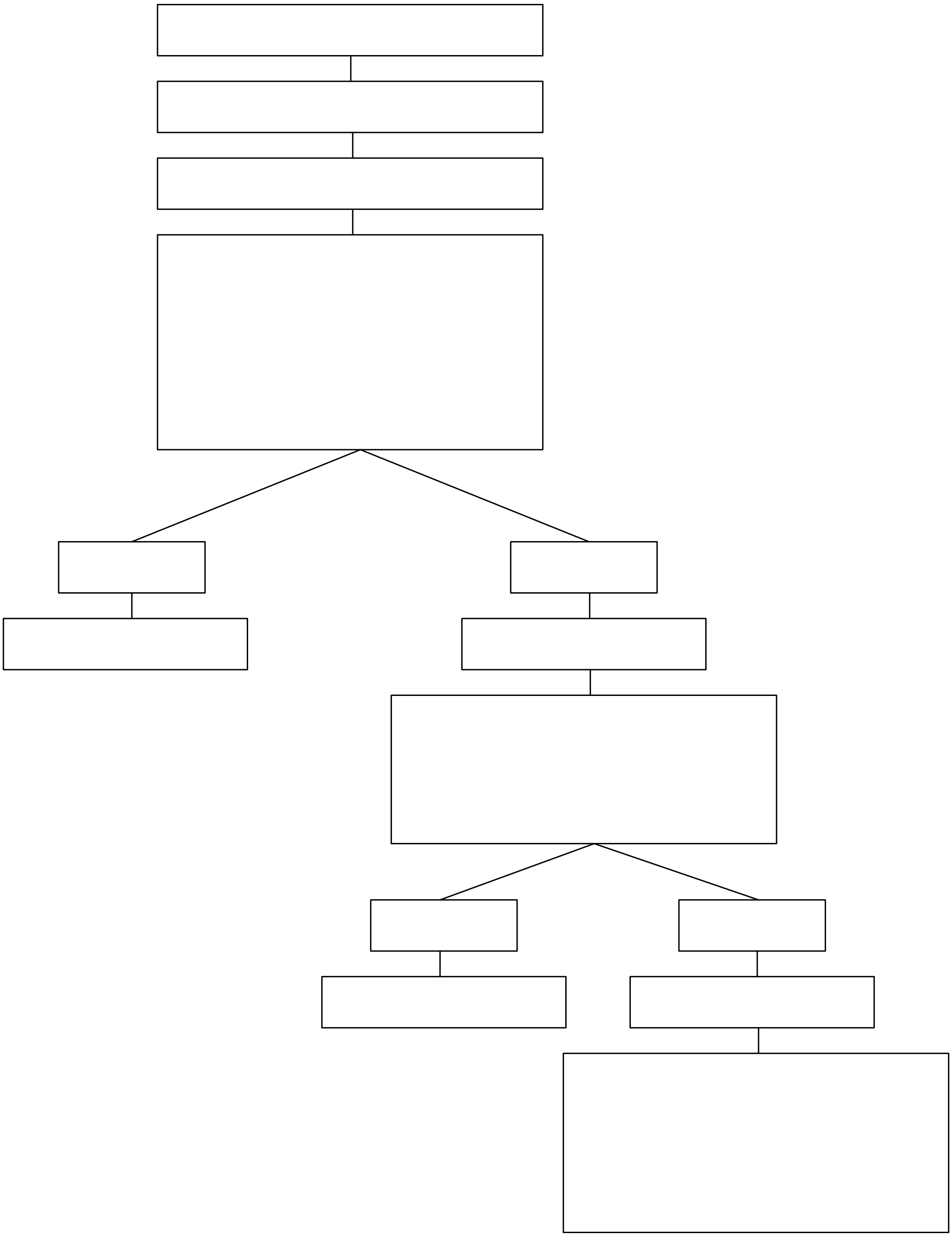

Figure 3 CBA framework for pilot evaluation[4]

1. Context analysis and pilot objectives

The first step in pilot evaluation should be understanding the social, economic and institutional context in which a specific pilot will be tested/implemented. Detailed analysis of

[4] https://ec.europa.eu/regional_policy/sources/docgener/guides/cost/guide2008_en.pdf

socio-economic context represents also an instrument for demand analysis which includes forecast of demand for services that the pilot will generate in the future. Demand forecast represents a key indicator for the estimation of future revenues and therefore, the financial performances of the pilot.

A clear definition of project objectives represents an important step for understanding the social value that an investment (a new mobility solution in this case) generates. The main question during a pilot evaluation is related to the net benefits of a project in its socio-economic environment. Considered benefits should not be only physical indicators but also quantifiable socio-economic variables. A key indicator of a net socio-economic benefit of a pilot is its economic net present value.

This first step is covered by the preparing phase of the pilot and the cross-cutting issues with the pilot's use cases description (see section 3.1.1, a).

2. Clear identification of pilots

A pilot represents an operation composed of a sequence of activities or services focused on reaching a task of precise economic or technical nature. Also, during the pilot identification direct, indirect, and network effects must be adequately considered. A specific pilot generates direct as well as indirect impacts. Direct impacts are related to a specific area of implementation and all directly and indirectly affected stakeholders. Indirect impacts are related to secondary markets impacted by a pilot. Direct network impacts are the impacts a specific pilot has on other users of a transport network, not those using a part of the network which is targeted by the pilot. Indirect network impacts represent the impact of the pilot implementation on other markets (real estate, human resources, capital).

The last step in this stage is a clear identification of stakeholders whose costs and benefits should be included by CBA.

This second step is already covered by the preparing phase of the pilot and the cross-cutting issues with the stakeholders' identification and involvement (see section 3.1.1, d).

3. Feasibility and option analysis

Pilots will conduct a “light” CBA based on their FNPV (Financial Net Present Value) and ENPV (Economic Net Present Value).

A pilot is feasible if its design fulfils technical, legal, financial, and other constraints relevant for a specific region or a stakeholder. For this purpose, it is needed to assess information related to the demand, available technology, production plan, human resources requirements, pilot location, and environment.

4. Financial analysis

In financial analysis, forecasts of net cash flows are used for the calculation of appropriate net return indicators. The most popular financial indicators are financial net present value (FNPV) and financial rate of return (FRR). The methodology which will be used in SPROUT for determining of financial return is discounted cash flow approach. Main assumptions in this step are:

Only cash inflows and outflows are considered;

Determining cash flows should be based on the difference in costs and benefits between “do something” and “do nothing” scenario.

The essence of financial analysis is the calculation of financial performances of a pilot. FNPV represents a sum which results from equality of a sum of expected investment and operational costs of a pilot and the discounted value of expected revenues:

$$FNPV = \sum_{t=0}^{n} a_t S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + \dots + \frac{S_n}{(1+i)^n}$$

S_t: balanced cash flow in period t;
a_t: discounting factor in period t;

FRR represents a discounted rate which makes FNPV=0;

$$FNPV = \sum \frac{S_t}{(1+FRR)^t} = 0 \; +$$

In conclusion, FNVP is a quantitative indicator that shows the financial performance of an investment alternative in the form of monetary values (see annexe 3).

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5. Economic analysis

The essence of the economic analysis is the pilots’ contribution to the economic welfare of a region (or state). The methodology for conducting economic analysis includes:

- Conversion of the market into accounting prices;
- Monetisation of non-market impacts;
- Inclusion of additional indirect effects;
- Discounting of estimated costs and benefits;
- Calculation of indicators of economic performances.

The key concept in economic analysis is the application of shadow prices based on social opportunity cost instead of observed market prices. For this purpose, appropriate conversion factors are used. For those costs/benefits of a pilot for which market prices are not available, these effects can be monetized by applying appropriate techniques. More specifically, it is needed to identify all positive and negative effects, quantify and assign a real monetary value to them. Willingness to pay (WTP) approach and Long-Run Marginal Cost (LRMC) are the two most popular approaches for this purpose.

Indirect effects made on secondary markets should not be included in the case when appropriate shadow prices for primary markets are defined.

Discounting rate in economic analysis – social discounting rate reflects a societal perspective on the estimation of future costs and benefits. It can be different from the financial discounting rate in cases when the market of capital is inefficient.

After an appropriate social discounting rate is determined, it becomes possible to calculate the economic performances of a pilot by:

- Economic net present value (ENPV): the difference between discounted total social benefits and costs;
- Economic internal rate of return (ERR): rate which produces value for ENPV;
- B/C ratio, the relation between discounted economic benefits and costs.

Comparing to FNPV, ENPV uses accounting shadow prices or opportunity cost of services instead of imperfect market prices and includes all social external effects as much as this is possible.

In conclusion, ENPV is a quantitative indicator that shows the economic performance of an investment alternative in the form of monetary values. It represents the most reliable social CBA indicator and it should be used as the main reference of economic performances for pilot estimation (see annexe 3).

6. Risk analysis

Financial and economic analysis are based on uncertain estimations of data about a specific pilot. Therefore, it is recommended including the risk.

Risk is defined as uncertainty in terms of expected effects from a pilot, or more precisely, a probability that observed effects will be different than estimated effects. Risk estimation includes determining of probability that a pilot will reach satisfactory performances (expressed through a limit Internal Rate of Return (IRR), Net Present Value(NPV)).

Steps for the assessment of pilot' risk are as follows:

- Sensitivity analysis: Enables determining critical variables - those variables whose variations, positive or negative, have the highest impact on the financial/economic performances of a pilot. It is performed by varying one by one element at the same time and by determining effects on IRR and NPV.
- The probability distribution of critical variables: Probability distribution for each variable can be determined from different sources (experimental data, expert estimation) and represents a range of values around the best estimation. It serves to calculate the expected values of financial and economic indicators.
- Risk analysis. Based on defined probability distributions for critical variables it is possible to calculate probability distributions of IRR and NPV of a pilot. For this purpose, the Monte Carlo method can be used.
- Estimation of acceptable levels of risk: Instead of calculation the NPV or IRR based on most likely values, pilot performances should be assessed based on the risk associated with it by weighting the performance with the risk.
- Risk prevention: This step is related to the reduction of "optimism bias" by specific adjustments in the form of increased cost estimates or decreased or delayed benefit estimates. These adjustments should provide a more accurate basis on which to develop risk analysis. Risk analysis should then be the basis for risk management.

4.1.2 Limitations

The main limitation is that all indicators are sensitive to uncertainty in future positive and negative cash flows. This uncertainty increases with the length of the considered time horizon.

4.2 Environmental & social KPIs

For assessing pilots' sustainability impact, SPROUT project relies on the Handbook for Transport Costs published in 2019. This Handbook was selected because it represents the best practice on the methodology to estimate different categories of external costs of transports. It considers the marginal external costs and the average external costs of transport in all EU-countries, Switzerland, and Norway. It includes external cost figures for some non-European countries allowing to compare them with European figures. It covers all main external categories, including air pollution, climate change, noise, accidents, and congestion, for freight, passengers, or a combination of freight and passenger transport. This handbook marginal costs procedure constitutes the basis for the definition of internalisation policies.

Other existing methodologies were investigated, such as the proposed Smart Freight Centre (SFC) Global Logistics Emissions Counting (GLEC) is the first initiative specifically designed from existing methodologies to carbon footprinting. It is the first logistics Framework globally applicable and covering all modes and transhipment centres that work for industries and is backed by stakeholders. Although, GLEC Framework provides a common, global platform for the industry to develop, apply an advocate for a harmonized logistics emissions accounting, SPROUT project T4.1's partners agreed upon with using the Handbook for transport external costs. Firstly, the Handbook not only considers freight but also passengers' mobility. Secondly, GLEC methodology is industry-oriented while the Handbook is for policymakers. Thirdly, the Handbook considers several environmental transport impact categories climate change, air pollution, well-to-tank, accidents, traffic delays, and traffic dead-weights, while GLEC refers only to GHG emissions. Finally, the Handbook's external cost factors allow monetizing the external transport environmental impacts facilitating the development of the Cost-Benefit Analysis.

To conclude, the Handbook provides SPROUT pilots with a unified framework to assess external transport environmental impacts that are considered as influential and crucial costs to include in the policymakers' decision-making process. Default values are also provided.

4.2.1 Guidance for using the handbook and collecting data

This section provides the pilots with guidance to estimate the external effects of urban mobility. This estimation is based on calculating the impact on society and the environment of external transport costs that are not usually considered when estimating the transport costs. Furthermore, it will facilitate pilots the development of the cost-benefit analysis to assess the impact of the pilot's implementations.

The SPROUT pilots' evaluation framework will contemplate the following external transport categories: climate change, well to tank, air pollution, noise, traffic congestion delays, traffic congestion dead-weights, and accidents. All of them will follow the same approach for calculating the external costs:

1) Identify the vehicle categories[5] in Table 5.
2) For every transport category, operators will compile daily values for the number passengers and corresponding average kilometers; total tonnes and corresponding average kilometers; number of vehicles and corresponding average kilometers
3) For every transport category, calculate the total pkm[6] or tkm[7] and vk[8]m.
4) Find the default external cost factor for the vehicle category highlighted in the corresponding tables below (*Table 6 Table 8 Table 10 Table* 12 *Table 14 Table 16* .
5) Multiply the external cost factor with the total values of pkm, tkm vkm.

For the steps above, the SPROUT project made the general following decision and assumptions. Specific considerations for every external cost category are further detailed in the corresponding section.

Although marginal external cost factors are available, the SPROUT project considers average external cost factors because they provide a good trade-off between the data compilation effort to yield this level of granularity and the level of accuracy to reduce uncertainty.
The main difference among the external cost categories lies in the definition of the vehicle categories, which may lead to confusion. To avoid pilots' mix-up when compiling data for calculating the external cost categories, the SPROUT project harmonizes the vehicle categories and describes the homogenization process followed (Table 5).

Table 5. SPROUT vehicle categories for assessing the environmental and social impacts (default values).

Passenger transport	
Passenger car	It does not differentiate between the type of fuel used (petrol, Diesel) considered in all the external cost categories (*Table 6, Table 8, Table 10, Table 12, Table 14, Table 16*)
Motorcycle	No differences with the external cost factors.
Bus	No differences with the external cost factors.
Coach	No differences with the external cost factors.

[5] Vehicle category: The categories classify vehicles for regulatory purposes, enable manufacturers to benefit from the EU Single Market, and allow them to export their products beyond the EU.(Wikipedia)
[6] Pkm: Abbreviation of passengers-kilometre. It is
[https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Passenger-kilometre]
[7] Tkm: Abbreviation of tonne-kilometre. It is a unit of measure of freight which represents the transport of one tonne over a distance of one kilometre. [*https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Tonne-kilometre_(tkm)*]
[8] Vkm: Abbreviation of
. [*https://www.bts.gov/content/us-vehicle-kilometers-0*]

Bike	This mobility form not included in the Handbook. This evaluation framework considers active and electric bikes. Values from desktop research.
Scooter	This mobility form not included in the Handbook. This evaluation framework considers electric bikes. Values from desktop research.
Freight transport	
LGV	Light commercial vehicles. This evaluation framework considers the aggregated value for diesel and petrol LCV for the climate change category in *Table 6*, the well-to-tank emissions category in *Table 8* and air pollution category in *Table 10*. This evaluation framework considers the aggregated value for urban and interurban LCV for the traffic congestion category in Table 16.
HGV	Heavy Good vehicles. This evaluation framework only considers the range (HGV 3.5-7.5t)[9] value for the noise category in Table 12. This evaluation framework considers the aggregated value for urban and interurban HGV for the traffic congestion category in Table 16 This evaluation framework considers the "Urban" value for the traffic congestion categories (delays, dead-weights) in Table 16.
Other	
Self-driving pods	This mobility form is not included in the Handbook.

The handbook does not provide default external cost factors for the new forms of mobility considered in the project (bikes, scooters, self-driving pods). Therefore, the SPROUT project has included them as vehicle categories the pilots will consider to compile data (pkm, tkm, vkm). For the external cost factors values, deep desktop research has been conducted, to find external transport costs explained below. For bikes and scooters, the EF provides default rates for all the categories from different sources (see sections below). For self-driving pods, there are few literature data or similar applications: for climate change and air-pollutions, it assumes the external costs are zero; about accidents and fatalities, some studies consider they should significative reduce them. According to (Fagnant, 2015), *"Autonomous vehicles may be assumed 50% safer than non-AVs at the early, 10% market penetration rate (reflecting savings due to eliminating these factors, as well as fewer legal violations*

[9] HGV 3.5t-7.5t: Pilots focused on boundaries within the city where larger vehicles are less frequent.

like running red lights), and 90% safer at the 90% market penetration rate (reflecting the near-elimination of human errors as primary crash causes, greater V2V use and improving technologies". About traffic-congestion, there are no data available, but the modularity should reduce waiting/travel times and make the traffic flow more fluid because they are designed to self-adapt in real-time to the needs.

T4.1 partners created an Excel tool that pilots may use to compile data daily and calculate the total external cost factors according to the description above. Figure 4, Figure 5 and Figure 6 show the home tab with the description for using the tool, the data collection, and the results tabs.

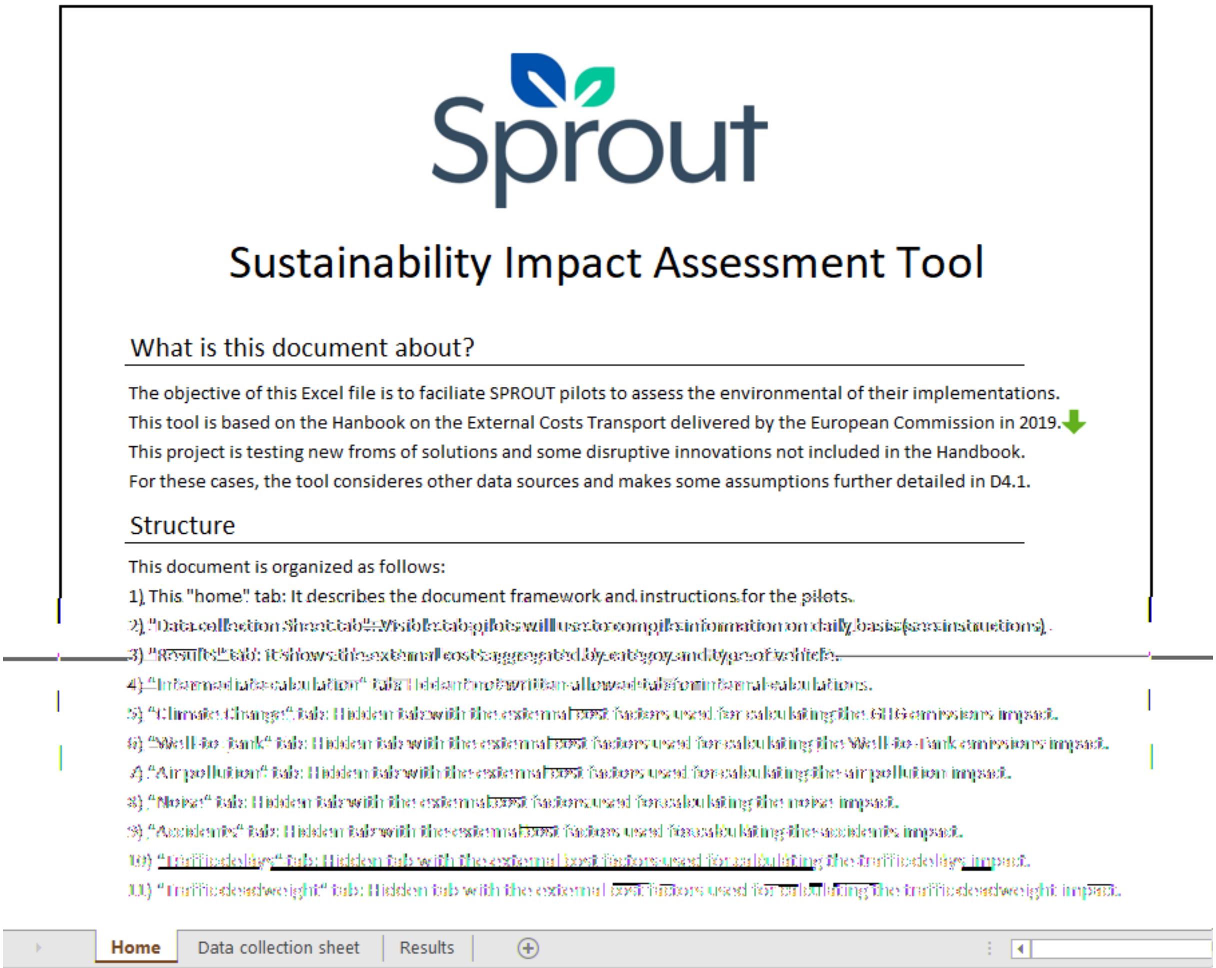

Figure 4. SPROUT sustainability impact assessment tool - Description Tab (Home).

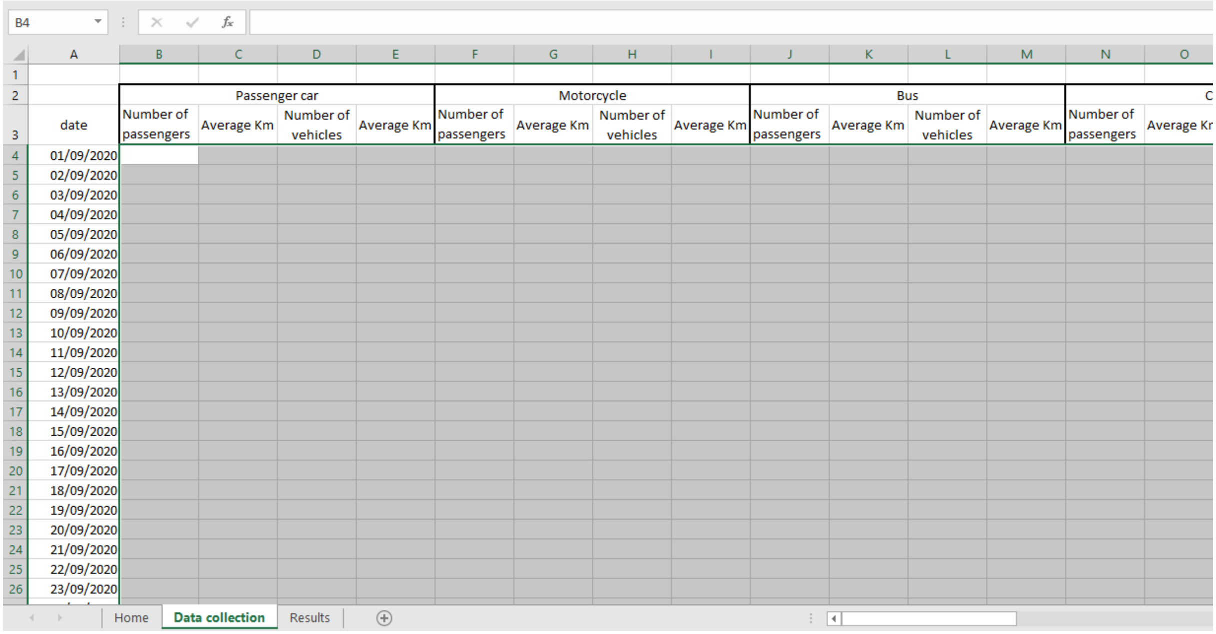

Figure 5.SPROUT sustainability impact assessment tool. - Data collection tab.

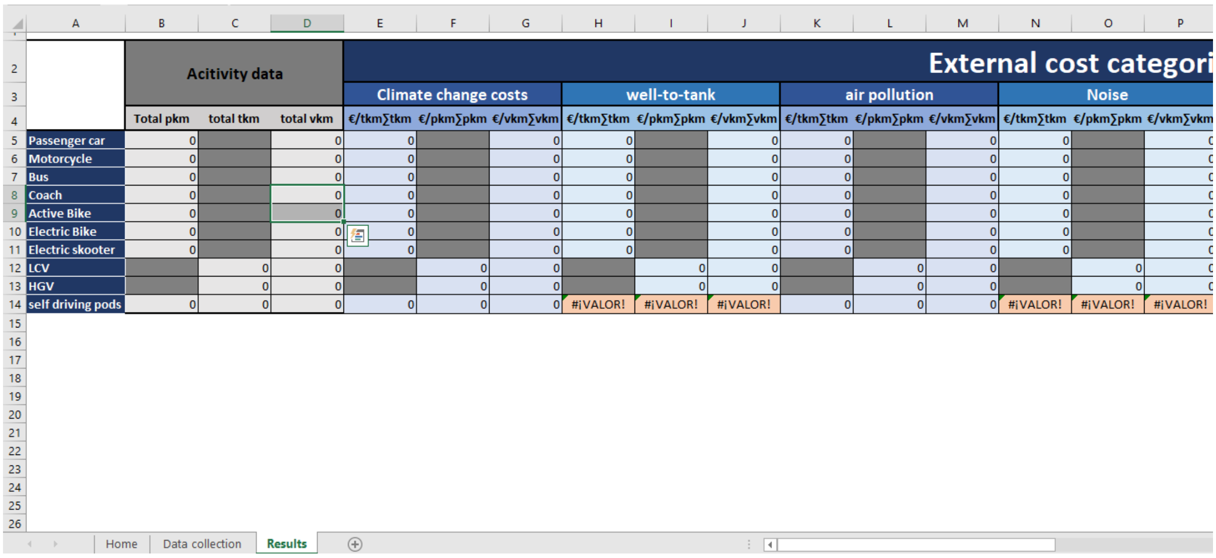

Figure 6. SPROUT environmental impact assessment tool. - Results tab.

4.2.2 Climate Change

This section presents how to calculate the climate costs produced by the effect of transport GHG emissions that contribute to climate change. For calculating these costs, the evaluation framework considers the average cost external factors presented in Table 6 and *Table 7*. The first table shows the values provided by the Handbook for land-based modes of the EU28, and the second, the values for electric and active bikes, and e-scooters which is zero, following the assumption they do not produce GHG emissions during the consumption phase.

Table 6. Total and average climate change costs for land-based modes of the EU28.

Table 7. Climate Change (new mobility forms external transport costs factors). 25T35432

Table 8. Total and average costs of well to tank emissions for land-based modes of the EU28.

	Total costs EU28	Average costs	
Passenger transport	**Billion €**	**€-cent/pkm**	**€-cent/vkm**
Passenger car	18.13	0.38	0.62
Passenger car - petrol	10.43	0.40	0.64
Passenger car - diesel	7.70	0.37	0.59
Motorcycle	0.83	0.51	0.53
Bus	0.30	0.17	3.12
Coach	0.53	0.15	2.85
Total passenger road	**19.79**		
High speed passenger train	0.33	0.30	90.7
Passenger train electric	2.70*	0.80	106.5
Passenger train diesel	0.07	0.11	6.71
Total passenger rail	**3.10**		
Total passenger transport	**22.90**		
Freight transport	**Billion €**	**€-cent/tkm**	**€-cent/vkm**
LCV	3.79	1.15	0.79
LCV - petrol	0.22	1.18	0.81
LCV - diesel	3.57	1.14	0.79
HGV	3.71	0.20	2.50
Total freight road	**7.50**		
Freight train electric	0.50	0.16	86.5

[redacted]

Table 9. Well-to-tank (new mobility forms external transport costs factors).

	Average costs (Well-to-tank)		
Bike Active			
Electric Bike			
E-skooter			
Self driving pods			

4.2.4 Air pollutant costs

This section presents one of the external costs' categories most analysed: the air pollutants. They are the result of the impact of the four effects below:

- Health care
- Crop losses
- Material and building manage
- Biodiversity loss

The first table shows the values provided by the Handbook for land-based modes of the EU28, and the second, the values for electric and active bikes, and e-scooters which are zero, following the assumption they do not produce air pollutants or any other substances during the consumption phase.

Table 10. Total and average air pollution costs for land-based modes of the EU28.

Transport mode	Total costs EU28	Average costs	
Passenger transport	**Billion €**	**€-cent/pkm**	**€-cent/vkm**
Passenger car	33.36	0.71	1.14
Passenger car - petrol	8.58	0.33	0.53
Passenger car - diesel	24.79	1.18	1.90
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Coach	[illegible]	0.73	[illegible]
Total passenger road	**39.23**		
High speed passenger train	0.002	0.002	0.66
Passenger train electric	0.03*	0.01	1.14
Passenger train diesel	0.52	0.80	47.0
Total passenger rail	**0.55**		
Total passenger transport	**39.78**		
Freight transport	**Billion €**	**€-cent/tkm**	**€-cent/vkm**
LCV	15.49	4.68	3.24
LCV - petrol	0.33	1.72	1.17
LCV - diesel	15.16	4.86	3.37
HGV	13.93	0.76	9.38
Total freight road	**29.42**		
Freight train electric	0.01	0.004	2.14
Freight train diesel	0.66	0.68	305.39
Total freight rail	**0.67**		
Inland Vessel	1.93	1.29	1,869
Total freight transport	**32.02**		
Total road, rail, inland waterway	**71.80**		

Table 11. Air Pollution (new mobility forms external transport costs factors).

	Average costs (Air-pollution)		
Bike Active			
Electric Bike			
E-skooter			
Self driving pods			

4.2.5 Noise

Traffic noise is generally experienced as a disutility and is accompanied by significant costs. In general, noise can be defined as unwanted sounds of varying duration, intensity, or other quality that causes physical or psychological harm to humans (CE Delft, 2011).

The exposure to noise results in several health endpoints due to prolonged and frequent exposure to transport noise. These health endpoints can take a multitude of forms. Health endpoints for which significant evidence is available are below ((WHO, 2011; (WHO, 2017-2018); (Defra, 2014)). The Handbook considers the five components below for calculating the external noise cost factors.

ischaemic heart disease
stroke
dementia
hypertension
annoyance

Table 12 shows the values provided by the Handbook for land-*based modes of the EU28.*

Table ***13*** includes the electric bikes and scooters ones from (Jochem, 2016). For active bikes, the EF assumes it is zero.

Table 12.Total and average noise costs for land-based modes of the EU28**.**

Transport mode	Total costs EU28	Average costs	
Passenger transport	**Billion €**	**€-cent per pkm**	**€-cent per vkm**
Passenger car	26.2	0.6	0.9
Passenger car - petrol	13.8	0.5	0.8
Passenger car - diesel	12.4	0.6	0.9
Motorcycle	14.8	9.0	9.4
Bus	0.8	0.4	8.0
Coach	0.9	0.2	4.7
Total passenger road	**42.6**		
High speed passenger train	0.4	0.3	97
Passenger train electric	2.6*	0.8	106
Passenger train diesel	0.9	1.4	81
Total passenger rail	**3.9**		
Total passenger transport	**46.5**		
Freight transport	**Billion €**	**€-cent per tkm**	**€-cent per vkm**
LCV	5.4	1.6	1.1
HGV 3.5-7.5 t	1.0	1.2	4.0
HGV 7.5-16 t	1.8	0.8	5.7
HGV 16-32 t	3.0	0.4	6.5
HGV > 32 t	3.2	0.4	7.2
Total freight road	**14.5**		
Freight train electric	2.1	0.6	359
Freight train diesel	0.4	0.4	201
Total freight rail	**2.5**		
Total freight transport	**17.1**		
Total road, rail, inland waterway	**63.6**		

Table 13. Noise (new mobility forms external transport costs factors).

	Average costs (Noise)		
Bike Active			
Electric Bike			
E-skooter			
Self driving pods			

4.2.6 Accidents

For the costs of external accidents, the Handbook defines them as the social costs of traffic accidents that are not covered by risk-oriented insurance premiums. For calculating the values in Table 14, the Handbook considered the five components below:

Human costs;
Medical costs;
Administrative costs;
Production losses;
Material damages.

Table 15 includes the ones for the electric and active bikes from Gössling, 2015. For electric scooters, this EF assumes the same values as for electric bikes.

Table 14. Total and average external accident costs for land-based modes for the EU28.

Transport mode	**Total costs EU28**	**Average costs**	
Passenger transport	**Billion €**	**€-cent per pkm**	**€-cent per vkm**
Passenger car	210.2	4.5	7.2
Motorcycle[13]	21.0	12.7	13.3
Bus/Coach	5.3	1.0	18.9
Total passenger road	**236.5**		
High speed passenger train	0.1	0.1	17.3
Conventional passenger train	2.0*	0.5	52.2
Total passenger rail	**2.0**		
Total passenger transport	**238.5**		
Freight transport	**Billion €**	**€-cent per tkm**	**€-cent per vkm**
LCV	19.8	6.0	4.1
HGV	23.0	1.3	15.5
Total freight road	**42.8**		
Freight train	0.3	0.1	34.1
Inland Vessel	0.1	0.1	86.3
Total freight transport	**43.1**		
Total road, rail, inland waterway	**281.7**		

Table 15. Accidents (new mobility forms external transport costs factors).

	Average costs (Accidents)		
Bike Active			
Electric Bike			
E-skooter			
Self driving pods			

4.2.7 Traffic congestion

For the road congestion, the Handbook has adopted the definition of (Goodwin, 2004) that assumed road congestion as the impedance that vehicles impose on each other, as the traffic flow approaches the maximum capacity of the network. The external road congestion cost factors are calculated for both delay10 and deadweight loss costs11.

Table 16 shows the values provided by the Handbook for land-*based modes of the EU28. Table 17* includes the electric and active bikes values from the unique studied the T4.1 partners have found (Sælensminde,2004), which are zero. For electric scooters, this EF assumes the same values as for bikes.

Table 16. Total and average congestion costs generated by road vehicle categories in the EU28 according to the simplified approach used.

Vehicle category	Delay costs			Deadweight loss costs		
Passenger transport	**Total EU28 [Billion €]**	**€-cent/ pkm**	**€-cent/vkm**	**Total EU28 [Billion €]**	**€-cent/ pkm**	**€-cent/vkm**
Passenger car	196.1	4.2	6.7	33.5	0.7	1.1
Urban	160.8	11.0	17.7	28.0	1.9	3.1
Inter-urban	35.3	1.1	1.7	5.5	0.2	0.3
Bus/ Coach	4.5	0.8	15.9	0.8	0.1	2.7
Urban	3.9	1.8	35.5	0.7	0.3	6.1
Inter-urban	0.5	0.2	3.1	0.1	0.0	0.5
Total passenger	**200.6**			**34.3**		
Freight transport	**Total EU28 [Billion €]**	**€-cent/ tkm**	**€-cent/vkm**	**Total EU28 [Billion €]**	**€-cent/ tkm**	**€-cent/vkm**
Light commercial vehicle	55.5	16.8	11.6	9.4	2.8	2.0
Urban	46.5	39.6	27.4	8.0	6.8	4.7
Inter-urban	9.0	4.2	2.9	1.4	0.7	0.5
Heavy Goods Vehicle (HGV)	14.6	0.8	10.9	2.5	0.1	1.8
Urban	11.6	2.5	34.1	2.0	0.4	6.0
Inter-urban	3.0	0.2	3.0	0.5	0.0	0.5
Total freight	**70.1**			**11.9**		
Total road transport	**270.7**			**46.2**		

[10] Delay costs:It is a way of communicating the impact of time on the outcomes we hope to achieve (link)
[11] Deadweight loss costs: also known as excess burden, is a measure of lost economic efficiency when the socially optimal quantity of a good or a service is not produced (Wikipedia).

Table 17. Traffic (new mobility forms external transport costs factors).

	Average costs (traffic-delays)			Average costs (traffic-deadweight loss)		
Bike Active						
Electric Bike						
E-scooter						
Self-driving						

4.2.8 Limitations

As stated above, there are some limitations concerning the availability of external cost factors. The Handbook gives default values for a wide variety of vehicle categories, but it does not provide values for the SPROUT mobility solutions. To overcome this shortage, the T4.1 partners conducted a literature review. In some cases, the default values are more recent and representative than in others. Therefore, results may present some bias from the real scenario.

The provided default values might not be very city representative. For those pilots with specific external costs factors available, the SPROUT EF allows pilots using their own values, as long as they explain how the factors have been calculated.

With the new COVID-19 situation, it is not possible to determine whether the results will be affected.

4.3 Product's quality and quality in use (ISO/ IEC 25010 description)

As all SPROUT pilots' mobility solutions have some ICT component will assess the Product Quality Model and the Quality in Use Model, as defined in ISO/IEC 25010. These models include several characteristics reflecting the degree to which the product/system satisfies the stated and implied needs of its various stakeholders, and thus provides value.

The ISO/IEC 25010 Product Quality Model will be used for defining the necessary and desired quality characteristics of the software products and IT systems developed in the project. It is composed of eight characteristics (further cascaded into sub-characteristics) that relate to static properties of software and dynamic properties of the computer (IT) system. The model applies to both computer (IT) systems and software products. The characteristics of the model are presented in Table 18.

Table 18. Characteristics of the Product Quality Model.

1.	**Functional suitability** *The degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions*

2.	**Performance efficiency** *Performance relative to the number of resources used under stated conditions*
3.	**Compatibility** *The degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions while sharing the same hardware or software environment*
4.	**Usability** The degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of the use
5.	**Reliability** *The degree to which a system, product or component performs specified functions under specified conditions for a specified period of time*
6.	**Security** *The degree to which a product or system protects information and data so that persons or other products or systems have the degree of data access appropriate to their types and levels of authorization*
7.	**Maintainability** *Degree of effectiveness and efficiency with which a product or system can be modified by the intended maintainers*
8.	**Portability** *Degree of effectiveness and efficiency with which a system, product or component can be transferred from one hardware, software or other operational or usage environment to another*

The ISO/IEC 25010 Quality in Use Model will be used for defining the necessary and desired characteristics of the software products and IT systems developed in the project, in terms of its interaction when used in a particular context. It is composed of five characteristics (further cascaded into sub-characteristics) and applies to the complete human-computer (IT) system, including both IT systems in use and software products in use. The characteristics of the model are presented in Table 19.

Table 19. Characteristics of the Quality in Use Model.

1.	**Effectiveness** *Accuracy and completeness with which users achieve specified goals*
2.	**Efficiency** *Resources expended concerning the accuracy and completeness with which users achieve goals*

3.	**Satisfaction** *The degree to which user needs are satisfied when a product or system is used in a specified context of the use*
4.	**Freedom from risk** *The degree to which a product or system mitigates the potential risk to economic status, human life, health, or the environment*
5.	**Context coverage** *The degree to which a product or system can be used with effectiveness, efficiency, freedom from risk and* *satisfaction in both specified contexts of use and contexts beyond those initially*

4.3.1 Guidance for using the models and collecting data

The process of employing the two models is as follows:

Step 1: Stakeholder requirements for the software/IT system to be developed in the pilot are defined.
Step 2: The stakeholder requirements are analysed and translated into formalised IT system requirements using the 'characteristics' of the two Models as a 'shopping list' of requirements.
Step 3: The Models' characteristics to be employed as requirements for the assessment of the software and IT systems developed in each pilot are prioritised, according to the pilot nature. This can be achieved through the circulation of questionnaires among the pilot stakeholders asking them to rate each characteristic as 'must be assessed', 'should be assessed', 'could be assessed', will not be assessed' (Likert scale).
Step 4: Procedures for assessing the software/system developed according to the selected requirements are defined. These can involve either the use of questionnaires (for the qualitative requirements) or the use of lab measurements (for the quantitative requirements). As ISO/IEC 25010 does not provide assessment indicators for each characteristic included in the two models, these will have to be defined according to the scope and aim of each pilot.
Step 5: The software/IT system is assessed, the results are documented, and if needed (especially to the Product Quality requirements) a revision of the software/IT system is undertaken. Concerning the Product in Use criteria, three categories of assessors will be used: Primary users (i.e. persons who interact with the system to achieve its primary goals); Secondary users who provide support (e.g. content

mobility solutions have some digital component, the operational feasibility will assess the mobility solution as a whole. Policy implementation and user acceptance.

4.4 Policy implementation and user acceptance

For assessing the policy implementation feasibility to citywide level, the SPROUT project considers pilots' control groups will measure the legal, operation and financial dimensions from city's point of view. For the user acceptance, the pilots will validate whether the mobility solution will be widely adopted by the city under a specific policy framework.

4.4.1 Legal dimension KPIs, guidance, and limitations

The SPROUT pilots will measure the probability of widely adcif7/F1 42 T(mi)-2.42 Tm[(w)15(i)5(de)3(l.4)-4/F

4.4.3 Financial dimension KPIs, guidance, and limitations

The SPROUT pilots will measure the financial dimension required for making the mobility solution feasible. Although Task4.5 will provide more detailed guidelines, the box below provides one indicator already identified.

1	***Financial net present value policymakers)*** Do you think that the city will improve the FNVP from widely adopting the mobility solution by the city with this policy framework?).

Procedures for collecting data and assessing the indicators will be qualitative. Policymakers will respond to specific questionnaires...

The main limitation is the accuracy of the results as they will be based on experts' opinions.

4.4.4 User acceptance, guidance, and limitations

Although Task4.5 will provide more detailed guidelines, the box below provides one indicator already identified.

1	***Probability of using the service (users)*** Potential users' subjective likelihood that they will use the mobility solution if the price is lower than the willingness to pay.

Procedures for assessing user acceptance will be the use of questionnaires.
The main limitation is the number of users reached to get a representative value.

4.5 Decision-support methods and existing tools (CIVITAS)

There are multiple existing tools within CIVITAS for the evaluation of mobility projects. In addition, the New Integrated Smart Transport Options (NISTO) Toolkit is a set of tools to evaluate mobility projects in terms of sustainability, stakeholder preferences, societal impact, and achievements of policy targets. Multi-Actor-Multi-Criteria analysis (MAMCA) is part of the NISTO Toolkit, as well as well-established within CIVITAS. All pilots will be evaluated using the MAMCA methodology, which is described in further detail in the next paragraph. Additional information about alternative methods and tools can be found on the CIVITAS website (https://civitas.eu/tool-inventory/www.civitas-initiative.eu/content/civitas-guide-urban-transport-professional-en)

4.5.1 MAMCA: Multi-Actor-Multi-Criteria analysis

Based on the results of T3.3, 'Policy impacts of future urban mobility scenarios', and T4.3, 'Sustainability assessment of the pilots' impacts', a list of alternative policy responses will be developed for each pilot city. These alternative policy responses will be ranked and prioritized for each 1st-layer city, considering the preferences of the stakeholders involved. This will be done through a MAMCA, a Multi-Actor-Multi-Criteria analysis. The MAMCA methodology (Macharis, 2004) is used in complex projects involving a large number of stakeholders and helps find a common ground between them. The process is facilitated through the MAMCA software, an online decision-making platform (www.mamca.be). It provides an interactive way to weight stakeholder objectives, to evaluate options, and it provides easily understandable visualisations of the outcomes of the evaluation.

The MAMCA methodology is made up of seven steps, which are graphically presented in Figure 7.

Step 1: Identification of the alternatives

This first step includes the identification of the alternatives that will be submitted for evaluation. These alternatives will include:

- Adapting current urban policy elements/instruments;
- Integrating urban mobility policy with other policies such as urban planning, social policy, gender-sensitive policies, employment policy, financing policy;
- Policies to help urban mobility innovators overcome regulatory obstacles.

To allow for comparisons, at least two alternative policy responses will be developed for each pilot.

Step 2: Identification of stakeholders and their objectives

For every pilot city, stakeholders participating in the MAMCA will be identified (see section 3.1.3). For all the stakeholders, it will be important to have an in-depth understanding of their objectives, to assess the identified alternatives appropriately. The identified objectives will then be translated into simple criteria.

Step 3: Criteria and weights

Once the stakeholders have formulated criteria, based on their objectives, they will attribute weights to their criteria. These weights represent the relative importance given to each of the identified criteria by the stakeholders.

Step 4: Indicators

The criteria previously identified for all stakeholders are operationalised through the construction of indicators. These indicators will measure whether an alternative contributes to each criterion, so they will measure the performance of each alternative. This will show how each policy alternative would impact a criterion, compared to the current situation.

Step 5: Overall analysis and ranking

This step consists of the construction of an evaluation matrix that aggregates the contribution of each identified alternative to the objectives of the stakeholders. Concretely, every identified policy alternative is evaluated on the different criteria by the use of the indicators and the measurement methods, and this is done for each stakeholder. This overall analysis can be done either by an analyst, experts, or the stakeholder themselves.

Step 6: Results

This step consists of the ranking of the identified policy alternatives, with each alternative's weak and strong points. This classification of the alternatives is done by the MAMCA software. This helps decision-makers by providing a comparison of the various alternatives.

Step 7: Implementation

The last step of the MAMCA is a consensus-making step, where stakeholders involved find a compromise so that the decision-maker can then select the policy option that resulted as being most favourable. The idea behind this step is to find the best alternative based on the synergies and conflicts that were identified in step six. This final result of step seven is what will be brought forward to T4.5, 'City-specific policies for harnessing the impact of new mobility systems.

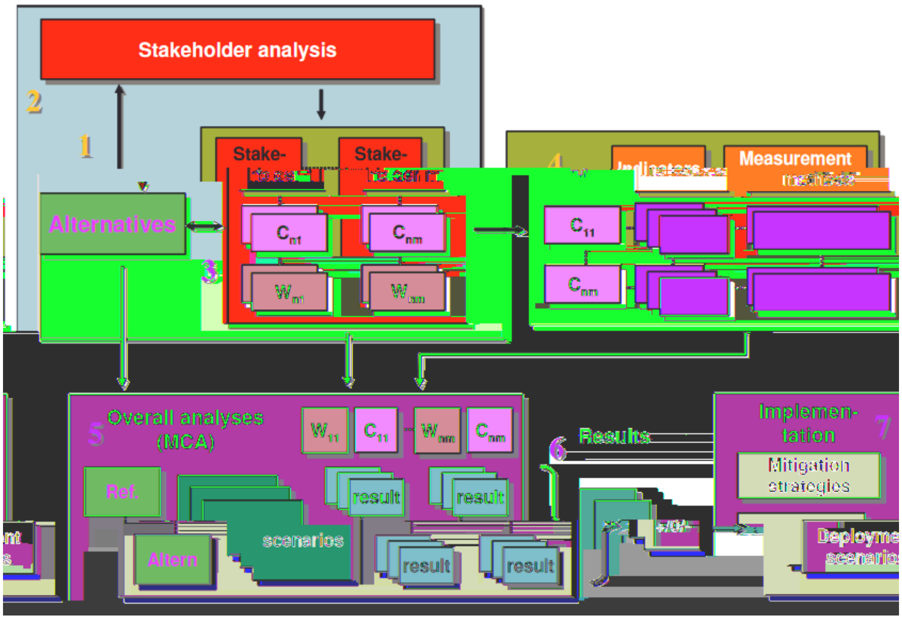

Figure 7 The MAMCA methodology (Macharis, 2004)

5 Summary and Outlook

This document provides SPROUT pilots with an evaluation framework to guide their setup activities and appraise the outcome and the process. This process is essential for both, either run the implementations and test activities smoothly or assess the impacts and results that corroborate an initial hypothesis and support decision-making. All these phases require a preparation stage that plans the timeline, required people, define the objective of the tests, identifies the indicators, data collection and analysis methods, and any other regard may ensure field operation tests execution successfully.

Specifically, SPROUT gives the rest of the tasks under WP4 a common project framework to prepare and conduct the tests, and validate results. It follows the FESTA methodology describing how defining indicators to respond to research questions effectively. It provides with methods to assess sustainability impacts (Handbook, 2019). It explains how implementing the cost-benefit trade-offs (CBA), how using the ISO/IEC 25010 to assess products quality and quality in use, and how to prioritize policy responses alternatives (MAMCA).

This evaluation framework points out the need to consider all challenges that may appear for running and testing the mobility solutions, including any unforeseen event requiring contingency and mitigation strategies such as the COVID-19.

Ensuring WP4 fruitfully execution following this evaluation framework, pilots will draw the city-specific policy response to ensure the satisfactory adoption of the new mobility solution. Furthermore, the whole process, along with the learning, and findings, may lay the methodological bases to use beyond the scope of the project.

6 References

CE Delft, INFRAS & Fraunhofer ISI, (2011). External costs of transport in Europe, Delft: CE Delft.

Annexe 1:The Festa Methodology

FESTA provides a common Field Operational Tests (FOT) methodology, advocating a systematic and scientific approach. Performing large-scale FOTs is not only meant to enable the assessment of a single or a few systems, but to get a better view of the potential impact of large-scale introduction of Intelligent Transport Systems (ITS) on impact areas such as safety, mobility, traffic efficiency, and the environment. These societal challenges are complex and require multiple studies that all contribute to a better understanding and assessment of how transport may become more intelligent, and how it may influence society. Providing a common general approach and a common vocabulary makes it easier to compare studies on similar systems, to gain a better understanding of the changes in society, users, industry and effects on mobility, safety, environment or efficiency and to interpret outcomes.

FESTA was the name of a European Project that developed a methodology in 2008 for conducting FOTs. It was developed as a systematic research-oriented approach to define and provide support when conducting them. It was maintained and updated by three FOT-Net support actions between 2008 and 2016. It started with the focus on Advanced Driver Assistance Systems and Nomadic Devices (e.g. collision warnings, automatics devices like navigation systems). Later updates also focused on naturalistic driving studies (e.g. U-Driver project) and cooperative systems (e.g. communication between infrastructure and vehicles and vehicles and infrastructure).

So far, this methodology has been widely used in both National and European Projects and also influenced international projects in other countries outside of Europe.

The FESTA methodology is owned, developed and updated by the large FOT community and plays an important role in international collaboration with countries like the US, Japan or Australia.

The FESTA methodology is an industrial V-Shaped model (Figure 8) that ensures scientific rigour. It starts from the top with the "*preparing*" study to the "*using*" phase at the bottom, and then to the "*analysing*" stage. V-shaped ensures all the boxes within each step are related. Next three chapters describe these three steps in-depth, giving examples of the FOTs already conducted by projects around Europe.

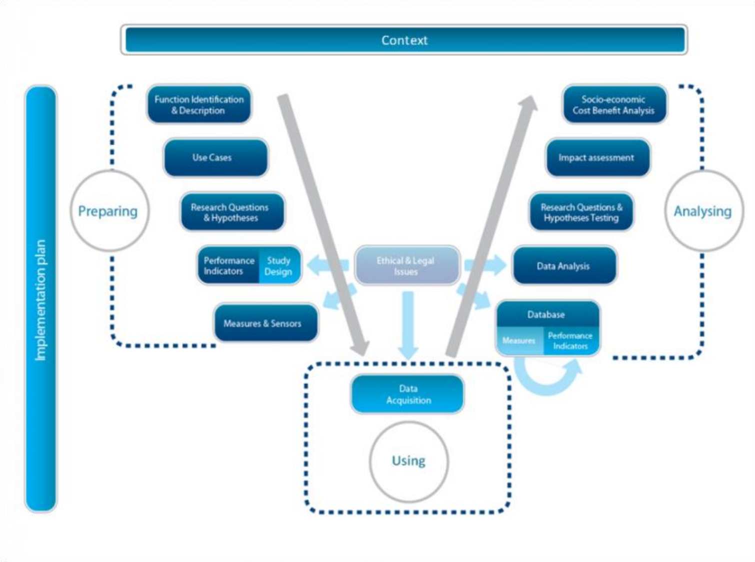

Figure 8. FESTA Methodology V-Shaped model.

There is some preliminary preparatory work or cross-cutting issues to consider and refers to the description of context and stakeholders involved, the definition of an implementation plan and the consideration of ethical and legal issues. Other crucial aspects are the selection of methodologies for assessing the environmental, the cost-benefit and the quality impacts.

Running and testing pilots mobility solutions requires defining the implementation plan, the evaluation framework and any other cutting issues will ensure successful adoption.

The SPROUT project has adapted the generic FESTA methodology (Figure 8) to cover the pilots' activities under the WP4 framework. The bottom of Figure 9 shows the SPROUT project evaluation framework based on FESTA phases and steps, and the top of Figure 9 shows the WP4 tasks pilots will implement and the correspondence with the FESTA phases (blue arrows) and other tasks inputs (green arrows)

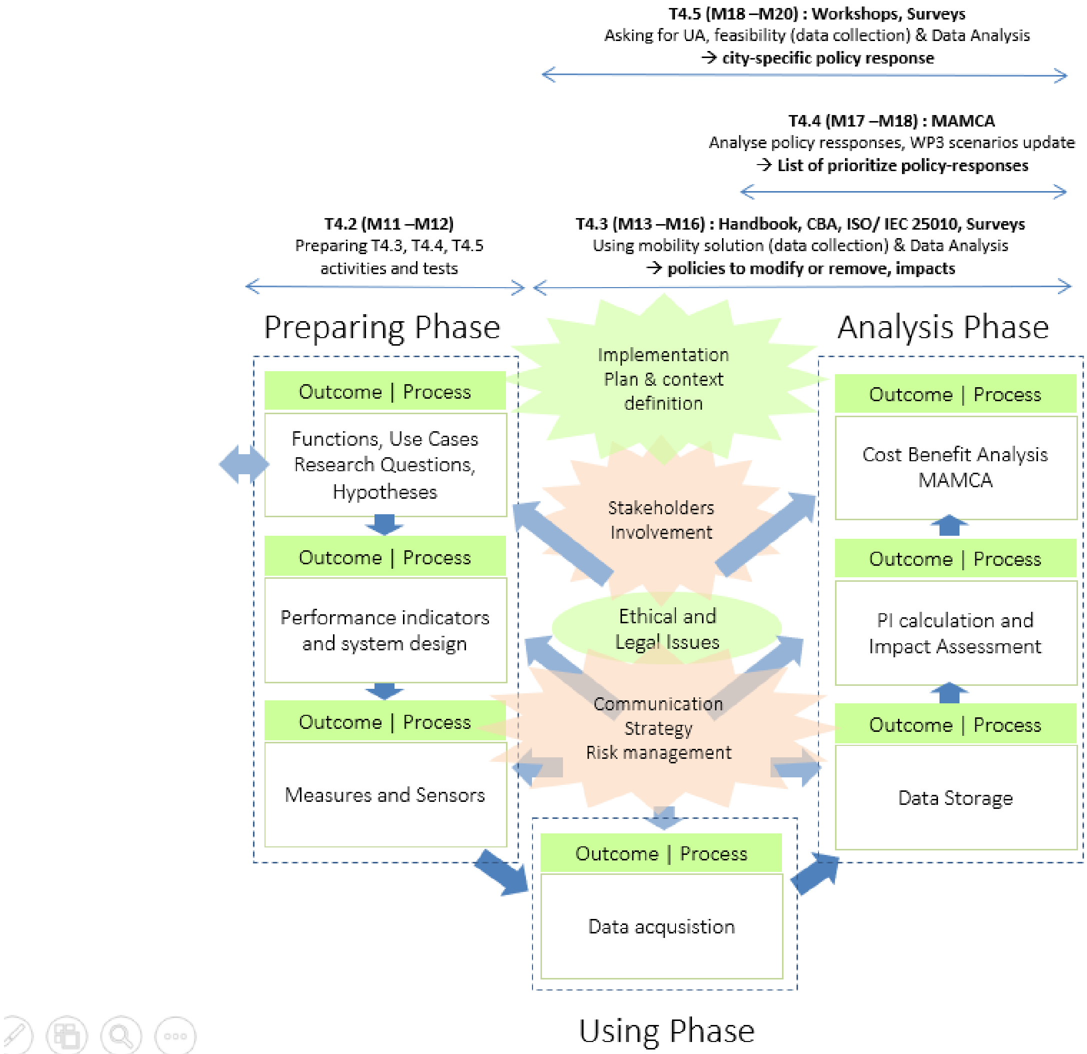

Figure 9. SPROUT evaluation framework.

"Cross-cutting issues": they are in the centre of (Figure 9) and includes all the aspects considered by the FESTA methodology such as the implementation plan & context definition; the role and involvement of the stakeholders will participate in the pilot activities; the ethical and legal issues required for ensuring data privacy, and cultural or regional backgrounds. As pilots are small-scale multi-stakeholder demonstrators, it is essential they define the communication strategy and foresee any event that may disrupt the initial implementation plan. Therefore, the SPROUT project has included two additional aspects: communication strategy and risk management.

"Preparing-phase": it covers all the steps defined in the preparing phase of the FESTA methodology. It focuses on the definition of the research questions that will help to find the indicators and define the collection and assessment methods pilots will use during the "using" and "analysis" phases. This "preparing phase" is covered by pilots T4.2 and prepares the running and test activities for T4.3, T4.4 and T4.5.

"Using phase": it covers the data collection phase when using the mobility solution (T4.3) and performing user acceptant test, questionnaires and workshops (T4.5).

“Analysis phase”: it covers the analysis of data compiled during the “Using phase”. About T4.4, it receives the input data from Task 2.4, Task 3.3. and Task 3.4, and T4.5 receives input from T4.4.

Annexe 2:Recommended indicators for assessing mobility solution performance (pilot level)

List of recommended indicators for operators' financial sustainability, operational feasibility, and mobility solution environmental and social impact assessment.

Table 20. *List of recommended KPIs for SPROUT pilots (T4.3).*

Indicator	Description	Type of indicator	Description of the methods, the data inputs,	Limitation	Remark
Overall financial and economic KPIs					
FNPV	Financial net present value	Quantitative indicator that shows the financial performance of an investment alternative in form of monetary values.	Financial performance indicator – It results in discounted net monetary values of an investment. Direct financial effects of an investment alternative included. It requires all the cash flows of an alternative – investments, costs, revenues, years of	Sensitive to uncertainty in future positive and negative cash flows. This uncertainty increases with the length of considered time horizon.	First CBA assessment level

Indicator	Description	Type of indicator	Description of the methods, the data inputs,	Limitation	Remark
			investment activation and exploitation and discount rate. Chapter 4.1		
ENPV	Economic net present value	Quantitative indicator that shows the economic performance of an investment alternative in form of monetary values.	Economic performance indicator – It results in discounted net monetary values of an investment. Direct financial and indirect (non-financial) effects included. Besides the inputs required for ENPV it also includes estimation of shadow prices and externalities. CBA Chapter 4.1	Sensitive to uncertainty in future positive and negative cash flows. This uncertainty increases with the length of the considered time horizon.	Second CBA assessment level Most recommended indicator for the CBA
FRR	Financial rate of return	Quantitative indicator that reflects the profitability of potential investments from financial point of view in terms of the percentage rate of return.	Financial performance indicator – used in combination with FNPV to judge the future performance	Sensitive to uncertainty in future positive and negative cash flows. This uncertainty increases with the length of	The rate that produces a zero value for the FNPV

Indicator	Description	Type of indicator	Description of the methods, the data inputs,	Limitation	Remark
		Complementary to FNPV and used in combination with it.	of the investment or to benchmark required rate of return. Calculated based on FNPV calculation. CBA Chapter 4.3	considered time horizon.	
ERR	Economic rate of return	Quantitative indicator that reflects the profitability of potential investments from economic point of view in terms of the percentage rate of return. Complementary to ENPV, used in combination with it.	Economic performance indicator – used in combination with ENPV to judge the future performance of the investment or to benchmark the required rate of return. Calculated based on ENPV calculation. CBA. Chapter 4.1	Sensitive to uncertainty in future positive and negative cash flows. This uncertainty increases with the length of the considered time horizon.	It is the rate which produces a zero value for ENPV
Environmental & social KPIs					
Climate change costs	External transport costs produced by energy production	Quantitative for the usage indicators and historical data	City Chapter 4.2 Testing: mobility solution usage	Lack of default values availability; Default values not very city	Frequently used environmental KPI associated to GHG emissions

Indicator	Description	Type of indicator	Description of the methods, the data inputs,	Limitation	Remark
Well-to-tank cost	External transport costs produced by energy consumption			representative COVID-19 influence	Frequently used environmental KPI associated to GHG emissions
Air pollutant cost	External costs produced by energy consumption				Frequently used environmental KPI for measuring air quality
Noise	External costs produced by noise				Frequently used KPI for measuring physical or psychological harm to humans
Accidents	External costs produced by accidents				Frequently used KPI for medical, human, material and other costs
Traffic congestion	External costs produced by delay costs and deadweight loss costs				Frequently used KPI for measuring costs originated by road congestion
IT system quality & use KPIs (Product's quality – ISO/IEC 25010)					
Functional suitability	Degree to which a product or system provides functions that meet	Qualitative properties will be measured using quantitative values from the stakeholders' opinion indicators. Each indicator is split down in a particular statement adapted to the pilot using	Chapter 4.2: Questionnaires to a group of stakeholders representing users, policymakers and operators.	The ISO/IEC 25010 specifically designed for software products and IT systems. Although all the SPROUT mobility solutions have some digital component,	Not remarks.
Performance efficiency	Resources performance				Not remarks.
Compatibility	Degree to which a product can exchange information				Not remarks.

Indicator	Description	Type of indicator	Description of the methods, the data inputs,	Limitation	Remark
	(interact) with previous existing products	a qualitative Likert scale on which stakeholders (users, policymakers, operators) indicate their opinion. Quantitative properties will be calculated from the mobility solution usage.	Testing: mobility solution usage	the proposed method may require some adaptation to cover all the aspects.	
Usability	Degree to which a product satisfies users expectative effectively and effectively				Not remarks.
Reliability	Degree to which a product responds as expected during a period time and specific conditions				Not remarks.
Security	Degree to which a product protects data				Not remarks.
Maintainability	Degree to which a product is modified by maintainers effectively				Not remarks.
Portability	Degree to which a product is transferable				Not remarks.
IT system quality & use KPIs (Quality in Use Model- ISO/IEC 25010)					
Effectiveness	Accuracy and completeness with which users achieve specified goals	Qualitative properties will be measured using quantitative values from the stakeholders' opinion indicators. Each indicator is split down in a particular statement adapted to the pilot using a qualitative Likert scale	Chapter 4.2: Questionnaires to group of stakeholders representing users, policymakers and operators. Testing: mobility	The ISO/IEC 25010 specifically designed for software products and IT systems. Although all the SPROUT mobility solutions have some digital component, the proposed method	Not remarks.
Efficiency	Resources expended concerning the accuracy and completeness with which users achieve goals				Not remarks.
Satisfaction	The degree to which user needs are satisfied when a				Not remarks.

Indicator	Description	Type of indicator	Description of the methods, the data inputs,	

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Annexe 3:Recommended indicators for assessing policy implementation feasibility and user acceptance (city level)

List of recommended indicators for city's implementation feasibility and user acceptance. For the implementation feasibility, it considers the legal, operation, and financial dimensions.

Table 21. *List of recommended KPIs for SPROUT pilots (T4.5).*

Indicator	Description	Type of indicator	Description of the methods, the data inputs,	Limitation	Remark
Policy implementation feasibility (legal)					
Legal framework compatibility	This indicator responds to the question: *Is there any regulation that hinders the policy adoption that cannot be modified (policymakers)?*	Qualitative values from the policymaker's response (yes, no)	Surveys and open discussion (policymakers)	Not foreseen	
Policy implementation feasibility (operational)					
City Investment costs	This indicator responds to the question: *Do you think that the city can assume the investment costs required for widely adopting the mobility solution by the city with this policy framework?*	Qualitative -Policymaker. Expert opinion.	Surveys and open discussion (policymakers).	Expert's opinion.	Reach policy makers with a financial background,
City Operational cost	This indicator responds to the question: "*Do you think that the city can assume the*	Qualitative -Policymaker. Expert opinion.	Surveys and open discussion (policymakers)	Expert's opinion.	Reach policymakers with a financial background,

Indicator	Description	Type of indicator	Description of the methods, the data inputs,	Limitation	Remark
	operational costs require for widely adopting the mobility solution by the city with this policy framework?"				
City Revenues	This indicator responds to the question: *Do you think that the city will increase the incomes from widely adopting the mobility solution by the city with this policy framework?*	Qualitative -Policymaker. Expert opinion	Surveys and open discussion (policy makers)	Expert's opinion.	Reach policy makers with financial background
Policy implementation feasibility (financial)					
City Financial net present value	Do you think that the city will improve the FNVP from widely adopting the mobility solution by the city with this policy framework?	Qualitative -Policymaker. Expert	To be defined by the pilots	Expert's opinion.	
User acceptance					
Probability of using the service	Potential users' subjective likelihood that they will use the mobility solution with the alternative policy framework	Qualitative: Users opinion	Questionnaires	Number of people asked not very representative. Users' opinions.	