ReVeAL

Regulating Vehicle Access for improved Livability

D4.1 Process evaluation and impact assessment framework

29 November 2019

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Project partners

Organisation	Country	Abbreviation
STADT BIELEFELD	Germany	Stadt Bielefeld
COMUNE DI PADOVA	Italy	Padova
UNIVERSITA' DEGLI STUDI DI PADOVA	Italy	UNIPD
GEMEENTE HELMOND	Netherlands	Helm
V-TRON BV	Netherlands	V-TRON BV
MUNICIPALITY OF JERUSALEM	Israel	JERUSALEM
THE MAYOR AND COMMONALTY AND CITIZENS OF THE CITY OF LONDON	United Kingdom	CoL
TRANSPORT FOR LONDON	United Kingdom	TFL
CENTRO DE ESTUDIOS AMBIENTALES	Spain	CEA
SADLER CONSULTANTS EUROPE GMBH	Germany	Sadler
TRT TRANSPORTI E TERRITORIO SRL	Italy	TRT
WSP SVERIGE AB	Sweden	WSP
POLIS – PROMOTION OF OPERATIONAL LINKS WITH INTEGRATED SERVICES, ASSOCIATION INTERNATIONALE	Belgium	Polis
UNIVERSITEIT GENT	Belgium	UGent
RUPPRECHT CONSULT-FORSCHUNG & BERATUNG GMBH	Germany	Rupprecht

Summary sheet

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List of acronyms

C-ITS	Cooperative Intelligent Transport Systems
EC	European Commission
EU	European Union
H2020	Horizon 2020
ICT	Information and Communication Technology
KPI	Key Performance Indicator
LEZ	Low Emission Zone
LTZ	Low (or Limited) Traffic Zone
MaaS	Mobility as a Service
SUMI	Sustainable Urban Mobility Indicators
SUMP	Sustainable Urban Mobility Plan
ULEZ	Ultra-Low Emission Zone
UVAR	Urban Vehicle Access Regulations
WP	Work Package
ZEZ	Zero Emission Zone

1 Introduction

1.1 About ReVeAL

Urban Vehicle Access Regulations (UVAR) are one of the most effective levers to achieve the collective goals of climate neutrality, air quality and urban liveability, and one of the inevitable pillars of the urban mobility transition. There is a need for concretely demonstrate that state-of-the-art UVAR approaches are - if planned and executed in smart ways - effective, financially viable, they make productive use of the latest technologies, fit into modern governance structures, can gain public acceptability and are compatible with legacy systems as well as with emerging mobility patterns, concepts and business models.

ReVeAL (Regulating Vehicle Access for Improved Liveability) will undertake concrete action with regards to "smarter Urban Vehicle Access Regulations" (UVAR). The overarching mission of the project is to enable cities to optimize urban space and transport network usage through new and integrated packages of urban vehicle access policies and technologies for the benefit of people living in these cities, in sense of reductions of emissions, noise, increased accessibility and quality of life.

The project combines desk research and case study research with hands-on UVAR implementation in six pilot cities: Bielefeld (Germany), Helmond (The Netherlands), Jerusalem (Israel), London (United Kingdom), Padova (Italy) and Vitoria-Gasteiz (Spain). Pilot cities are committed to develop, implement, test and evaluate UVAR measures in one or more of the four "Measure Fields":

- Zero emission zones,
- Spatial Interventions,
- Pricing Measures,
- Future Options.

One of ReVeAL's key conceptual underpinnings is the notion of transition management, which states that changes to an entire system require holistic attention to all of its components. Since the introduction of any UVAR measure impacts a city's transport system as a whole, it requires the coordinated upgrade of multiple elements of the system, which fall into four "Transition Areas": Governance and Financing, User Needs/Acceptance, Mobility Concepts; and System Design/ Technology – all of which play a role in any change process.

ReVeAL will monitor and evaluate the activities in the six pilot cities to ensure a methodologically rigorous process of extracting the lessons to be learned. The flagship outputs of the project will be two complementary decision support tools - UVAR Readiness Assessment and Process Advisor - and a set of recommendations for the integration of UVAR in SUMPs to support the wider rollout of smart UVAR approaches across European cities.

1.2 About this document

The role of WP4 is to monitor the ReVeAL process, primarily the activities within the six pilot cities and to assess the impact of the UVAR measures in these cities. This will result in both qualitative and quantitative data as basis for a comprehensive evaluation, to detect patterns, and to draw empirically founded conclusions, to identify transferable lessons about good practice (potentially also about issues to avoid) and to tease out recommendations both for practitioners and policy makers.

Deliverable D4.1 (this document) provides a framework for the evaluation activities of the pilot projects in the six ReVeAL's cities (Bielefeld, Helmond, Jerusalem, London, Padua, Vitoria-Gasteiz), aiming at achieving a coordinated and consistent set of results. It is important to note that **this document provides a set of general guidelines to be taken into account in the development of local UVAR evaluation plans**: since the ideation and design process of pilot project measure(s) is at different stages in each city, the framework shall be further detailed and "personalised" by Site Evaluation Managers during the course of the project.

The deliverable is organised with the following sections:

- Section 1: Introduction;
- Section 2: Evaluation framework, in turn divided into:
  - General considerations,
  - Impact assessment,
  - Process evaluation, and
  - Data collection;
- Section 3: Annexes with list of KPIs as well as templates.

2 Evaluation framework

2.1 General considerations

As stated in the Description of Action, ReVeAL's evaluation framework includes two different types of assessment:

- Impact assessment includes the evaluation of a wide range of economic, energy, environmental, social and transport-related impacts of the pilot projects resulted from the implementation by the ReVeAL cities.

The impact assessment analyses the impacts that can be attributed to an intervention such as a measure, a package of measures, or a policy which has been designed to reach a certain objective. Broadly speaking, an impact assessment measures to what extent the well-being of the society has changed due to the implementation of a measure.

- Process evaluation involves the evaluation of the processes of ideation, design, implementation and operation of measures, including the roles of communication and participation.

The process evaluation focuses on the implementation process and attempts to determine how successfully the project followed the strategy initially laid out; it allows evaluators to make the important distinction between implementation failure and theory failure.

Impact evaluation deals with understanding of the practical/technical effects of measures within the city whereas process evaluation is concerned with understanding why measures implementation has succeeded or failed. The integration and interpretation of the results from both aspects will provide the necessary comparative insights and understanding of the effectiveness of the pilot projects.

One of the main actions in setting up the evaluation framework is to identify a set of indicators with which compare and assess pilot projects scope, results and implementation. In this regard, it's worth noting that two of the pilot cities (Bielefeld and Vitoria-Gasteiz) are also currently involved in the EC's SUMI project, which main goal is to support a common development and use of a methodically sound, practically feasible and harmonised indicator set on sustainable urban mobility in European urban areas. This allowed to build up synergies between the two projects by taking into account some of the parameters already defined in SUMI. However, it is important to note that the scope of the SUMI indicator set is the urban area at minimum, while ReVeAL pilot projects work mainly on portions of urban areas; this is a crucial issue, since the use of urban-scale indicators wouldn't allow to appreciate the changes that would occur at the local level.

2.1.1 Pilot cities and pilot projects in ReVeAL

Core activity of ReVeAL is the implementation of UVAR pilot measures in the six pilot cities. All of the cities have been developing ambitious plans appropriate to their local contexts and the cooperation in ReVeAL will support them in pursuing the topic as champions at the European level.

As already stated, ReVeAL is providing a framework for the evaluation activities of the pilot projects. The following table summarises pilot projects' key activities[1] within ReVeAL (and beyond) and quickly synthetises the types of measure that will be assessed in ReVeAL (see last column – this is useful when consulting the detailed list of KPIs for each pilot city shown in the Annex).

Pilot city	**Pilot project's key activities**	**UVAR measure(s) to be assessed in ReVeAL**
Bielefeld	Preparation and implementation of the redesign of Jahnplatz, one of the main traffic, public transport, cycling and pedestrian nodes in the urban area, as part of a wider strategy to implement a LEZ (Low Emission Zone) in the city centre. This is an important step towards the city's goal of a ZEZ (Zero-Emission Zone), consisting of a set of measures including barrier gates, smartphone applications to grant real time special access and ICT to support freight management.	Spatial intervention
Helmond	Brandevoort district, a recently built residential area west of Helmond's city centre, will be equipped with the latest innovative solutions and will function as an urban living lab. Within ReVeAL, Helmond will implement an Intelligent Speed Adaptation System and a ZEZ (Zero Emission Zone). The ISA system will limit the speed of vehicles in the district to a safe maximum and the ZEZ will result in cleaner air in the district.	1) Speed adaptation 2) ZEZ

[1] It is worth noting that the table provides an initial description of pilot projects; this might vary over the course of the project following a better understanding of pilot projects' objectives.

Pilot city	Pilot project's key activities	UVAR measure(s) to be assessed in ReVeAL
Jerusalem	Aim of the project within ReVeAL is to implement a LEZ (Low Emission Zone) in the city; it will be enforced by license plate recognition technology. In two stages, the zone will be expanded and the restrictions will become stricter. Jerusalem is examining more effective enforcement through smart ICT and picture processing technologies in the long term. The results of the LEZ will allow a better understanding of the difficulties, the engagement process and access criteria needed to further move from LEZ to ZEZ.	LEZ
London	The Mayor's Transport Strategy proposes a ZEZ (Zero Emission Zone) in central London (including the City of London) by 2025. This goes beyond the emissions standards for the existing ULEZ and introduces phased restrictions for non-zero-emission capable vehicles. ReVeAL pilot will implement a ZEZ that covers a high-density commercial district in the City of London, in advance of the central London ZEZ. The pilot aims to significantly reduce exposure to air pollution.	ZEZ
Padua	Padova will pursue two goals in two different parts of the city: 1. Introducing new regulations in a wide area of the city centre converting it in a stricter LTZ (Limited Traffic Zone); 2. Fostering the implementation of a superblock model in a suburban area of the city (Guizza district) which lies along the existing tram line. To reach the objectives, Padua will use smartphone apps, ICT services to regulate vehicle mobility and "My Data" to connect existing IT systems.	1) LTZ 2) Superblock
Vitoria-Gasteiz	The city is moving forward in the implementation of the superblock model. Vehicle access restrictions and traffic calming will be the main tools to complete more superblocks in the city centre. The ambition within ReVeAL is to create two superblocks (Médico Tornay and Paseo de los Arquillos) with public works and pedestrianisation of streets and to extend a "light" superblock model to the rest of the city centre by means of video camera surveillance, lane reduction, removal of parking, changes in street directions, etc.	1) Superblock 1 2) Superblock 2

During the first phases of the project, pilot cities have been asked to fill in a template for the collection of a series of preliminary information such as a description of the measure(s) that will be included in each pilot project, the socio-economic context of the pilot area(s), the pilot project context and the pilot projects design. This template is presented in section 3 (Annexes).

Moreover, in conjunction with the consortium meeting held in Padua on 20-21-22 November 2019, an internal fine-tuning workshop dedicated to the evaluation framework has been performed. Scope of the workshop was to facilitate the convergence to a shared approach on the methodological contents and the related practical implications of the evaluation framework after the preparation of a first version of this document (D4.1).

The collection of the preliminary information and the workshop discussion allowed a first "personalised" selection of the most relevant indicators for each of the six pilot projects.

2.1.2 Data protection and ethics

In WP4 (Monitoring and evaluation), data will be gathered purely for research purposes, that is, as a precondition to synthesize new, empirically grounded, knowledge. This will happen through quantitative data gathering, sometimes through manual counts (e.g. vehicles entering a certain area) and in other situations through automated techniques. For qualitative analysis, data will be collected through interviews, focus groups, surveys etc.

None of this data will leave the consortium in an individualised form. Any publication released into the public realm by ReVeAL will only contain such data in highly aggregate form, which does not allow to identify any individual. In cases where quotes from individuals are published, these will always be anonymised (unless the agree to their real name being disclosed) and great care will be taken not to disclose the speakers through their professional affiliation or through any other way.

The participants of these activities will be provided with detailed written information about the project, about the intended use of data, that their participation is entirely voluntary, that their data will be deleted upon request etc. They will be offered an informed consent sheet (in language and terms intelligible to the participants), explaining these details. These informed consent/assent forms and information sheets will be kept on file. Confidentiality requirements survive the termination of the project.

In any case, no personal data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, or genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation will be asked nor processed.

They will also be assured:

- compliance with the General Data Protection Regulation (GDPR) ((EU)2016/679); personal data will only be processed for the purpose of project management;
- in case data will be shared with the European Commission as the awarding authority, compliance with the Regulation (EC) No. 45/2001 on the protection of individuals
- in case of data collected in non-EU countries, compliance with the laws of the country in which the data is collected.

2.1.3 Definitions and recommendations for pilot cities

Before proceeding with the methodological description of both the impact assessment and the process evaluation, it is considered useful to point out a few strategical issues upon which the evaluation framework is based and through which the assessment can be smoothly conducted.

The following box introduces a series of initial definition that could help the reader to understand the less common or more controversial terms in the field of project evaluation. Please note that the concept of "business-as-usual scenario" is also extensively presented in section 2.2.1. After the green box, a couple of clarifications that might be useful for the pilot cities are presented.

Box 1: Some definitions

- Monitoring: supervising and measuring activities in progress in pilot cities to ensure they are on-course and on-schedule in meeting the objectives
- Evaluation: analysis of ongoing and/or completed activities in pilot cities to determine the value, the quality or the significance of them
- Impact: extent of the tangible and intangible effects (or consequences) of the projects implemented in the pilot cities
- Business-as-usual scenario: a hypothetical scenario developed by considering what would have happened without the realization of the pilot project

As regard to impact assessment, it is important to underline that **it is crucial to determine a clear baseline in each of the pilot cities during the early phase of the monitoring and evaluation process** (i.e. before the implementation of the pilot projects in ReVeAL cities), so that the impacts can be assessed in the sense of a before-after comparison. Without the definition of a baseline, the assessment cannot be performed.

Moreover, **there is the essential need to clearly define the physical area(s) in pilot cities within which the assessment is performed**. The area in which the measure(s) of the pilot project, also defined as pilot area later in the document, will be implemented refers to the area of the city where the measure(s) is/are expected to generate impacts on relevant dimensions of the evaluation framework. Borders of the pilot areas should necessarily be consistent throughout the entire project/process.

It is critical that pilot cities and their supporting partners take into account the above-mentioned recommendations when drafting their local UVAR evaluation plans.

2.2 Impact assessment

This section of the report presents the approach to the impact assessment of UVAR measures[2] developed by ReVeAL pilot cities. It is important to remark the impact assessment requires a consistent approach across all pilot cities to allow for a systematic comparison between before and after situations. This is necessary to consistently assess the envisaged impacts of planned interventions.

The following subsections are organised as follows. Section 2.2.1 introduces to the meaning of the impact assessment, its objectives, when it is required and the procedural steps. Section 2.2.2 describes the relevant categories of impacts that an evaluator should consider in carrying out the analysis (list of KPIs with respect to which measure the impacts are also reported in section 3). Section 2.2.3 illustrates possible methodological approaches to evaluate the relevant impacts, mindful of the importance of context-specific aspects and comparability across pilot cities.

2.2.1 Introduction and objectives

What is an impact assessment and when is it required?

Defining a problem correctly is the starting point when developing a measure, because if a problem is ill-defined it is difficult to design effective interventions on the ground.

A problem should be described in terms of magnitude and known consequences of a situation for the society[3], for the individuals or for concerned sectors, like for example, the impact of pollution on the health and the environment. This should also be done considering the likelihood of the persistence of a problem in the absence of a measure. The following box summarises some tips and commonly encountered issues in problem analysis.

[2] The meaning of measure could be also interpreted in a broader sense, namely as package of measures.

[3] As general rule, it is worth remarking that the larger and more contentious the measure, the more assessment effort is normally required. In participle, the assessment should be proportional to the impact in order to avoid the risk of getting a paralysis of the analysis.

Box 2: Tips and commonly encountered issues in problem analysis

- A commonly made mistake is to conclude that a problem exists because a measure does not exist. The missing element is not a problem *per se*, but may be the possible measure to solve an appropriately defined problem.
- A problem and its cause are often not supported by tangible evidence. For example, without solid evidence, it is difficult to explain why people's behaviour is biased and correct the behaviour accordingly.
- If the information or data is available, it is also informative to present the problem (and related causes and drivers) in a spatially disaggregated way, using maps or other visual aids.
- Where there are several problems and drivers, or they are complex or even interrelated, it is often a good idea to use visual aids to describe them and to link them through the objectives and identified measures.
- It is important that problem analysis identifies the roles, issues and drawbacks for concerned stakeholders so that a certain measure can be designed in a way that tackles effectively the behaviour of the actors that would need to change.

When a problem is identified it should be qualitatively and/or quantitatively analysed developing an impact assessment. So, the next point is to show how assess the actual impact of a (UVAR) measure in a structured way. To do this we start introducing what an impact assessment is and the sequence of activities to carry out an impact assessment.

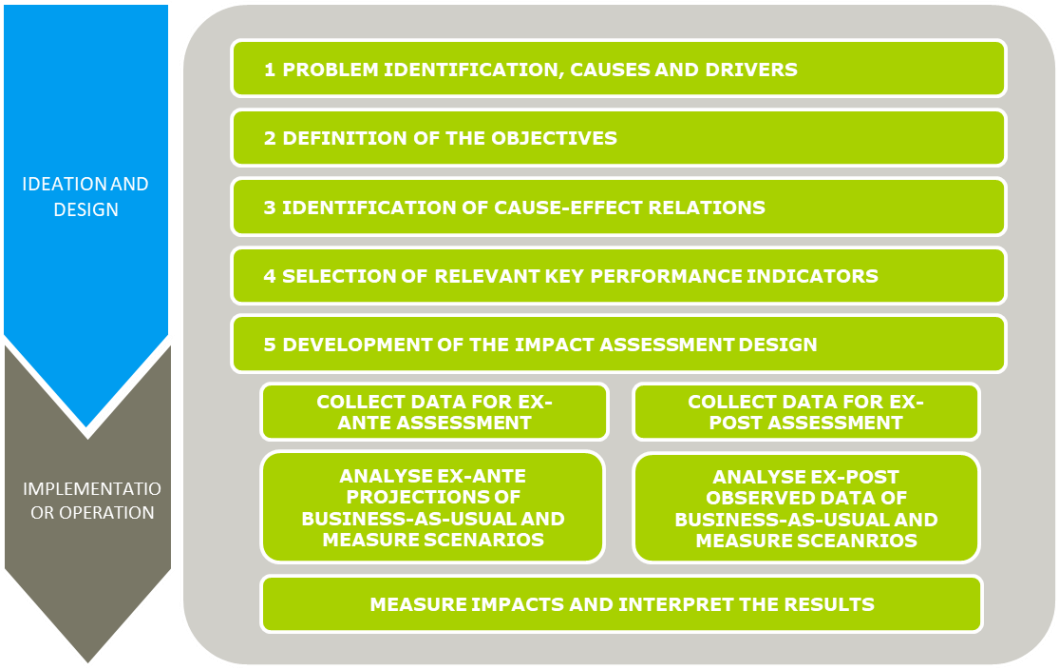
The impact assessment analyses the impacts that can be attributed to an intervention such as a measure, a package of measures, or a policy which has been designed to reach a certain objective. Broadly speaking, an impact assessment measures to what extent the well-being of the society has changed due to the implementation of a measure.

There are some important aspects to note. First, for the assessment of an impact it is essential to collect and analyse the data from the field where a measure will be or has been introduced, developing a scenario without a measure being implemented (i.e., business-as-usual scenario) and with its implementation (i.e., measure scenario). Second, the assessment of an impact can be carried either before or after the implementation of a measure. If the assessment is developed before (i.e., ex-ante), it can help to decide which measure is best to solve the problem. If the assessment is developed after (i.e., ex-post), it can help to understand if a measure has been helpful, and to what extent, to tackle a problem. These aspects are analysed in detail hereinafter.

What are the procedural steps?

The following figure illustrates the procedural steps through which an impact assessment is carried out, also putting them in relationship with the sequence of phases envisaged to develop a measure and that will be discussed in the next section on process evaluation.

Figure 1: Sequence of procedural steps to carry out an impact assessment



Source: elaboration of the authors

The first step consists of identifying the problem to be addressed and, in order to solve the problem, its underlying causes or drivers.

This activity is important for two reasons. First, it is impossible to design a measure and assess how it could tackle a problem without knowing underlying causes and drivers involved. This implies an analysis of the links between problems, drivers and measures. Second, the nature of the problem, in terms of size, geographic scale and actors involved plays a key role to identify of a measure, which in general, may be justified when:

- it can deliver an efficient outcome for the society (e.g., reducing the level of road congestion);
- a previously implemented measure appeared justified, but failed to solve the initial problem satisfactorily, or generated new problems (e.g., once implemented a road pricing measure,

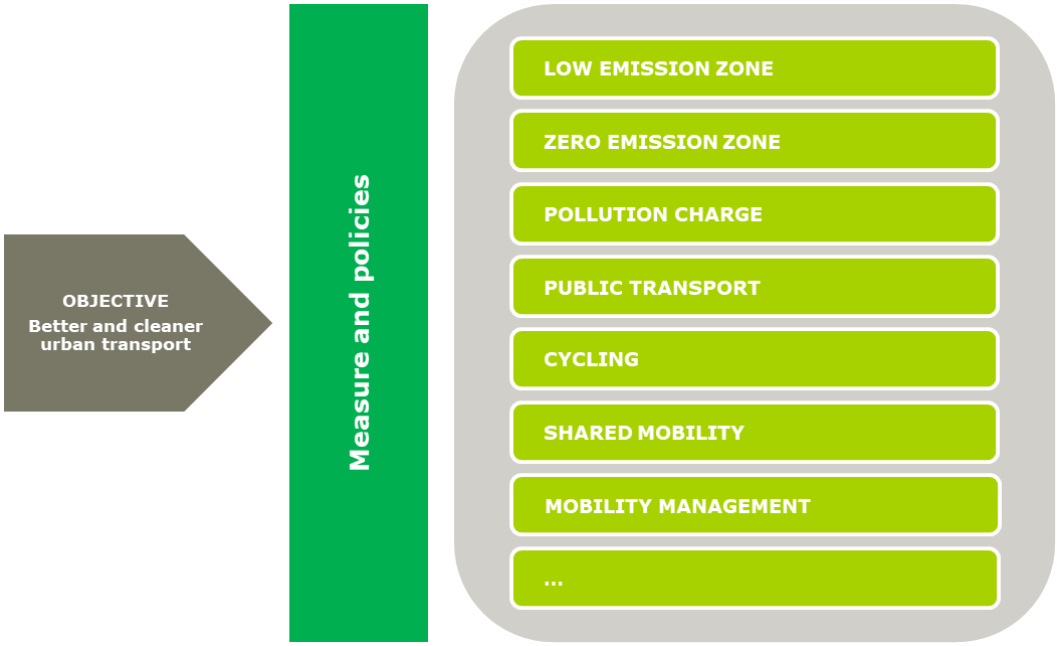
collective transport is found not having adequate capacity to manage the demand diverted from private cars);

- for equity considerations, when an efficient outcome may not be the most desirable one for the measure in question (e.g., once implemented a road pricing measure, part of the demand diverted from private cars no longer enjoys of the previous level of accessibility to relevant destinations, or longer travel times are necessary);
- behaviours are biased and individuals do not decide on their own best or collective interest (e.g., being road congestion an external cost, the social costs generated by the decision to travel by private car are not fully perceived by the individuals).

The second step focuses on the definition of the objectives that one wants to achieve through a measure. In order to evaluate the impact of a measure, the objectives targeted by the implementation of that measure must be clearly identified and, where necessary, explain how different objectives relate each other.

For example, the objective could be that of providing better and cleaner urban transport by introducing measures and policies towards sustainable mobility. The goal is to encourage a shift towards more sustainable transport modes, which can be reached introducing less polluting vehicles (with innovative technologies) or the implementation of a UVAR measure, like a LEZ or road/parking pricing (see next for explanatory purpose).

Figure 2: Measures addressing the objective of better and cleaner urban transport



Source: elaboration of the authors

Regarding the objectives, it can also be useful introducing a two-level hierarchy, namely (i) high-level objectives and (ii) measure-specific objectives. The former category refers to higher, more long-term level ones, like for example the improvement of the quality of life of the citizens or the reduction of transport-related emissions. The latter are short-termed ones and involve small steps to achieve the ultimate goal identified at the high-level.

To show how a measure relates to a certain objective, the impact needs to be translated in the extent to which it contributes in addressing high-level and measure-specific objectives, less other influences, which would have happened without the measure.

The defined objectives describe what can be achieved by implementing a certain measure or policy**. The third step consists of understanding the extent to which the objectives can be achieved, and which spheres are influenced by the implemented measure.** It becomes therefore important to identify and analyse the cause-effect relations of the measures, also to prepare the decision for the choice of the indicators (see the next step in this respect).

Basically, the analysis of the cause-effect relations shows the linkage between possible effects and the resources that are bounded through the implementation of measures and policies. This approach is helpful to understand the wide range of possible intended and unintended impacts and to consolidate the choice of the indicators measuring the impacts.

Considerations of causal relationships are not a waste of time, because the impact of measures and policies can always be caused by a variety of effects, often indirect and with several steps between an activity and its eventual impact. The cause-effect analysis should be integral part of an impact assessment also considering that, after analysing the results, one can interpret the outcomes for corrections or improvements.

After the definition of the objectives and understanding of the cause-effect relations, **the fourth step consists of the selection of the most relevant Key Performance Indicators (KPIs).** They should be those able to show a possible impact best and that can realistically be assessed with the given time and resource budget. Indicators must closely relate to the objectives and allow for statements about the degree to which the objectives can be achieved.

There are some basic requirements which are helpful to guide for selecting the KPIs, as they must:

- clearly reflect the performance or impact of an identified measure or policy;
- match the objectives;
- be consistent with the actual information and data gathered from the ground; and
- be capable of reliable assessment using the selected type of analysis.

An important thing to remind when selecting the KPIs is that if one wants to evaluate a number of transport measures in parallel there are indicators which might be affected by more than one measure.

There are various sets of KPIs already developed in a number of programmes for assessing and monitoring the impacts of urban mobility measures and policies. The list presented in section 2.2.2 and further elaborated in the Annex has been developed taking into account the variety of UVAR measures that will be implemented in the six ReVeAL pilot cities and therefore what objectives are intended to be reached. However, according to context-specific characteristics and specific

circumstances they eventually have to be adapted, also considering the availability of information and data.

As an example, it could be important to assess to which extent a LEZ promotes the use of a cleaner vehicle fleet in a particular area of a city; to this purpose, the distance travelled by vehicles per fuel type and EURO emission standard in that area could be used as an indicator to assess the shift towards a more environmental sustainable vehicle use; if this is the case, quantitative data such as vehicle-km travelled ought to be gathered (measured, collected or derived) in order to measure the parameter.

The following figure illustrates the sequence of steps from the definition of the objective to the identification and description of the indicator.

Figure 3: Sequence of steps from objective to description of the indicator

Source: elaboration of the authors

The fifth step develops the impact assessment design. It consists of a plan for collecting data and analysing the evidence that will make it possible to answer about the outcomes and impacts of the measures. This is an important task, because in assessing transport-related measures, all factors which may change during the evaluation period need to be collected and presented. But, before drawing conclusions, it is first necessary to identify what would have happened if a certain measure was not introduced. Only then one can ensure that the impact generated by a measure relying on the actual effect of the measure implemented.

What is a business-as-usual scenario and why is it necessary?

The impact assessment is based on an incremental approach, which estimates the impact of a measure as the difference between a scenario implementing the measure and a counterfactual scenario without the measure being implemented.

The business-as-usual scenario is usually the reference situation to elaborate what would have happened if a certain measure had not been introduced and its goal is to determine the impacts of the measures by comparing the world with and without the measure being implemented. This implies that the business-as-usual scenario should be developed as the best assessment of the world absent of the measure, or in other words, if the measure under consideration is not

undertaken. It is important to stress that a sound elaboration serves as a starting point and primary point of comparison of the impacts with respect to the current state of the world.

In this approach the business-as-usual scenario provides the framework to include other measures, which would probably be implemented even in the absence of the measure considered. The definition of a sound business-as-usual scenario is therefore an underlying aspect to inform consistent comparisons, because under equal conditions, the actual impact should be measured only with respect to the implemented measure. The more accurate is the business-as-usual scenario, the more reliable is the impact assessment and the conclusions drawn. This point makes important that a sound information and data is necessary from various sources to feed the impact assessment, which in turn is linked to the measure of the objectives and selection of the indicators.

A number of approaches are feasible to develop a business-as-usual scenario. They include forecasting from historical data, modelling exercises (where context-specific transport models can be developed) or monitoring a parallel control site with the same characteristics without applying the project measures to it. In assessing the impact of transport projects, this latter solution could be very expensive and not always very precise or appropriate[4].

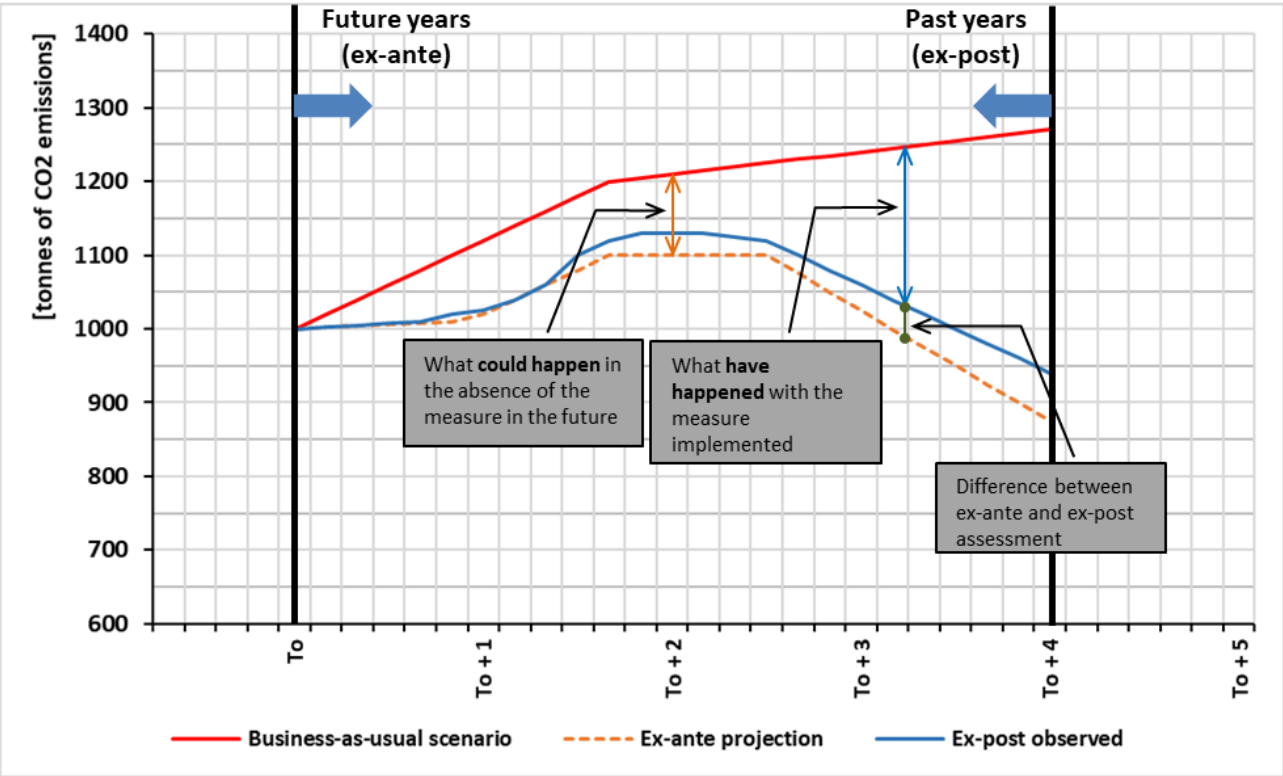
According to the timing of implementation and assessment of a measure, ex-ante and ex-post assessments are possible, being both carried out with respect to the same business-as-usual scenario. The figure below graphically illustrates an example, which develops the assessment of a measure targeting the reduction of CO_2 emissions.

Assessing the measure when planned for future years (e.g., starting at time T_0), it is important to ex-ante predict to what extent it could impact in the context where it will be implemented. All the effects need to be identified and measured with respect to the realistic the business-as-usual scenario assumed. The envisaged effects may be modelled or interpreted through processes of extrapolation and predictions, or with a mix of both. This will depend on the data and models available on a context-specific basis.

Assessing the same measure for ex-post assessment, it is important to monitor, and ultimately evaluate, whether the impacts originally foreseen have actually materialised (e.g., at time $T_0 + 4$) and to what extent. The ex-post situation provides a set of observed measurements from the field, which can be used for comparison with the predictions done at the ex-ante level of assessment. By comparing the ex-ante predictions against the ex-post observed data, it is possible to determine the effects of the measure, with respect to the assumed objectives.

[4] However, it is worth noting that this approach could be used considering in a city which develops a measure only in a restricted area. Other areas of the same city, where the same measure is not developed, could be assumed as parallel control sites for comparison.

Figure 4: Comparison of ex-ante and ex-post assessments with respect to business-as-usual scenario



Source: elaboration of the authors

Box 3: Checklist for preparation of an impact assessment

- Establish what the problem is and why it is problematic
- Assess the magnitude of the problem
- Establish the causes and drivers and assess their relative importance
- Identify who the relevant stakeholders are
- Identify the objectives that are related to the measure
- Select the indicators and check for consistency with respect to data gathering
- Describe how the problem is likely to evolve without intervention
- Develop a realistic business-as-usual scenario

2.2.2 Impacts measurement and related KPIs

How can a relevant impact of a measure be identified?

The identification and assessment of the most relevant impacts is a core task of every impact assessment.

An objective approach to the identification of the most relevant impacts is needed, in order to identify all potentially important ones and considering them in terms of both (i) positive and negative, (ii) direct and indirect, (iii) intended and unintended and (iv) short- and long-term effects. A well-justified choice should then be made, retaining the most relevant ones for in-depth analysis to be carried out consistently with availability of information and data gathered from the field.

In general, there is no-single rule for the best approach to develop the assessment of relevant impacts, however, they should be assessed qualitatively and, whenever possible, measured quantitatively. This should be done using the most sensible methodological approach in the light of specific characteristics of the urban context, the measures at hand and the requirement to carry out a proportionate analysis.

To give guidance in selecting and analysing the relevant impacts, the following factors can be considered.

- Relevance: all key parameters of a measure that will directly contribute to achieve the objectives of a measure should be retained for in-depth analysis, as the evaluation is a necessary condition for assessing the actual effectiveness of the measure.
- Absolute magnitude: the analysis should focus on the impacts with the greatest magnitude.
- Relative size of the impacts for specific categories of stakeholders: while some impacts may be small in absolute terms, they may be particularly significant for some groups of residents or urban areas.
- Importance for horizontal objectives: when the analysis of the impacts shows that there are potentially significant trade-offs between the objectives of a measure (and its effects) and other politically important objectives, the relevant impacts should be analysed in-depth. For example, an emission charge which restricts the access to a certain urban area, indeed reduces private vehicles emissions, but also increases the safety level. In turn, this could encourage pupils to do the school-home trip on their own (by bike or foot) making them less dependent on the parents.

What are the relevant impacts of a measure?

Taking into account the abovementioned factors the following, impact areas can be considered when developing an impact assessment. For each type of impact, a number of KPIs is defined and listed both in the following paragraphs and in the annex of this report (see section 3), also providing a brief description and the data or input needed to carry out quantitative calculations or qualitative estimations.

KPIs are categorised in "pilot-related indicators" and "context indicators" according to their scope. Furthermore, a priority level has been assigned to each of the UVAR measure in each of pilot city:

- Recommended indicators are considered as fundamental in the assessment of a specific measure (these include the ones that are strictly linked with a declared objective);
- Relevant optional indicators are parameters that, if collected anyway, could increase the significance of the assessment by exploring other relevant-to-measure variables;
- Less-relevant optional indicators have less pertinence with the specific measure.

It must be noted that a recognizable pattern exists in the selection of pertinent or less relevant KPIs, which is based on the type of measure is intended to evaluate. **The list of KPIs, including parameters and calculation methods, will be further elaborated or amended during the elaboration of local UVAR evaluation plans in pilot cities**.

2.2.2.1 Economic impacts

The economic impact focuses on the estimation of the benefits (or effectiveness) generated by a measure in relation to the resources used for ideation, preparation, implementation and operation. In economic terms, the balance between the costs a measure implies and benefits generated has to be judged, in order to assess the extent to which it can contribute to the economic welfare of the residents of an urban area. In this respect, it is worth reminding that the economic impact is measured on behalf of the whole society, instead of considering the perspective of a single individual.

The costs of a measure include the activities related to ideation and preparation at feasibility stage, the capital costs for construction works, the expenses for maintenance during the operation of a measure (i.e., ordinary and extraordinary) and finally the renewal costs.

If collective transport modes are involved, it is also necessary to design an operating model to assess its costs. For example, a measure considering the operation of bus lines should include the number of vehicles running the service and the operating costs associated, which in turn depends on the assumed service schedule.

The benefits of a transport-related measure are generally linked to travel time savings and improved environmental and safety levels, which derive from enhanced conditions in the area where a measure is implemented. In general, travel time savings and improved environmental and safety levels can be estimated considering the following aspects:

- improvement in accessibility for people living in peripheral areas;
- improvement of the performance of a transport network or link, by increasing travel speed and travel safety conditions;
- shift of transport demand to more faster transport modes (i.e., collective transport running on dedicated lanes); and
- reduction of road congestion by (i) eliminating capacity constraints on single network links or nodes, (ii) building new alternative links or (iii) introducing road pricing measures. In this respect, it is worth observing that the users that still continue using private cars after a modal shift to collective transport (but also to cycling and walking) has occurred may benefit of travel time savings.

For a good quantitative assessment of the impacts, the estimates of costs and times need to be realistic and preferably "on the safe side" given the uncertainties involved.

Transport measures may also have an impact on the economy of an urban area. This is a controversial issue from the theoretical point of view and the only conclusions that seem to be universally acknowledged are that the impacts can be both positive and negative. In general, an increase of accessibility may result in some advantages, like urban regeneration, which generates impacts on residential land values and commercial property values of the area (and nearly) where a measure is implemented. On the other hand, higher residential land values can increase the risk of social substitution.

Under certain conditions these effects can be considered in the assessment of the economic impact, but with the warning to avoid double counting, namely the possibility of considering the same benefit from different points of view. The variations of costs to access to the areas and the benefits from travel time savings can be considered as an acceptable approximation of the final economic impact of transport measures.

KPIs

Impacts	Category	Indicator
Pilot-related indicators (scope: pilot area)		
Benefits	Operating revenues	Operating revenues
	Rent	Land rent
	Savings	Travel time savings
Costs	Costs	Capital costs
		Operating costs
		Managing and maintenance costs
		Congestion costs
		Social costs

2.2.2.2 Energy impacts

Energy impact concerns the effect of a transport measure on energy consumption, for example assuming the introduction of alternative fuels or changes in the mix of propulsion systems of the fleet of vehicles in the area where a measure is implemented. In addition to these options, other measures can also contribute to the reduction of the energy impacts, like for example encouraging the users to shift to less energy consuming transport modes (i.e., collective transport, car sharing, bicycle, walking, etc.).

Energy impacts can be estimated as variation of fuels consumption of the vehicles fleet in the scope of the application of the measure.

KPIs

Impacts	Category	Indicator
Pilot-related indicators (scope: pilot area)		
Energy Consumption	Fuel consumption	Vehicle fuel efficiency
		Fuel mix

2.2.2.3 Environmental impacts

Environmental impacts consider transport measures that aim at improving the quality of the environment, or according to public economics, at reducing the external costs of transport. Implementing a transport measure, this objective can be achieved by using cleaner or less noisy vehicles, which in general allow for lower emission levels at source.

Environmental impacts can be quantified as variations of the volume of emissions of local pollutants (i.e., CO, NO_x and Particulate Matter), greenhouse gases emissions (i.e., CO_2) and noise perception of affected residents. As noted, discussing the energy impacts, the emissions of pollutants also depend on the mix of vehicles and the assumed evolution of the fleet through time.

A full discussion of the assessment of the environmental impacts goes beyond the scope of this report, but the monetisation of the environmental impacts can be integrated in the estimation of the economic impacts previously introduced to provide a more insightful analysis of the broadest impact of a transport measure.

Once the variations of the volume of the emissions have been quantified, they can be converted into monetary terms, introducing realistic unit values of the external costs for which the emissions are available. Where possible, and depending on the available type of information and data, this step can be developed relying on the input values of the 2019 Handbook on external costs of transport (van Essen, et al., 2019).

KPIs

Impacts	**Category**	**Indicator**
Pilot-related indicators (scope: pilot area)		
Pollution and nuisance	Emissions	CO_2 emissions
		CO emissions
		NO_2 emissions
		Particulate emissions
	Noise	Level of noise
Context indicators (scope: city-wide)		
Pollution	Air quality	CO levels
		NO_2 levels
		Particulate levels
		Black carbon levels

2.2.2.4 Society impacts

Society impacts evaluation is focused on assessing the general acceptability of a measure and its effects on how easily people are able to travel around in a city with respect to physical and economic accessibility, including their feelings about security. These may in turn have further effects on, for example, such factors as health and employment opportunities.

Usually, when a measure is implemented, the impacts are unevenly distributed across a number of affected social groups and typically there are winners and losers. The analysis of the economic impacts provides information, at aggregate level, by stating whether the society is better off, with or without the measure regardless of who is bearing the costs and receiving the benefits. For this reason, it is suggested that the distribution of costs and benefits amongst users and other stakeholders be developed in parallel with the analysis of the economic impact. A disaggregated description of the groups advantaged or disadvantaged by the measure can help in better assessing the impacts associated with a measure, and in some cases, identify mitigation measures or compensations for those found disadvantaged.

The analysis of social impacts can allow for the identification of possible problems for specific groups and may be decisive to inform a final decision whether to implement a measure. The level of detail of the analysis depends on the availability of information and data on awareness, acceptance, perception on physical accessibility, perception of security and equity levels.

Regarding equity levels, the ethical issues concerning gender aspects and vulnerable groups are significant factors to account for differences in mobility and travel behaviour. The mobility of women', persons with reduced mobility and poor in day-to-day life differs from that of a typically assumed average transport user. For instance, women are more likely to travel shorter distances and to stop more frequently than men during their journeys, persons with reduce mobility have specific needs to be considered to access to services and a poor has income which limits the possibility to access to better employment opportunities. Although these gaps could be slowly closing through time, the recognition of the links that exist between specific groups of the society and their mobility opportunities can be useful to improve the quality and scope of impact analysis.

KPIs

Impacts	**Category**	**Indicator**
Pilot-related indicators (scope: pilot area)		
Acceptance	Awareness	Awareness level
	Acceptance	Acceptance level
Accessibility	Spatial accessibility	Accessibility level by social groups
Safety	Transport safety	Injuries and deaths caused by transport accidents
Equity	Equity	Equity level by social groups

2.2.2.5 Transport system performance impacts

The transport system performance considers different aspects, which are related to the implementation of a measure. The analysis of this type of impacts aims to understand how much a measure could contribute to a better urban transport.

In particular, the purpose of this analysis is to show to what extent a measure could be effective and efficient, also considering the modal choices available in the area of implementation. Some parameters are useful to provide indications for this objective, such as for example: the quality of public transport service, the traffic safety levels, the volume of transport activities carried out by mode, which should also include cycling and pedestrians, and level of usage of public space dedicated to transport and other needs.

KPIs

Impacts	**Category**	**Indicator**
Pilot-related indicators (scope: pilot area)		
Quality of PT service	Service reliability	Accuracy of timekeeping - peak
	Travel times	Average service speed - peak
Transport system	Traffic levels	Traffic flow by vehicle type - peak
		Traffic flow by vehicle type - off peak
	Congestion levels	Car travel time - peak
		Car travel time - off peak
	Freight movements	Goods vehicles
	Soft mobility levels	Pedestrian flows
		Cycle flows
	Sharing mobility	Access to shared modes
	E-mobility	Charging points
Public space	Public space usage	Area dedicated to transport and other needs

Impacts	Category	Indicator
Context indicators (scope: city-wide)		
Transport system	Modal split	Average modal split
	PT usage levels	PT ridership
	Regulated zones	Area included in regulated zones

Box 4: Checklist for analysis of relevant impact

- Identification and selection of relevant impacts for in-depth analysis
- Selection of KPIs consistent with the assessment of relevant impacts
- Avoid double counting of impacts analysed

2.2.3 Types of analysis

How can a relevant impact of a measure be measured qualitatively or quantitatively?

This section introduces different type of analysis that can be developed to assess the impact of a transport measure. Before entering into technical aspects some considerations are necessary to provide guidance to select the most suitable methodological approach.

All relevant impacts should be assessed qualitatively and quantitatively wherever possible. Quantification of the impacts will be not possible for all ReVeAL's UVAR measures, but it is suggested to deploy efforts to allow for a more transparent presentation of the benefits arising from their implementation. There are several methods to quantify the impacts, both in terms of overall approach and specific techniques for individual types of impacts. Whatever the case, the most appropriate one should be used and the choice clearly justified.

There is no one ideal approach which would apply to all possible measures and contexts, but it is recommended to select the most sensible methodological one. Methodological complexity is not an excuse for not presenting practical implications of different options and for not explaining how different parties can be affected. All significant impacts should be analysed regardless of the nature of the methodology to do so.

Similarly, the fact that it may not be possible to quantify some impacts does not mean that they should not be taken into account. If a qualitative analysis is developed, it should be rigorous and thorough. As for the quantitative assessment, important underlying assumptions have to be stated and the conclusions should rely on available evidence, including illustrative examples and

also referring to stakeholders' views. Furthermore, if a broad order of magnitude of an impact cannot be given, qualitative reasoning should explain why a measure is considered to have larger (or smaller) impacts than another.

Some considerations can be useful to provide guidance on selecting the approach, also considering that different types of the analyses can be complementary and not substitutes. Whatever the case, for both quantitative and qualitative analysis, it is important to remember the following points.

- A good understanding of the effects of a measure is the starting point and necessary to elaborate a convincing narrative of the envisaged impacts.
- The activity of information and data gathering must be developed to feed in a coherent manner the indicators used.
- Any change of the indicators should be assessed relative to the business-as-usual scenario, namely in terms of incremental variations relative to the situation in the absence of the measure.
- Impacts should be assessed from the point of view of the society as a whole, although distributional effects between groups and cumulative burdens on individual parties should be proportionally assessed and considered. Whenever impacts are aggregated double counting should be avoided.
- Different impacts can occur at different times (with costs often being incurred early and benefits emerging only later). This should be reflected in the assessment, discounting monetised estimates as appropriate when these are available.
- An impact could materialise on a long-term period (e.g., on residential land and commercial property values) and therefore not measurable within the time frame of a pilot project. Although it might not be possible to provide an estimation for the context in which a measure is implemented, a comparable outcome should be derived extrapolating from a context with analogous socio-economic characteristics.
- It is unlikely that a very spatially-specific measure, e.g. focusing on a very small portions of the concerned context, might have substantial impacts on indicators measuring relevant impacts.

In the light of the above considerations, it is suggested to develop the impact assessment in the framework of a cost benefit analysis. However, mindful of context-specific characteristics and information and data gathering limitations, the cost effectiveness analysis and the multi-criteria analysis can be referred to enlarge the spectrum of methodological options, whenever a quantitative assessment of the envisaged impacts is very difficult or not possible. A combination of cost benefit analysis and multi-criteria analysis could be useful to take into account context-specific situations and would also allow for some degree of comparability between the pilots.

The key features of the three approaches are briefly presented in the following paragraphs. **Proper guidance will be developed and made available to pilot cities for the definition of the local UVAR evaluation plans**.

2.2.3.1 Cost benefit analysis

The cost benefit analysis (CBA) is the commonly used technique for the evaluation of the overall economic impact of transport measures and relies on a standardised and straightforward methodological framework.

The key aspects to consider are, on the one hand, the investment costs borne to develop a measure and, on the other hand, the benefits resulting from the variations of: users' surplus, producers surplus, impact on the Government and external costs (see next figure). The changes are measured as variations between the business-as-usual and the measure scenarios.

Figure 5: Overall basic calculation of the economic impact

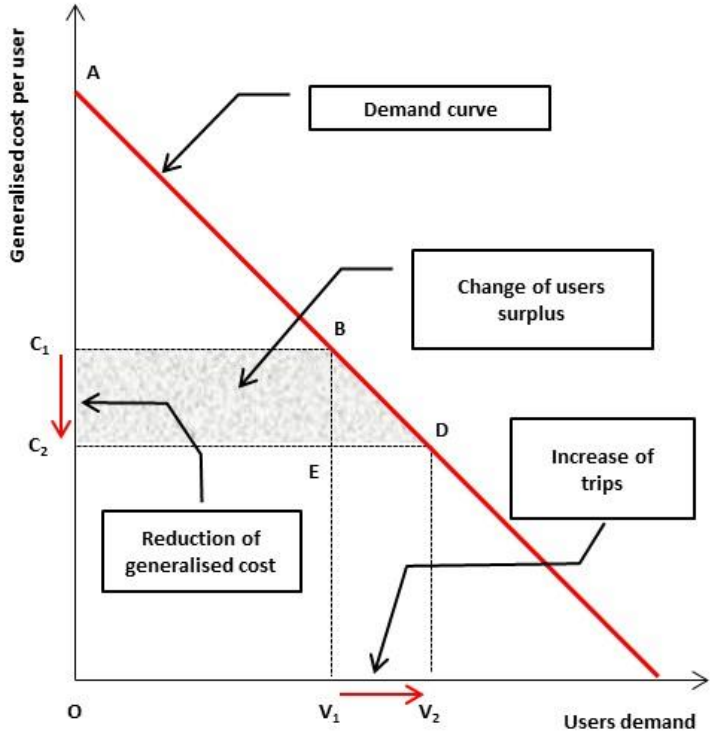
Overall Economic Impact	=	Change of transport user benefits (users' surplus)	+	Change of operating costs and revenues (Producer surplus and impact on Government)	+	Change of external costs (pollutants, accidents, etc.)	-	Investment costs

Source: elaboration of the authors

- users' benefit is measured as change of users' surplus before and after the development of a measure, where the users' surplus is represented by the area beneath the demand curve and above the equilibrium generalised cost (**C**). Being the areas **ABC_1** and **ADC_2** users' surplus, respectively before and after the development of the measure, the users' benefit is the area **C_1C_2BD**.

  Depending on the transport mode, the generalised cost of travel sums all monetised travel cost components perceived by the user (i.e., value of travel time, fares, tariff, tolls, vehicle operating cost, etc.). The changes of the generalised cost of travel (**$C_1 - C_2$**) may be estimated assuming a (linear) demand curve, which correspondingly provides the variation of the demand of users before and after the development of a measure (**$V_2 - V_1$**). When calculating the benefits, it is recommended that a distinction be made between the benefits of existing demand (**C_1C_2BE**) and the benefits of demand diverted (from other transport modes) or generated (**BDE**).
- infrastructure and service operators surplus (i.e., producer surplus), namely variations of revenues and costs borne for infrastructure and services operated;
- taxes and subsidies for the Government; and
- external costs (i.e., pollutants and noise emissions and accidents).

Figure 6: Graphical representation of users' surplus and benefit



Source: elaboration of the authors

Costs and benefits occurring at different times must be discounted and the social discount rate reflects the social view on how future benefits and costs should be valued against the present ones. Discounting is applied throughout an appraisal period that can vary from measure to measure and which is assumed on either the technical, market or economic life. The social discount rate changes at country level, but suggested values are available in the guide to cost benefit analysis of the European Commission (Sartori, et al., 2014).

The economic performance of the measure can be estimated using the following indicators:

- Net Present Value (ENPV): the difference between the discounted total social benefits and costs;
- Economic Internal Rate of Return (EIRR): the social discount rate that produces a zero value of the ENPV;
- Benefits/Costs ratio (B/C): the ratio between discounted economic benefits and costs.

2.2.3.2 Cost effectiveness

Cost-effectiveness analysis (CEA) is a comparison of alternative measures with a unique common effect which may differ in magnitude. It aims to select the measure that, for a given output level, minimises the net present value of costs, or, alternatively, for a given cost, maximises the output level. CEA results are useful for those measures whose benefits are difficult, or impossible, to evaluate, while costs can be estimated confidently. Technically, a CEA solves a problem of optimization of resources that is presented in the following two forms:

- given a fixed budget and n alternative measures, decision-makers aim to maximise the outcomes achievable, measured in terms of effectiveness (E);
- given a fixed level of E that has to be achieved, decision-makers aim to minimise the cost (C).

Although one could compare the simple ratios of costs to outcomes (C/E) for each alternative, the correct comparison is based on ratios of incremental costs to incremental outcomes, since this tell how much the society is paying in adding the extra (more beneficial) measure. In particular, when the alternative measures are competitors and mutually exclusive, an incremental analysis is required in order to rank the projects and single out the one that is most cost-effective. It is calculated as the following ratio defining the incremental cost per unit of additional outcome.

$$R = \frac{(C_a - C_b)}{(E_a - E_b)} = \frac{\Delta C}{\Delta E}$$

Basically, the CEA is a tool for measures comparison, when only a single dimension of outcome matters. This aspect limits significantly its field of application: in most circumstances, measures have impacts not falling into a unique effectiveness dimension.

2.2.3.3 Multi-criteria analysis

The Multi-criteria analysis (MCA) is useful when the monetisation of the costs and benefits is difficult or even impossible, when the benefits can be monetised only partially, or when the impacts are measured both qualitatively and quantitatively The technique consists of algorithms used to select alternatives according to a set of different criteria and their relative "weights".

In contrast to CBA, which focuses on a unique criterion (the maximisation of social welfare), the Multi-criteria analysis is a tool for dealing with a set of different objectives that cannot be aggregated. There are many ways to design an MCA exercise. One possible approach is as follows:

- objectives should be expressed in measurable variables. They should not be redundant, but could be alternative (the achievement of a bit more of one objective could partly preclude the achievement of the other);
- once the objectives vector has been determined, a technique should be found to aggregate information and to make a choice; the objectives should have assigned weights reflecting the relative importance given to them by the decision-maker;
- definition of the appraisal criteria; these criteria could refer to the priorities pursued by the different parties involved or they could refer to particular evaluation aspects;

- impact analysis: this activity involves describing, for each of the chosen criteria, the effects it produces. Results could be quantitative or qualitative;
- forecast of the effects of the intervention in terms of the selected criteria; from the results coming from the previous stage (both in qualitative and in quantitative terms), a score, or a normalised value, is assigned (this is the equivalent of money in CBA);
- identification of the typology of subjects involved in the intervention and the determination of respective preference functions (weights) accorded to different criteria;
- scores under each criterion are then aggregated (simply with a sum or with a non-linear formula) to give a numerical evaluation of the intervention; the result can then be compared with the result for other similar interventions.

When the benefits are not just non-monetary, but also physically not measurable, a qualitative analysis should still be conducted. A set of criteria relevant for the project appraisal (i.e., equity, environmental impact, equal opportunity) is collected in a matrix, together with the impacts (measured with scores or percentages) of the project on the relevant criteria. Another matrix should then assign weights to each relevant criterion. By multiplying scores and weights, the total impact of the project is obtained. This allows the selection of the best alternative.

The following table summarises advantages and disadvantages of the type of analysis presented.

Table 1: Advantages and disadvantages of CBA, CEA and MCA

Type of analysis	Advantage	Disadvantage
Cost benefit	Focuses on a unique criterion (the maximisation of social welfare) Standardised and straightforward methodological framework Quantitative analysis of the relevant impacts	Performance indicators provide information at aggregate level, irrespective of who is bearing the costs or receiving the benefits
Cost effectiveness	Useful for those measures whose benefits are difficult, or impossible, to evaluate, while costs can be estimated confidently	Tool for measures comparison, when only a single dimension of outcome matters
Multi-criteria	Useful when (i) monetisation of the costs and benefits is difficult or even impossible, (ii) benefits can be monetised only partially, or (iii) impacts are measured both qualitatively and quantitatively	Deals with a set of different objectives that cannot be aggregated Multiple ways to design the analysis

Box 5: Checklist for impact analysis

- Assess the UVAR impacts qualitatively or quantitatively wherever possible
- Justify the methodological approach
- Develop a rigorous and thorough analysis according to the methodology used

2.3 Process evaluation

This section of the report presents the approach to process evaluation throughout the following subsections. Section 2.3.1 introduces to the topic and explains what the general and specific objectives are. Section 2.3.2 addressed the procedural aspects to develop a process evaluation. First, considering the influencing factors (barriers and drivers) and main UVAR events in each of the ReVeAL's transition areas. Second, presenting the phases of the UVAR life cycle.

2.3.1 Introduction and objectives

What is a process evaluation and when is it required?

The previous section has described how verifiable impacts of a measure can be determined. However, the overall success of the implementation of a UVAR/transport measure in the urban context depends not only on the selected technical, organisational or regulatory solutions, but also on a sound optimisation of the overall internal dynamics of the implementation process. This activity refers to process evaluation.

The general objective of process evaluation is concerned with the process of how initial proposals for a measure are developed into a feasible design and how the measure is then implemented and operated.

The starting point of a process evaluation consists of investigating the procedural aspects of the pilot cities to detect differences and similitudes between them. This is done by collecting and analysing all the relevant information regarding the transport (UVAR) measure under consideration which, together with the observed outcomes coming from the impact assessment activity (see also the previous section), provides the basis for evaluating the effects.

In theory, a process evaluation is part of an overall decision-making process. It should be activated for the implementation of a transport (UVAR) measure and should involve a plan for identifying key decision-making steps and a realistic timing for starting necessary implementation actions.

In reality, a process evaluation developed at pilot city level could be a difficult task. The actual development of a measure could deviate from the theoretical pattern, take more time than

expected, need more development steps, be incremental and need some fine-tuning[5]. This means that a transport measure developed at pilot city level could develop slowly, or with stop-and-go, through time and adaptively to incorporate context-specific situations, or conditions which have not been envisaged at the beginning of the process. Even when planning a transport measure which involves some trial period, its final shape could differ from that initially conceived.

As previously noted, the process evaluation focuses on the internal dynamics and actual operation of a UVAR/transport measure. This means that the process evaluation aims to understand the points of strength and weakness, for example in relation to the effect of specific activities in the implementation of the measure. This also entails that the process evaluation is not only focussed on formal activities and consideration of anticipated outcomes, but it rather investigates patterns to increase the envisaged positive effects and avoid, or minimise, unexpected negative effects in the context wherein the measure is implemented.

This implies that a process evaluation should look for explanations for a delay of implementation with respect to a theoretical or initial development plan, introduced modifications and failures, but also highlight the success factors. Therefore, if a process evaluation is conducted in a structured way during the development phase of a transport (UVAR) measure, as well as at a later stage, it can provide useful information for adaptations and improvements. In this view, it can be also useful for follow-up measures, scaling, or provide support for motivation at political or management level. Finally, a process evaluation should also consider feedback and perceptions from the users and citizens living close to an implemented measure about how things are going, or have been going in the past.

2.3.2 Procedural aspects for process evaluation

The previous section has introduced how a process evaluation should work theoretically and how it could actually develop at pilot city level, also indicating possible reasons for deviations. This section develops in two parts addressing the procedural aspect of a process evaluation.

Process evaluation of pilot projects within ReVeAL follows the same procedural steps described in deliverable D1.1 ("Guidelines to the ReVeAL Transition Framework"), as part of WP1.

In the first part of this section the approach to monitor the actual development pattern is presented, providing information on influencing factors (which can also be identified as barriers and drivers) and key events. In the second part, the sequence of the phases of process evaluation is presented.

2.3.2.1 Influencing factors and key events

The identification of influencing factors (barriers and drivers) is an important activity when considering a measure and its future development. Barriers are events, or situations, that may

[5] This is particularly true for innovative measures.

overlap interfering with the envisaged development path and hampering the achievement of the goal set. Drivers are events, or situations, that may overlap stimulating the development path or facilitating the achievement of the goal set.

As already stated, the evaluation framework relies upon the work done in WP1, in which four "transition areas" have been identified in order to assess the process of the UVAR life cycle:

- Governance and financing;
- Mobility services and concept;
- System design/technology;
- User needs and acceptance.

The following boxes provide guidance on the scope of each transition area.

Box 6: Governance and financing

Governance is defined by the OECD as "the exercise of political, economic and administrative authority necessary to manage a nation's affairs" (OECD Glossary of statistical terms). Questions linked to the concept of governance are: Who has a voice in the decision process? How are the decisions made? And who is being accountable once a decision has been made? (Institute of Governance, Defining Governance).

Another key notion to present is the notion of good governance, which can be characterised by "participation, transparency, accountability rule of law, effectiveness, equity etc." (OECD Glossary of statistical terms).

Within the ReVeAL context, good governance implies transparent procedures for project management, procurement, financial management and allocation of revenues at the local level. It many cases, policy and operational coordination between different levels of government affected by the UVAR is needed.

At best, effective governance translates into professional project management of the UVAR scheme, with long-term accompanying measures institutionally anchored by means of a specific agency or through the establishment of public-private partnerships.

Financing refers to the way UVAR measures are funded and how the revenue streams are used. Within the ReVeAL context, financial allocation must be linked to transparency. Up front financing of the UVAR scheme investment might be a challenge for UVAR implementers, but there are a number of financing instruments and options which can be considered for this purpose. Understanding how UVAR revenue streams from UVAR (from fines or fee collection) are spent, improves the acceptance.

Box 7: Mobility services and concept

Mobility concept refers to a mobility scheme (and mobility services) focused on the use transport technologies, vehicles, infrastructures and policies, also in combination with existing mobility elements (e.g. active mobility, public transport, parking schemes), in order to accelerate, maximise or introduce significant changes in mobility patterns and landscapes or significantly mitigate negative impacts.

Within the ReVeAL's UVAR mobility services stream, the mobility concept can be described as a set of coherent and organised actions and measures (both physical and intangible) able to support the ideation, design, implementation and operation of a specific UVAR measure.

Examples of mobility services inside a mobility concept are: public transport, cycle network, parking schemes, infrastructures for electric mobility, shared mobility (bikes, cars, vans and mopeds), automated and/or electric shuttles, MaaS (Mobility as a Service), ride hailing platforms, C-ITS (Cooperative Intelligent Transport Systems), logistics schemes, etc.

Box 8: System design/technology

The system design/technology transition area focus on the availability, functionality, and status of UVAR-related systems – and the technologies that make up these systems – in a city throughout the UVAR life cycle. This transition area identifies five different clusters. These are:

- Curbside management (Parking): in the context of the "system design/technology" transition area, this cluster focus on the enforcement mechanisms, and the technological capabilities of the control entities with regard to (dynamic) pricing strategies.
- UVAR Technology (Enforcement): this cluster provides an overview of the different technological options used for UVAR enforcement. Special attention is given to the main drivers (and barriers) for the selection of the alternatives (e.g. interoperability, reliability, privacy, etc.).
- UVAR Technology (Communication): communication in the "system design/technology" transition area relates to the different communication channels used and their purpose (one-way vs. two-way communication engagements).
- Traffic management systems: this cluster covers the variety of data applications used for traffic management, grouping them from a functional point of view. These systems give support to the UVAR measure during its development.
- Infrastructure: the objective is twofold. It refers to (1) dedicated infrastructure for targeted modes (EV charging stations), necessary to impulse a modal shift, in this case to cleaner technologies, and (2) dedicated infrastructure for communication (VMS) necessary for traffic information management and control, that in later stages of the UVAR life cycle can also support the communication of the UVAR measure.

Box 9: User needs and acceptance

User needs captures the habits and preferences of users of a service or an environment. In understanding future user needs special attention should be paid to the differences among users regarding age, socio-economic and cultural background, preferences and abilities etc.

Within the ReVeAL context user needs are the degree to which users can understand how an UVAR functions. For example, do travellers understand what vehicles are allowed into a low-emission zone or how much they need to pay going into a congestion charging zone? How easy is it to pay? What is the process for getting an exemption?

User acceptance is the demonstrable willingness within a group to use a system or measure for the tasks for which it was designed. User acceptance is partly affected by the design characteristics of policy measures and partly by individual mechanisms. It relates also to political acceptance, and UVAR measures in general are controversial.

Understanding how user acceptance will develop over time is essential for creating political acceptance. Hence monitoring and measuring public acceptance should be performed periodically during the ReVeAL process. In doing this it is important to understand and address questions regarding equity, fairness and self-interest and how it affects level of acceptance in both policy design and communication. Equity refers to how the costs and benefits resulting from a measure are distributed over the population, whereas perceptions of fairness are individual.

Hence, also data and information needed to describe the processes in the four transition areas refer to the transition area templates already prepared and provided in deliverable D1.1. However, it is worth noting that activities in ReVeAL's transition framework are still alive and the framework itself might be subject to changes over the course of the project.

The table below summarises the influencing factors and the related key events to be considered in the evaluation process of each transition area as result of the work done by Transition Area Mentors in WP1.

Table 2: Influencing factors and key events of the transition areas

Transition areas	Influencing factors	Key events
Governance and financing	• Decision making context • Legal framework • Institutional setting and organisational arrangements • Local policy frameworks • Political context • Information and communication with citizens	• Status of national legal frameworks • Relevance and status of local regulations • Assessment of institutional competences for UVAR development • Assessment of institutional competences for development of the accompanying measures • Knowledge assurance • SUMP status/development • UVAR champion identification • UVAR objectives: status development
	• Financing of accompanying measures • Funding of UVAR establishment • Management and purpose of revenue streams • Presence of audit and oversight procedures • Procurement procedure	• Funding assurance: plan/study • Funding assurance: equipment installation • Funding assurance: communication and public involvement • Funding assurance: enforcement • Funding assurance: accompanying measures • Transparency assurance • Establishment of audit mechanisms
Mobility services and concept	• Current and historical presence of mobility services • Implementation of mobility services • Presence of evaluation activities • Plans and other strategies in force • Design, monitoring and mitigation elements for each mobility service	• Status and availability of sustainable mobility services • Context of sustainable mobility services (e.g. UVAR-related, included in SUMP) • Evaluation of existent sustainable mobility services • Assessment of previous/past sustainable mobility services • Operational assurance of sustainable mobility services

Transition areas	Influencing factors	Key events
System design/ technology	• Presence of technologies related to traffic and mobility management • Importance of technologies in decision-making • Presence of decision support tools in decision-making • Technologies and communication tools in each UVAR • Presence of technologies for UVAR enforcement • Use of third-party and/or open data	• UVAR enforcement technology (alternatives) consideration • UVAR enforcement technology selection, implementation, update/upgrade • Status of the different traffic management systems • Evolution of the availability of infrastructure • Availability and status of UVAR communication technology • Utilization of Decision support systems for UVAR selection • Availability and status of parking payment mechanisms • Availability and status of parking pricing strategies • Availability and status of open access data update mechanisms • Availability and status of third-party data provider systems • Agreement on third-party data use • Beginning of communication with third-party data providers for data use
User needs and acceptance	• Importance of different user needs • Presence of processes to identify user needs • Information and communication with citizens • User groups identification • Monitoring of media • Measurement of public acceptability • Interest groups identification • Vulnerable groups identification • Arguments of support and/or of the opposition • Opinion of the general public	• User needs assessment and evolution • User groups identification • Media inclination towards UVAR • (Public) acceptability assessment • Interest groups identification • Vulnerable groups identification • Opposition evaluation • Support evaluation

There are two aspects worth considering when a UVAR/transport measure is not developing as planned in a pilot city. First, some more time would be needed to carry out corrections or deploy flanking measures. If a transport measure is evaluated at the very end of its implementation, there could be no more room for corrections or supporting flanking measures. Second, a process evaluation should not come to a halt after new actions have been identified or undertaken. One might have overlooked other influencing factors, not linked to the ones initially considered, and hampering the overall implementation process.

How a process evaluation should be developed, and data collected?

Because a process evaluation is progressive, descriptive, continuous, flexible and inductive, it needs to rely on sound data and information collected during the development phases of a certain transport measure and this also have to be done in a consistent manner. In particular, to get the most updated picture of what is actually influencing the development process of a measure, it is necessary to gather data and information on a regular base. The methods and data collection for process evaluation can be use of standardised forms, learning history and focus groups meetings, which are presented in detail in section 2.4.

2.3.2.2 Phases and related elements to be considered

With respect to the methodological approach to process evaluation, it basically takes place at the UVAR measure level. It develops along four phases as outlined in Figure 7. The four phases are those identified in WP1's "Transition framework" aiming at describing the UVAR streams.

Box 10: UVAR phases

An UVAR phase is a well-defined time span in the lifecycle of an UVAR implementation in a city. Each time span is defined by processes that can be active in this period and gates that define the events in place in order to evolve from one phase to the other. A gate is thus a specific point in time that sets the end of a phase and allows the beginning of a new one. In the ReVeAL "Transition framework", four phases and three gates are considered. These are:

- Ideation phase: time span in which problems come to the attention of governments (Agenda-setting) and a set of solutions emerges in response. It is characterized by the identification and the incomplete definitions of the problem. This stage only ends when a problem is re-conceptualized or redefined in such a way that a range of feasible solutions becomes imaginable. The solutions in the stage can be found in a conceptual stage, the details of the scheme (use of technology, communication strategy, etc.) are not necessarily discussed in this phase. The gate for passing to the Design phase is the Decision-making gate.
- Design Phase: time span by which measure's designs are developed in more detail. In this stage, the measure's initial concept is worked out. Multiple designs may be considered here;

alternative enforcement technologies, different communication strategies, etc. The gate for passing to the Implementation phase is the Adoption gate.

- Implementation phase: involves executing the policy option selected at the decision-making phase. This involves all the necessary action to put the measure into practice - if applicable: pilots, demos, referendum, establishing of communication channels, legal permits, etc. The gate for passing to the Operation phase is defined by Commissioning gate.
- Operation phase: here all the activities following the launching of the measure (full scale) take place. This may include the monitoring and evaluation of the measure, the coupling with new measures, feedback collection and design fine-tuning, etc.

Figure 7: Phases of process evaluation

Source: elaboration of the authors

The information or data gathered is necessary for two reasons. First, to monitor the actual evolution of the development process. Second, to get the evidences of the reason why the actual development pattern is evolving differently from what initially envisaged, which could be useful to find timely corrective actions or overcome any difficulty encountered.

The templates for data collection based on the process evaluation questions are the ones prepared in WP1 addressing the four transition areas; they should be considered as a proxy for the process evaluation parameters, which will need to be defined in a later stage in WP4 following the arrangement of the final set of questions. **Guidance materials for pilot cities and supporting partners will be provided in due time**.

Box 11: checklist for process evaluation

- Investigate the UVAR procedural aspects
- Look for possible deviations between theoretical and real process evaluation
- Look for influencing factors (barriers and drivers) and key events
- Develop a progressive, descriptive, continuous, flexible and indictive process evaluation
- Collect consistent data and information at each phase of process evaluation

2.4 Data collection

2.4.1 Data sources for impact assessment

In general, there are two different type of data that can be used for impact assessment, namely data that is already available and data that is specifically collected or elaborated. The acquisition of data is called primary data collection, since the data is collected by the evaluators themselves. If the data is re-analysed or used from something that has already been collected for the impact assessment, then it is a secondary data analysis.

It is always advisable to look for available data, which could be for instance figures and statistics available from transport operators, local administrations, ministries or offices of statistics[6]. The research of available data should focus on figures providing information on: observed passengers (or vehicles) number of trips, costs and revenues of the services run, accidents statistics, emissions level, pollutants concentration, traffic counts at sections or borders and periodic mobility surveys.

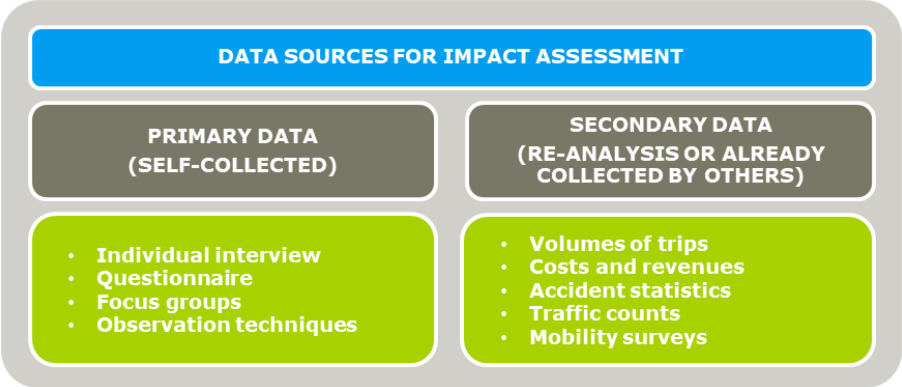
Secondary data is useful as it usually (i) saves resources and time for collection activities, (ii) can be applied for triangulation[7] of data sources and (iii) allows for checks of primary data analysis collected directly as part of the measure. However, it is worth reminding that secondary data is not collected for a specific measure and this implies that it could not be always relevant, reliable or enough to assess the variation for all identified indicators.

The following figure indicates possible data sources to develop an impact assessment.

[6] Another possible channel to gather information could be the so-called "big data". The public web constitutes big data that is widespread and easily accessible.

[7] Data used for impact assessment usually originates from multiple sources and results of data analysis are mutually set against one another or compared. This procedure is called triangulation and is used to ensure reliability of the data gathered and define the logically and methodologically proper conclusions. Triangulation can be used for data collection methods (i.e., diversity of methods applied), but also for information sources. By combining multiple methods and empirical materials one can overcome the weakness or intrinsic biases.

Figure 8: Data sources to develop an impact assessment



Source: elaboration of the authors

Mobility data are particularly important for impact assessment as it provides useful inputs to quantify the relevant impacts. Mobility data can be gathered from passengers or transport operators through interviews or questionnaires. Vehicles counts can also be used for specific measures in concerned urban areas.

Interviews or questionnaires focus on the behaviour of people. They can be structures to get information on current travel preferences (i.e., stated preferences) or to infer on a future behaviour (i.e., declared preferences) presenting a set of possible travel options. Interview or questionnaires can be provided to a representative sample (panel) in a more or less structured way. This can be done either face-to-face or via communication channels (i.e., telephone or internet). Eventually, mobility data gathered through interviews, open public consultations (e.g., via online questionnaire), survey questionnaires and traffic counts can be used for land use analysis, elaboration of demographic data and preparation of datasets for transport modelling exercises.

2.4.2 Methodology for process evaluation

As for the impact assessment, data collection for process evaluation of pilot measure is responsibility of concerned pilot cities with the help of supporting partners and the guidance of pilot coordinators. It should take in due consideration the following aspects.

- Some characteristics or aspects of a measure could be changing during design, implementation and operation phases. These should be duly noted to keep correct track of the evolution through time.
- Different stakeholders can have different views on barriers and drivers concerning a measure and the information provided in this respect could be to some extent filtered or biased.
- Regularly check the quality of information and data provided, and as much as possible, to avoid the same work several times.

- Pay special attention to the "*stories behind the figures*" to understand how and to what extent design and planning phases might influence before and after measurements, as well as to the principles of deepening, broadening and scaling-up the measure.

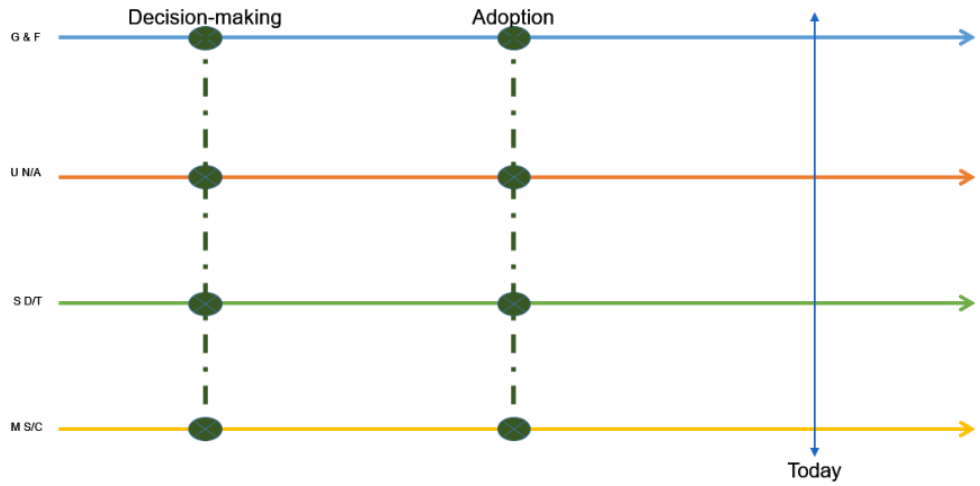
The process evaluation should be done using the transition area templates prepared in WP1. The templates help focussing in the key procedural and contextual factors that describe the pilot city's situation in the specific UVAR (pilot measure) life time.

Using templates for process evaluation has some practical advantages. First, everyone involved in the measure process can do it. Second, only few persons are necessary to fill the form. Third, because the form is standardised it is easy to compare the responses of other processes.

The procedural assessment of the UVAR pilot measures in each pilot city will have to be undertaken both in a historical (at the beginning of the process evaluation) and in a "real-time" (every six months) point of view. The historical assessment should be done following a "backtracking" methodology, as described in the following steps:

1. Maturity assessment and identification of gates: identification of the UVAR gates that have already passed and allocate the UVAR implementation in a UVAR phase accordingly.

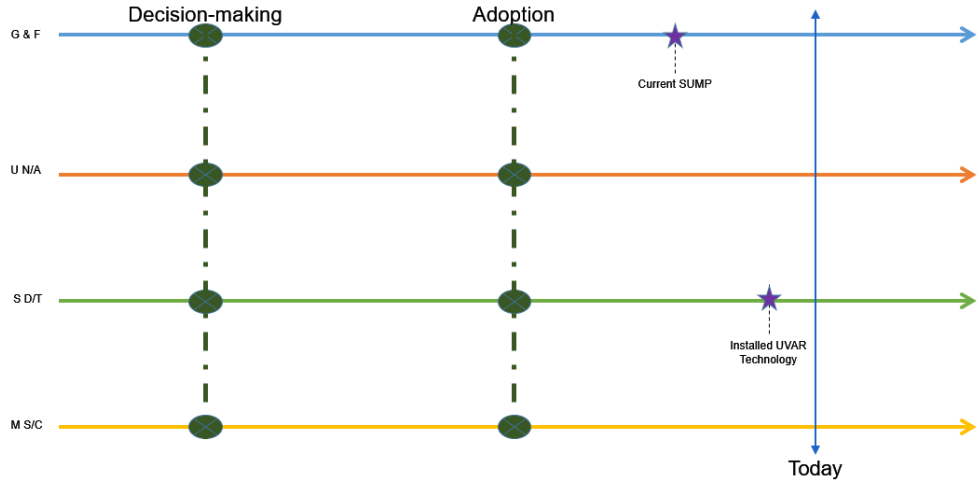
Figure 9: Maturity assessment and identification of gates



Source: ReVeAL Transition Framework (WP1)

2. Assessment of current state: Identification and allocation of the main and most recent UVAR activities or key events.

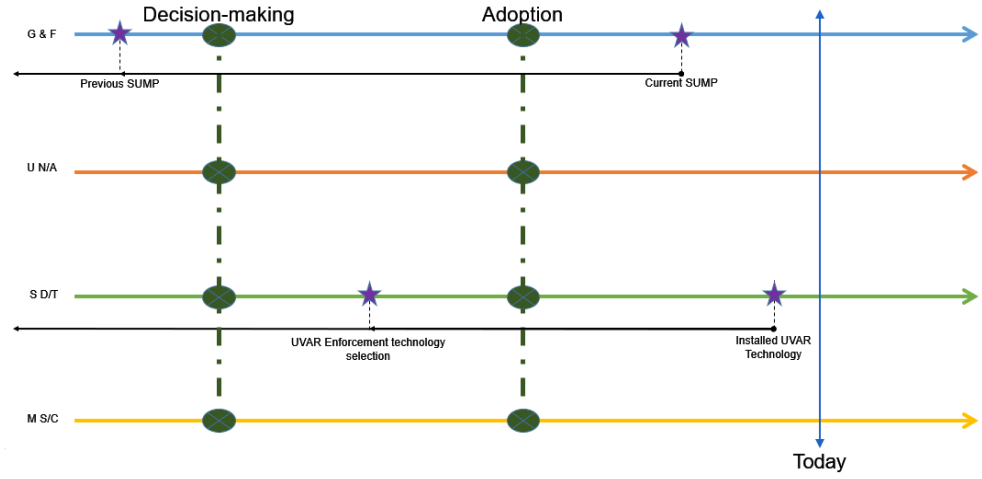
Figure 10: Assessment of current UVAR state



Source: ReVeAL Transition Framework (WP1)

3. UVAR activity's background assessment: Back track evolution of the key events identified in step 2.

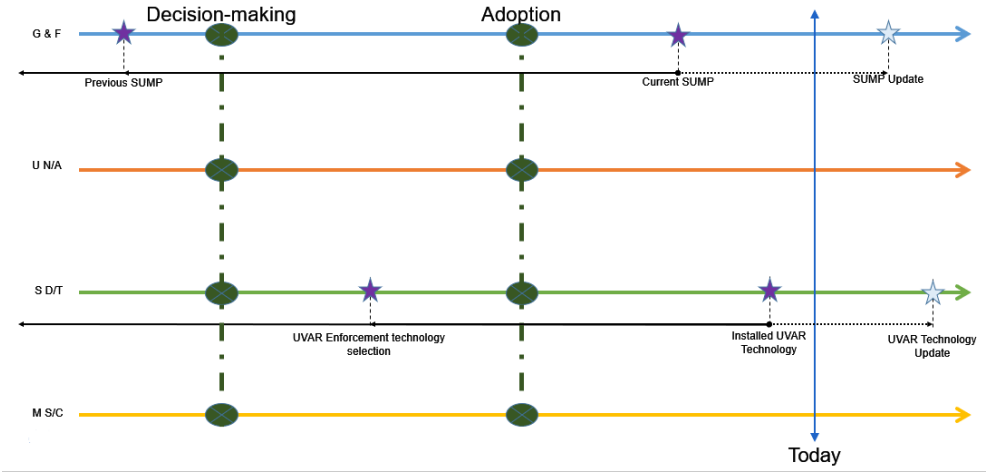
Figure 11: UVAR activity's background assessment



Source: ReVeAL Transition Framework (WP1)

In contrast, the "real time" assessment refers to the periodic update of the transition areas templates, allowing to track the development of previous and planned activities every six months (see following figure).

Figure 12: Update and tracking of planned UVAR activities



Source: ReVeAL Transition Framework (WP1)

3 Annexes

3.1 Detailed list of KPIs

Economy

No.	Impacts	Category	Indicator	Description	Data and/or unit	Recommended (M) or Optional (O) / if optional: Relevant (R) or Less relevant (L) / red: indicator linked with a declared objective									Additional info
						Bielefeld	Helmond		Jerusalem	London	Padua		Vitoria-Gasteiz		
						Spatial interv.	Speed adaptation	ZEZ	LEZ	ZEZ	LTZ	Super-block	Super-block 1	Super-block 2	
Pilot-related indicators (scope: pilot area)															
IA1	Benefits	Operating revenues	Operating revenues	Revenues per pkm or vkm	Euros/pkm or Euros/vkm, quantitative	M	M	M	M	M	M	M	M	M	
IA2		Rent	Land rent	Mean real estate values	Euros, quantitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	
IA3		Savings	Travel time savings	Monetised savings in travel time	Euros/pkm or Euros/vkm, quantitative	O/L	O/L	O/R	O/R	O/R	O/R	O/L	O/L	O/L	
IA4	Costs	Costs	Capital costs	Capital cost per system or unit	Euros, quantitative	M	M	M	M	M	M	M	M	M	
IA5			Operating costs	Costs per time period	Euros/time period, quantitative	M	M	M	M	M	M	M	M	M	
IA6			Managing and maintenance costs	Costs per time period	Euros/time period, quantitative	M	M	M	M	M	M	M	M	M	
IA7			Congestion costs	Costs per vkm	Euros/vkm, quantitative	O/L	O/L	O/R	O/R	O/L	O/R	O/L	O/L	O/L	
IA8			Social costs	Costs per fatalities and injuried persons	Euros/fatality and Euros/injuried, quantitative	M	M	M	M	M	M	M	M	M	

Energy

No.	Impacts	Category	Indicator	Description	Data and/or unit	Recommended (M) or Optional (O) / if optional: Relevant (R) or Less relevant (L) / red: indicator linked with a declared objective									Additional info
						Bielefeld	Helmond		Jerusalem	London	Padua		Vitoria-Gasteiz		
						Spatial interv.	Speed adaptation	ZEZ	LEZ	ZEZ	LTZ	Super-block	Super-block 1	Super-block 2	
Pilot-related indicators (scope: pilot area)															
IA9	Energy Consumption	Fuel consumption	Vehicle fuel efficiency	Fuel used per vkm, per vehicle type	MJ/vkm, quantitative	O/L	O/L	M	M	M	M	O/L	O/L	O/L	
IA10			Fuel mix	Percentage of fuel used by type	%, quantitative	O/L	O/L	M	M	M	M	O/L	O/L	O/L	

Environment

No.	Impacts	Category	Indicator	Description	Data and/or unit	Recommended (M) or Optional (O) / if optional: Relevant (R) or Less relevant (L) / red: indicator linked with a declared objective									Additional info
						Bielefeld	Helmond		Jerusalem	London	Padua		Vitoria-Gasteiz		
						Spatial interv.	Speed adaptation	ZEZ	LEZ	ZEZ	LTZ	Super-block	Super-block 1	Super-block 2	
Pilot-related indicators (scope: pilot area)															
IA11	Pollution and nuisance	Emissions	CO2 emissions	CO2 per vkm by type	G/vkm, quantitative	M	O/L	M	M	M	M	O/L	O/L	O/L	
IA12			CO emissions	CO per vkm by type	G/vkm, quantitative	M	O/L	M	M	M	M	O/L	O/L	O/L	
IA13			NO2 emissions	NO2 per vkm by type	G/vkm, quantitative	M	O/L	M	M	M	M	O/L	O/L	O/L	
IA14			Particulate emissions	PM10 and/or PM2.5 per vkm by type	G/vkm, quantitative	M	O/L	M	M	M	M	O/L	O/L	O/L	
IA15		Noise	Noise	Level of noise (relevant locations)	Index (%), qualitative	M	O/L	O/L	O/L	M	O/L	M	M	M	It could be measured by a panel survey
Context indicators (scope: city-wide)															
IA33	Pollution	Air quality	CO levels	CO concentration	Ppm or g/m3, quantitative	O/L	O/L	O/R	O/R	O/R	O/R	O/L	O/L	O/L	
IA34			NO2 levels	NO2 concentration	Ppm or g/m3, quantitative	O/L	O/L	O/R	O/R	O/R	O/R	O/L	O/L	O/L	
IA35			Particulate levels	Particulate PM10 and/or PM2.5 concentration	Ppm or g/m3, quantitative	O/L	O/L	O/R	O/R	O/R	O/R	O/L	O/L	O/L	
IA36			Black carbon levels	Black carbon concentration	Ppm or g/m3, quantitative	O/L	O/L	O/R	O/R	O/R	O/R	O/L	O/L	O/L	

Society

No.	Impacts	Category	Indicator	Description	Data and/or unit	Recommended (M) or Optional (O) / if optional: Relevant (R) or Less relevant (L) / red: indicator linked with a declared objective									Additional info
						Bielefeld	Helmond		Jerusalem	London	Padua		Vitoria-Gasteiz		
						Spatial interv.	Speed adaptation	ZEZ	LEZ	ZEZ	LTZ	Super-block	Super-block 1	Super-block 2	
Pilot-related indicators (scope: pilot area)															
IA16	Acceptance	Awareness	Awareness level	Awareness of the policies/measures	Index (%), qualitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	It could be measured by a panel survey
IA17		Acceptance	Acceptance level	Attitude of current acceptance of the measure	Index (%), qualitative	M	M	M	M	M	M	M	M	M	It could be measured by a panel survey
IA18	Accessibility	Spatial accessibility	Accessibility level by social groups	Physical accessibility of pilot area (by gender, age, physical condition, nationality/ethnicity)	Index (%), qualitative	M	M	M	M	M	M	M	M	M	It could be measured by a panel survey
IA19	Safety	Transport safety	Injuries and deaths caused by transport accidents	Numbers of accidents, fatalities and casualties caused by transport accidents, per mode	No, quantitative	M	M	M	M	M	M	M	M	M	
IA20	Equity	Equity	Equity level by social groups	Equity of the UVAR measure (by gender, age, physical condition, nationality/ethnicity)	Index (%), qualitative	M	M	M	M	M	M	M	M	M	It could be measured by a panel survey

Transport

No.	Impacts	Category	Indicator	Description	Data and/or unit	Recommended (M) or Optional (O) / if optional: Relevant (R) or Less relevant (L) / red: indicator linked with a declared objective									Additional info
						Bielefeld	Helmond		Jerusalem	London	Padua		Vitoria-Gasteiz		
						Spatial interv.	Speed adaptation	ZEZ	LEZ	ZEZ	LTZ	Super-block	Super-block 1	Super-block 2	
Pilot-related indicators (scope: pilot area)															
IA21	Quality of PT service	Service reliability	Accuracy of timekeeping - peak	Percentage of services arriving / departing on time	%, quantitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	
IA22		Travel times	Average service speed - peak	Average speed of PT (selected bus and tram lines)	Km/h, quantitative	O/L	O/L	O/R	O/R	O/L	O/R	O/L	O/L	O/L	
IA23	Transport system	Traffic levels	Traffic flow by vehicle type - peak	Average vehicles per hour by vehicle type - peak (relevant locations)	Veh per hour, quantitative	M	O/L	M	M	M	M	M	M	M	
IA24			Traffic flow by vehicle type - off peak	Average vehicles per hour by vehicle type - off peak (relevant locations)	Veh per hour, quantitative	O/R	O/L	O/R	O/R	O/R	O/R	O/R	O/R	O/R	
IA25		Congestion levels	Car travel time - peak	Average travel time - peak (selected corridors)	Minutes, quantitative	M	O/L	O/R	O/R	M	O/R	O/R	O/R	O/R	
IA26			Car travel time-off peak	Average travel time - off peak (selected corridors)	Minutes, quantitative	O/R	O/L	O/R	O/R	O/R	O/R	O/R	O/R	O/R	
IA27		Freight movements	Goods vehicles	Daily number of goods vehicles	No, quantitative	O/L	O/L	M	M	M	M	O/R	O/R	O/R	
IA28		Soft mobility levels	Pedestrian flows	No. of pedestrians (relevant locations)	No. per hour, quantitative	M	O/L	O/L	O/L	M	O/L	M	M	M	
IA29			Cycle flows	No. of cyclists (relevant locations)	No. per hour, quantitative	M	O/L	O/L	O/L	M	O/L	M	M	M	
IA30		Sharing mobility	Access to shared modes	No. of bike sharing, car sharing and micro-mobility stations	No, quantitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	
IA31		E-mobility	Charging points	No. of charging points for electric vehicles	No, quantitative	O/R	O/L	O/R	O/R	O/R	O/R	O/L	O/L	O/L	

No.	Impacts	Category	Indicator	Description	Data and/or unit	Recommended (M) or Optional (O) / if optional: Relevant (R) or Less relevant (L) / red: indicator linked with a declared objective									Additional info
						Bielefeld	Helmond		Jerusalem	London	Padua		Vitoria-Gasteiz		
						Spatial interv.	Speed adaptation	ZEZ	LEZ	ZEZ	LTZ	Super-block	Super-block 1	Super-block 2	
IA32	Public space	Public space usage	Area dedicated to transport and other needs	Extent of walkable areas, cycle paths, PT lanes, surface reserved to vehicles (general speed limit and reduced speed limit - 30km/h), parking spaces, green areas	m2, quantitative	M	O/L	O/L	O/L	M	O/L	O/R	O/R	O/R	
					Context indicators (scope: city-wide)										
IA37	Transport system	Modal split	Average modal split- passengers	Percentage of passenger-km for each mode	%, quantitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	Alternative 1
IA38			Average modal split-vehicles	Percentage of vehicle-km for each mode	%, quantitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	Alternative 2
IA39			Average modal split- trips	Percentage of trips for each mode	%, quantitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	Alternative 3
IA40		PT usage levels	PT ridership	PT trips per inhabitant	No, quantitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	
IA41		Regulated zones	Area included in regulated zones	Extent of Limited Traffic Zones, Low Emission Zones, Zero Emission Zones	km2 or m2, quantitative	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	O/R	

3.2 Template for detailed pilot project description

Preliminary remarks

For each information provided for the pilot project and measure(s), please indicate relevant reference source(s) (i.e., title of the document, author(s) and date).

The area in which the measure(s) of the pilot project will be/is/are being implemented (hereafter: pilot area) refers to the area of the city where the measure(s) is/are expected to generate impacts on relevant dimensions of the evaluation framework (i.e., transport activities, society, economy, environment, etc.). In case the pilot project includes two or more areas, the provision of relevant information for each area should be done by filling in different forms.

Some of the answers to the following questions should be complimented by a map, if possible.

→ City name (and pilot area name, if relevant)

Description

1. Socio-economic context of the area involved by the implementation of the measure(s) of the pilot project.

→ Current population in the pilot area and possible future projections (values, year)
→ Population composition in the pilot area: current total and possible future projections by gender, age, ethnic groups (values, year)
→ Average income per capita in the pilot area

→ Land use of the pilot area (residential, services, industrial, retail, wholesale). If detailed information is not available, please provide a list of the land uses in order of significance
→ Location of main trips attractors, like transport nodes and other relevant amenities (e.g., universities, shopping centre, hospitals, etc.). Please indicate them on a map, if possible. Please also indicate the size of the main trip attractors (i.e., large, medium, small)

2. Pilot project design: information of the pilot area with respect to quantitative analysis for the before and after the implementation. Please also indicate the year of the information provided.

→ Outputs of modelling exercise (urban level, or larger scope), by scenario(s): please provide flow maps and/or textual information (location and values)
→ Systematic traffic counts at road sections (number and timing (year, month, day, hour)). Please indicate them on a map, if possible
→ Other traffic counts at relevant sections (toll gate, LTZ, major transit road, ring road, bridge, tunnel). Please indicate them on a map, if possible

3. Pilot project context: any information available of the pilot area. The table below provides a tentative list of information for initial guidance. The actual list can be modified and adapted according to the specific characteristics of the measure(s).

Information can be provided at urban area level, if there are no specific implications with the implemented measure(s). If information is available for the pilot area, it should be provided at this scale.

Regarding the evaluation framework, and depending on the measure analysed, some information is mandatory, while other could be optional. For example, if a measure to limit private cars access is implemented, then the information of public transport and other modes is necessary, while the extension of the road network could be optional. For measure(s) that will be implemented, please indicate the availability of information for the before and after situation.

Information (tentative list)	**Scope**		**Mandatory/ Optional**	**Availability and comments (→ please fill in)**
	City-wide	**Pilot area**		
Transport context				
Modal split	X		Mandatory	
Car ownership rate	X		Mandatory	
Fleet composition, fuel type[8] and Euro class[9]: cars (M1), buses and coaches (M2 and M3), LDV, HGV, motorbikes	X	X	TBD based on specific measure(s)	
Traffic calming, walking, cycling, shared mobility				
Length of traffic calmed roads. To be indicated on a map, if possible.	X	X	TBD based on specific measure(s)	
Extension of Low Traffic Zones, Low Emission Zones, Zero Emission Zones, etc. To be indicated on a map, if possible.	X	X	Mandatory	

[8] Gasoline, diesel, hydrogen, electricity, other fuel types (city-wide scope only)
[9] Pre-Euro/Euro 0, Euro 1, Euro 2, Euro 3, Euro 4, Euro 5, Euro 6/post-Euro 6 (city-wide scope only)

LTZ, LEZ, ZEZ, etc.: authorisation policy for certain categories (e.g., disabled people, residents, …) and/or vehicle types (e.g., motorbikes, …) and enforcement policy		X	TBD based on specific measure(s)	
Surface of walkable area		X	TBD based on specific measure(s)	
Extension of the cycle network (lanes, paths)	X	X	TBD based on specific measure(s)	
Pedestrian and cycle flows counts (relevant locations)		X	TBD based on specific measure(s)	
Free floating car sharing (number of vehicles, charging scheme, area coverage)	X		Optional	
Station-based car sharing (number of vehicles, charging scheme, area coverage)	X	X	Optional	
Free floating bike sharing (number of vehicles, charging scheme, area coverage)	X		Optional	
Station-based bike sharing (number of vehicles, charging scheme, area coverage)	X	X	Optional	
Micromobility vehicles in sharing (number of vehicles, charging scheme, area coverage)	X	X	Optional	
Public transport				
Trips per inhabitant	X		Mandatory	

Percentage of urban area within a 400-meter radius from a public transport stop		X	Optional	
Charging scheme and ticketing integration	X	X	TBD based on specific measure(s)	
Segregation (dedicated lanes for buses and tramways)	X	X	Optional	
Fleet characteristics and composition	X		Mandatory	
Park and ride (extension, parking slots, location and charging scheme)	X		Optional	
Road mode				
Extension of the road network (by type[10])	X		Optional	
Extra road network works (intersection(s) improvement, roundabout, lane widening)	X	X	Optional	
On- and off-street parking slots (linear extension and location)	X	X	Optional	
Parking fee (per hour, day)	X	X	Optional	
Road accidents (fatality, sever injury, slight injury; car driver, pedestrian, cyclist, motorcyclist). To be indicated on a map, if possible.	X	X	TBD based on specific measure(s)	

[10] Motorway or similar, primary, secondary, tertiary, local.

Environment				
Emissions (CO2, NOx, NO2, PM10, PM2.5, carbon)	X	X	TBD based on specific measure(s)	
Noise measurements		X	TBD based on specific measure(s)	

4. Pilot project measure(s) description.

→ Detailed narrative description of the measure(s) included in your pilot project (focus only on what is being/will be implemented and evaluated within ReVeAL). If available, please also provide the information on how the measure(s) of the pilot project has/have been/is/are being coordinated with other measure(s) implemented in the city
→ Map displaying the localisation of the measure(s)
→ Explain why and how the measure(s) of the pilot project has/have been selected
→ Indicate the planned timeline of implementation of the measure(s) that will be/is/are being implemented of the pilot project (start date, end date, important interim dates). Any deviation from the planned timeline (i.e., delayed start or end) and motivation. If necessary, describe if the implementation of the measure(s) will be phased through time

→ Provide information on the monitoring process, once the measure(s) will be completed
→ Provide the estimated costs related to the implementation of each measure of the pilot project, the annual operating and management costs
→ Provide information on possible effects (at least qualitative, if not available quantitatively) on transport-related, social, urban and environmental aspects within the pilot area and its surrounding.
→ Indicate if the implementation of one or more measures of the pilot project depends on the implementation of other measure(s) or other factor(s) (governance and funding, social acceptance, system design and technology). In particular: ▪ For funding, please indicate funding amount(s) and the quota(s) of each entity involved ▪ For social acceptance, please indicate for which stakeholder(s) and/or group(s), social acceptance measure(s) is/have been put in place and the approach used
→ Indicate if one or more measures of the pilot project will be combined with other integrated/coordinated measures and explain for what purpose the complementary measures will be/are being implemented.

- Any other relevant information and/or documents about the measure(s) of the pilot project you can share. Please provide by email or upload them on ReVeAL SharePoint

3.3 Templates for the data collection

See spreadsheet for the collection of KPIs.

Collection of process evaluation information should be done using spreadsheets provided in D1.1.