D2.5 – Scenarios and MUV Key Performance Indicators

Horizon 2020 - Mobility Urban Values (MUV)

Caroleo, Brunella; Vesco, Andrea; Di Dio, Salvatore; Massa, Francesco; Morelli, Nicola; Lissandrello, Enza

Publication date:
2020

Document Version
Publisher's PDF, also known as Version of record

D2.5 – Scenarios and MUV Key Performance Indicators

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No [723521]

Disclaimer

Document	Title: D2.5 - Scenarios and MUV Key Performance Indicators	
	Version: 1.0	
	Dissemination level: Public	
	Available at: https://www.muv2020.eu/resources/	
	Files: 1	
Authorship	Written by	Brunella Caroleo (ISMB), Andrea Vesco (ISMB)
	Contributors	Salvatore Di Dio (PUSH), Francesco Massa (PUSH) Nicola Morello (AAU), Enza Lissandrello (AAU)
	Reviewed by	Karen Soens (LUCA) Judith Veenkamp (WAAG) Bernat Gaston (I2CAT), Rafel Nualart (I2CAT)

Table of contents

Executive summary

This deliverable, released within Task 2.6, outlines the set of indicators that will be used for MUV impact evaluation in each pilot.

The MUV impact assessment framework (see D7.1) envisages three types of indicators: *impact indicators* (measuring the impacts generated by MUV), *context indicators* (providing information describing the geographical context of interest, i.e. the neighbourhood/the city), and *process indicators* (for the purpose of MUV process evaluation). MUV context indicators have been detailed in D7.5, while MUV process indicators and the first results stemming from MUV process evaluation will be presented in D7.4, and finally exposed in D7.6. This deliverable is focused on MUV impact indicators.

In more detail, this document firstly presents the *common set of MUV impact indicators*, used by all the pilots to measure the impacts of MUV measure on four impact areas: Society-People, Society-Governance, Economy, and Environment. The choice and the selection of MUV impact indicators has followed a co-creation process, that involved different stakeholders, i.e. the consortium partners, the pilot managers and the representatives of the six involved municipalities.

This work led to a set of 40 indicators (about ten per impact area), which can still evolve during the course of the project. A detailed description of each indicator is provided in 'MUV impact indicators definition sheets' in Annex 1, where for each indicator it is possible to find its definition, its formula, its unit of measurement, its frequency of computation, and its data source.

Moreover, this deliverable connects to the work performed within Task 2.2, in which the MUV partners have been asked to complete a theory of change framework. The theory of change description for each pilot, reported in D2.2, gives us the opportunity to link the specific priority objectives of each pilot to some MUV impact indicators, that can be considered of higher relevance with respect to the others depending on the objective defined in each pilot and on the scenarios co-created by the stakeholders in each pilot.

Therefore, this deliverable also contains an attempt to provide guidance to the local stakeholders in understanding the relevance of some impact indicators, not only with respect to MUV future goals and long term impacts, but also with respect to more concrete and measurable impacts, related to outputs and outcomes.

1. Introduction

This deliverable provides the set of MUV impact indicators that will be used for MUV impact evaluation in each pilot, in accordance with the impact assessment framework presented in D7.1. The following sections are organized as follows.

Section 2 is a general introduction to indicators, providing some basic concepts and definitions that lay the foundations for the terminology used in the rest of the document.

Then, in section 3 the MUV impact indicators are defined, together with the criteria used for their selection, and the co-creation process for their definition is presented.

Section 4 puts in relationship MUV impact indicators with the theory of change framework (D2.2), linking the specific priority objectives of each pilot to some MUV impact indicators.

Conclusions are drawn in section 5, while section 6 discusses about ethics.

Finally, the annexes show in detail the MUV impact indicators (definition, formula, unit of measurement, etc.) and its related parameters.

2. About indicators

"Indicators are a way of seeing the big picture
by looking at a small piece of it" [1]

This section lays the groundwork for the terminology that will be used in this deliverable, providing some basic definitions and concepts concerning the indicators in general.

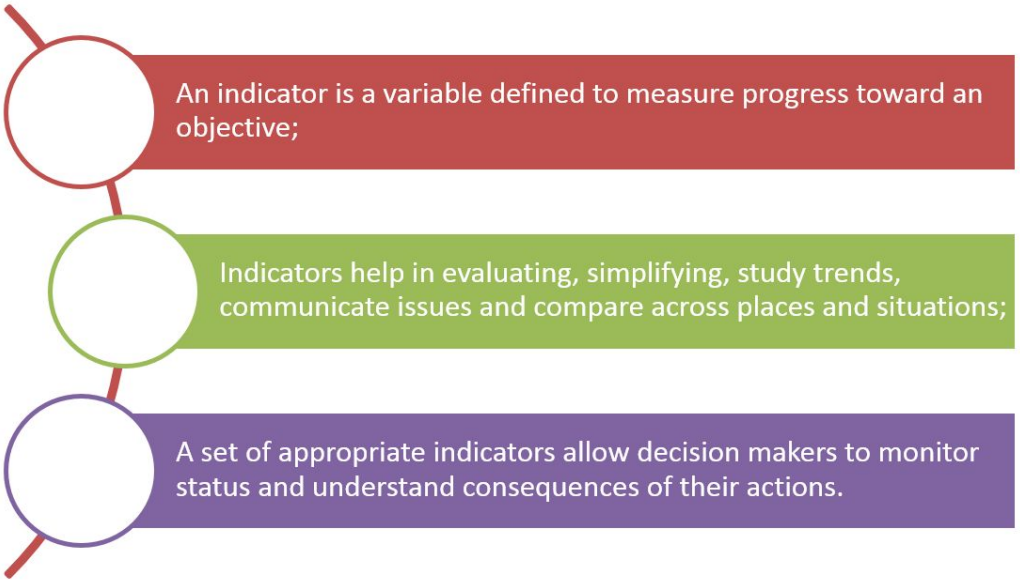

Figure 1: Indicators' definition [2]

An indicator (figure 1) could be a quantitative or qualitative variable, that provides a simple and reliable basis for assessing achievement, change or performance. While *quantitative indicators* are related to objective facts that can be easily counted, are numerical, and measure the scale of an intervention, *qualitative indicators* are subjective, can be numerical, and measure quality, opinions, perceptions [3].
For the purposes of the MUV project, we believe it may be important to highlight the difference between *performance indicators* and *impact* (evaluation) *indicators*:

- performance measurement is a continuous monitoring of a result through time to look for different signals of change that might be due to a range of different programs or campaigns or initiatives. On the contrary, evaluation is used to see if a specific initiative has had an impact on a particular measure;
- while performance indicators could give an indication of what might be considered an "acceptable" or "alarming" performance under average conditions, impact indicators measures the impact of a specific initiative on a particular measure, without necessarily having an ideal target of performance to be achieved;
- furthermore, impact evaluation measures not only the change that has occurred, but also the extent to which this change is attributable to a defined program intervention. Evaluation is usually a before and after comparison. For this reason, impact indicators require data collection at the start of a program (to provide a baseline) and then compare those same indicators at the end, after the intervention takes place.

In addition, there is a growing body of research which identifies the need of *context* specific *indicators* [4]. Such indicators relate to the environment of the programme, providing a better understanding of the local context (e.g. socio-economic conditions of a programme area), and cannot be controlled by the initiative taking place. Context indicators could be qualitatively used by impact evaluators to interpret and motivate the change in outcomes in the local community where the initiative takes place.

The fundamental challenge with indicators is to meaningfully capture key changes or "results". This is accomplished by combining what is substantively valid with what is practically possible to monitor. It is often difficult to make objective and exact observations of the complex development changes we are addressing. Instead, we frequently rely on observations that approximate intended changes, i.e. "proxy" [5]. Thus, in the cases where direct measures of some variables are impossible or impractical to gather, *proxy indicators* are used to measure changes.
It is worth mentioning that *indicators only indicate*, they do not explain. Determining that change has occurred does not explain why it has occurred: the latter is subject of the evaluators' study.

By themselves, indicators do not necessarily contain all aspects of change, but they hugely contribute to explaining them. They allow comparisons over time between, for instance, countries and regions, and in this way assist in gathering 'evidence' for decision making [6].

Indicators could be classified also temporarily, according to their temporal effects in the 'results chain'. The results chain (figure 2) is the linear representation of the theory of change (see D2.2), and show how a project will trigger different levels of change from activities to impact.

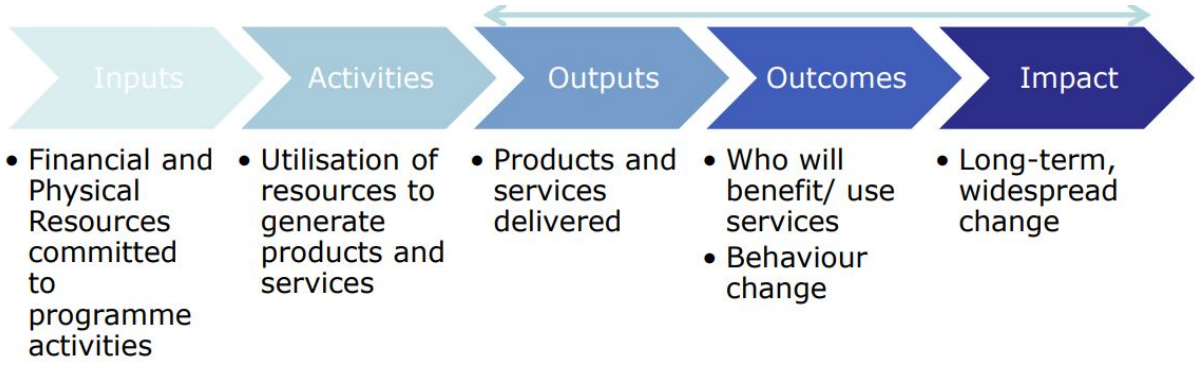

Figure 2: The results chain [3]

As far as results are concerned, there can be indicators of outputs (short term), outcomes (medium term), and impacts (long term) [7]:

- Output indicators add more details in relation to the product ("output") of the activity, e.g. the number of smart meters distributed, the number of electric busses in the system.
- Outcome indicators measure the intermediate results generated by project outputs. These indicators refer to the reason why it was decided to conduct certain interventions in the first place. They are the result of both the "quantity" ("how many") and quality ("how well") of the activities implemented. Often they are 'coverage indicators' measuring the extent to which the target population has been reached by the project.
- Impact indicators measure the quality and quantity of long-term results generated by programme outputs, e.g. measurable change in quality of life, reduced energy use, reduced air pollutant emissions and (even a more distant impact) improved air quality.

There is no correct number of indicators to assign per result, but the following are useful questions to ask: is this indicator absolutely necessary to measure whether progress toward the strategic objective is being achieved? Will it create additional burdens on the respondents or on the staff collecting the data? How will this indicator help with monitoring, management, and evaluation?

In order to properly define an indicator, the following information is needed:

- name;
- definition (with formula, where appropriate);
- unit of measurement;
- source of information;
- baseline (i.e. the initial value against which the indicator is subsequently measured);
- target (not always required, it depends on the type of analysis).

As previously noted, the indicators (and resulting data) may give us an idea of what is happening, but not necessarily why. Interpretation of the data is thus key. For example, an initiative may not be achieving its objectives and targets for a variety of reasons, including unrealistic initial objectives and targets (poor design), constraints outside the project's direct control, and/or poor project management. This is what could be performed during the *process evaluation*, that envisages - due to its nature - more qualitative methods with respect to the impact evaluation. Following CIVITAS SATELLITE 2020 approach [8], process evaluation focuses on how the initiative is implemented and operates, assessing whether it conforms to its original design and documenting its development and operation, together with the main drivers and barriers. The resulting analysis can be a valuable source of information on how to improve the implementation of the initiative.

2.1 Criteria of selection of indicators

It is required to select limited indicators from existing long list that not only provides a holistic view of the system but also helps in understanding the system without dealing with too much complexity. This requires answering several questions, such as: how to decide what is the optimal number of indicators? What is the importance of each indicator in the indicator set?

The challenge in selecting indicators is to find measures that can meaningfully capture key changes, combining what is substantively relevant as a reflection of the desired result with what is practically realistic in terms of actually collecting and managing data. Even a carefully selected, clearly defined indicator is of little use unless it is actually put to use. A critical test of an indicator is how practical it is to monitor. Thinking about an indicator is one thing; actually finding, recording and presenting the data is another. Indicators are a practical tool, not merely a conceptual exercise.

Literature agrees in setting indicators according to the SMART criteria: **S**pecific to the objective; **M**easurable, either quantitatively or qualitatively; **A**greed among

stakeholders; **R**elevant to the information needs of decision makers; **T**rackable, at reasonable costs/efforts.

The SMART way to select indicators (adapted from [5])

- **S**pecific: the indicators should capture the essence of the desired result, should be clearly defined, and should have an appropriate level of aggregation.
- **M**easurable: the identified indicators should be capable of being measured, objectively or subjectively.
- **A**greed: the indicators should be accepted by the involved stakeholders.
- **R**elevant: the indicators should represent an assessment criterion, i.e. have a significant importance for the evaluation process.
- **T**rackable: the data to construct and collect indicators should be affordable at reasonable cost and effort.

Furthermore, in the case of comparisons in different geographical areas, a fundamental criterion for indicator selection is **comparability**: the data sources should be reviewed to ensure the availability and the comparability of the constructs (consistency) of each indicator [9].

In other words, a 'good' indicator should be [9]:

- politically relevant: it should address an important policy question or issue, but not necessarily politically driven, since answering only to a particular political agenda may give a very partial picture of a situation under examination;
- robust: in this respect, an indicator has to be related to global and lasting characteristics of the system, to avoid too much sensitivity to accidental fluctuations;
- connected with priorities and significant issues;
- coherent: an indicator should be connected/connectable with other indicators;
- feasible: the data to construct an indicator should be readily available and affordable to collect;
- accessible to a large audience;
- valid, reliable, accurate, which implies a high quality the data sources.

The evaluators should be sensible and practical in applying these criteria. No indicator will satisfy all criteria equally well. Ultimately, the choice of indicators is determined through a holistic assessment of validity and practicality.

The selection of indicators is an iterative process, building on consultations between evaluators, stakeholders and partners. The process of selecting an indicator takes several steps including brainstorming ideas, assessing each one and narrowing the list (using the criteria above) and, finally, making an indicator monitoring plan.

3. The indicators of MUV impact evaluation

As introduced in D7.1, the MUV evaluation work within WP7 is aimed at answering the following research questions:

- to what extent MUV can change citizens' mobility behaviours?
- to what extent MUV can reduce the perceived gap between the use of private car and the use of other sustainable transport modalities?
- to what extent MUV can lead to a reduction of urban vehicle traffic?
- to what extent the supporting activities (e.g. dissemination, communication, co-creation workshops) affect MUV outcomes? Which of them are more effective?
- what is the added value of data collected by MUV? How such data should be used to provide insights to policy makers?
- how different interactions among local stakeholders (i.e. citizens, local businesses, local authorities) could affect the behavioural change envisaged by MUV?
- what is a possible set of measures acting as mutually reinforcing with MUV?

In order to answer these questions, special attention is paid to the development of a proper set of indicators for MUV impact evaluation.

Following the terminology introduced in section 2, the MUV assessment framework envisages three types of indicators: *impact indicators* (measuring the impacts generated by MUV), *context indicators* (providing information describing the geographical context of interest, i.e. the neighbourhood/the city), and *process indicators* (for the purpose of MUV process evaluation).

MUV context indicators have been detailed in D7.5. Since, due to their nature, such indicators are not likely to drastically change during the project lifetime, an update of the reported values -if necessary- is envisaged in D7.6. MUV process indicators and the first results stemming from MUV process evaluation will be presented in D7.4 and finally exposed in D7.6. This deliverable is focused on MUV impact indicators.

We are interested in *impact indicators*, rather than performance indicators, since -in order to answer to the above mentioned research questions- the focus should be on to what extent a specific initiative, i.e. MUV, has had an impact on different aspects (e.g. society, economy, environment). Since there is not an ideal target of performance to be achieved, targets will not be defined for MUV impact indicators.

MUV impact indicators include both *quantitative* and *qualitative* variables, and the combination of both impact and process evaluation will lead to a quali-quantitative assessment that attempts to capture the quantification of the results, as well as the understandings related to the implementation of the solution. In the cases in which it is

impossible to make exact observations of the changes we are addressing, *proxy indicators* are used to approximate the intended changes.

As far as the temporal classification of results is concerned, i.e. the results chain, the decision is to merge results in the unique category 'impact'. The choice of aggregating the chains of causality is due to different reasons [4]: a. after detailing the chain's structure, it becomes evident that some chains (considered as minor) could be deleted; b. to be practical, the number of categories should not be excessive; c. a temporal classification of the results would have added greater complexity to the assessment framework.

We do know that output and outcome indicators could be affected in the MUV timeframe, while impact indicators are likely to be affected after the project has been implemented and is in full use, which might take a few years. Nevertheless, (long term) impacts are included among the MUV indicators since they are a fundamental measure for reaching the project objectives, making it clear how progress toward strategic objectives will be assessed. Thus, from now on, we will refer to MUV impact indicators meaning indicators of short, medium and long term effects generated by MUV.

As regards the *data source* of the indicators, figure 3 summarizes the main data sources for MUV impact indicators computation: the MUV app, pilot managers, MUV monitoring stations, and local decision makers. Table 2, that presents the set of indicators, includes a special column aimed at specifying which is the data source of each indicator.

Figure 3: Data sources of MUV impact indicators

Since indicators are measured to indicate progress toward goals, MUV impact indicators have been selected by capturing the essence of MUV objectives. As a matter of fact, as detailed in [10], it is essential to link objectives with future monitoring and evaluation

activities: without clear objectives you cannot monitor and evaluate whether your innovative action is on track.

With this in mind, MUV indicators for impact evaluation are selected according to the following project's objectives:

OBJ 1: Sustainable urban mobility / new mobility culture: MUV promotes a shift towards more sustainable mobility choices, leveraging on a behavioural change approach to reduce urban vehicle traffic;

OBJ 2: Better health and environment: MUV raises citizens' awareness on the quality of urban environment and promotes healthier mobility choices, leading to a better environment;

OBJ 3: Evidence-based and human-centered urban mobility planning: MUV promotes the integration of people and personal mobility data into urban policy making and planning processes at neighbourhood level;

OBJ 4: Foster local development: MUV is likely to generate positive spillover effects on the whole neighbourhood and surroundings, even at city level, involving local businesses and stimulating an innovative environment.

MUV assessment framework envisages the following four impact areas, that are well-grounded in the literature of impact evaluation and coherent with CIVITAS SATELLITE evaluation framework [8]:

IA-1 Society - People: it refers to the effects of MUV on the citizens living in the neighbourhood and in the city, in terms of acceptability of MUV, mobility habits, perceived well being, and new opportunities at community level.

IA-2 Society - Governance: it refers to the effects of MUV on the way society is organized in terms of governance, e.g. planning and urban mobility policies.

IA-3 Economy: it focuses on the effectiveness and/or benefits derived from MUV in relation to the costs associated with its preparation, implementation and operation, together with the economic spillover effects deriving from MUV implementation in the local development.

IA-4 Environment: it relates to the effects on environment of reducing the use of private motorized transport thanks to MUV, covering both polluting emissions and energy consumption.

Figure 4 shows the relationships between the overall project objectives, the impact areas, and the sub-areas of impacts. The indicators herewith presented (table 2) measure the achievement of MUV objectives for each impact area and sub-area.

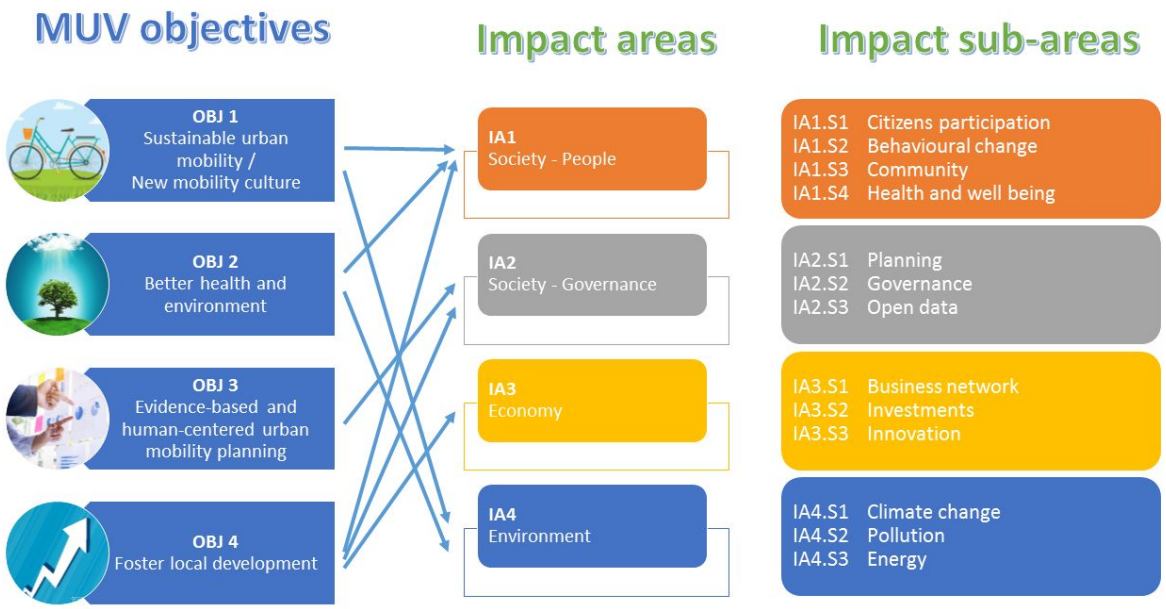

Figure 4: MUV evaluation framework

The concept of using the relationships between MUV objectives and impact areas (Society-People, Society-Governance, Economy, and Environment) as guiding principle to define the impact indicators should guarantee that the resulting set of indicators will measure the effects really relevant to MUV, and that they will cover different perspectives of the same result.

3.1 Criteria of selection of MUV impact indicators

Various institutes and authorities have developed mobility indicators. Even though consensus on meeting the 'triple bottom line' exists (i.e. environmental, social and economic sustainability), yet different indicator sets have been used to evaluate mobility measures in a urban context [11-13].

The process of choice and selection of MUV impact indicators has followed the following steps (figure 5):

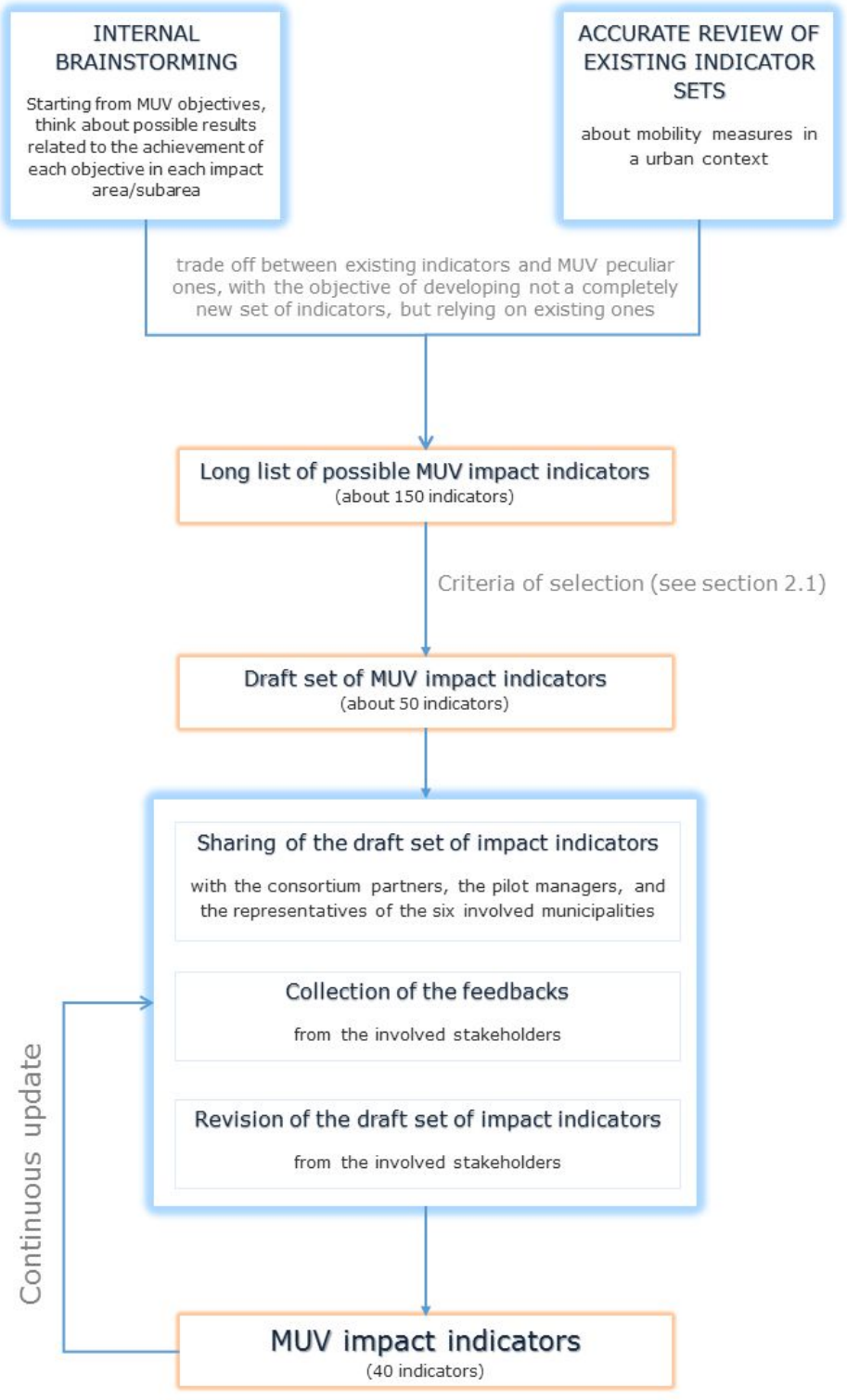

Figure 5: The process of co-creation of MUV impact indicators

This process has been guided by the following principles:

- MUV assessment framework accounts for the peculiarities of each of the six neighbourhoods, at the same time allowing a comparability of the results in the six pilots;

- as regards the number of impact indicators, there is no optimal number of 'core' indicators, but an approximate indication from the literature would suggest that about 10 indicators per impact area could be a good number to describe the system ensuring not too much complexity to the readiness and the interpretation of the indicators;
- MUV indicators should be flexible enough to let new cities willing to join the "MUVement" to be assessed as well;
- some indicators have been proxied by app's data, but other indicators would have been more appropriate in case they were available. During the continuous update of indicators, some indicators can be added or modified whether new data sources become available;
- MUV impact indicators come from different sources such as CIVITAS [11], CITYKeys [12] and TrafficO_2 [14]; whenever necessary, tailored-made indicators have been designed;
- since we are interested in the impacts of MUV on the whole system (i.e. city/neighbourhood), the impact indicators refer to the pilot and not to a single individual. Obviously, the computation of some indicators need individual's data (e.g. the indicators whose data source is the app), but their final value indicates an impact of MUV on the neighbourhood/city;
- many impact indicators whose data source is the MUV app relate to the kms travelled on frequent routes by the players of each pilot. The choice of computing such indicators *only basing on the frequent routes travelled* relies on the fact that a real behavioural change will occur if the MUVers will change their daily mobility behaviours (i.e. the ones on their frequent routes), and not if they are only occasionally sustainable. Consider, for instance, an employee going to the workplace from Monday to Friday by his private car. Then, suppose that in the weekend he goes jogging and he has an occasional bike ride, thus accumulating a lot of points on the MUV app. Not for this reason his mobility habits could be considered 'sustainable'. A real change in his mobility habits will rather be seen when he changes his mode of transport to go everyday to the workplace, leaving his car at home and going to work, for example, by riding a bike.
- where possible, the choice has been to define ratio indicators, that are measurement units normalized to facilitate comparisons (e.g. per-year, per-capita, per-mile, per-trip, per-vehicle-year).

Moreover, coherently with CIVITAS approach [11], in order to have a transparent and correct understanding of the impact of MUV measure it is necessary that *evaluation in*

each individual city/neighbourhood should follow the same guidelines of evaluation, especially:

- all the pilots should follow the same approach for evaluation (see D7.1);
- the **indicators used for measuring the MUV impact should be the same in all the pilots**. This does not prevent cities from having their own additional local indicators for evaluation and assessment of important aspects of the impact (outside the scope of the MUV project). But the set of MUV impact indicators presented in table 2 should be the same in all the sites to guarantee consistency in all the cities;
- the methods of measurement of MUV indicators in the pilots (see Annex 1) must all be aligned, allowing the understanding of differences in results;
- the monitoring of MUV context indicators should be provided, thus contributing to understanding the nature and extent of the results collected (see D7.6).

The resulting co-created set of MUV impact indicators is presented in section 3.2.

3.2 MUV impact indicators

The indicators presented in table 2 are the MUV impact indicators, that (following the process of figure 5) result to be the most important ones to understand the impact of MUV in the four impact areas above defined. Some impact sub-areas have been identified to better organize the set of indicators.

More detailed indicator definition sheets have been developed to serve as practical information and use guidelines for each impact indicator. The structure of the sheets is shown below in table 1.

Code	**Indicator name**
Impact area	Impact area, as described in section 3
Impact sub-area	Impact sub-area, as described in section 3
Definition	Description of the indicator, definition of its computation, eventually considerations about proxy indicators
Formula	(Where applicable) Formula that can be used to compute the indicator
Unit of measurement	Unit of measurement (where possible, the choice has been to define ratio indicators to facilitate comparisons)
Frequency of computation	Frequency of computation defined for the indicator
Data source	Data source, as described in section 3

Table 1: Structure of the indicators' sheets in Annex 1

Annex 1 exposes the full set of MUV impact indicators, providing further details and formulas for their computation. The formulas present in Annex 1 sometimes refer to the so called 'basic' indicators (i.e. intermediate indicators introduced to facilitate the computation of impact indicators) and to some parameters, established for the definition and the computation of some indicators. Please refer to Annex 2 for the definition of both basic indicators and parameters.

Apart from this list of impact indicators, and outside the scope of the MUV project, some cities may wish to use other 'local' additional indicators for their own evaluation. Such indicators may be used, for instance, to assess the impacts concerning a particular local problem.

Impact sub-area	INDICATOR		SHORT DESCRIPTION	Unit of measurement	Data source
IMPACT AREA 'IA1 - SOCIETY-PEOPLE'					
IA1.S1 **Citizens participation**	IA1.S1.1	Awareness level	% of people in the pilot with knowledge of MUV	%	pilot managers
	IA1.S1.2	Involvement level	% of people in the pilot involved in the co-creation activities and/or other MUV-related activities	%	pilot managers
	IA1.S1.3	Acceptance level	% of people in the pilot registered to MUV app	%	MUV app
	IA1.S1.4	Activeness level	% of active players in the pilot	%	MUV app
	IA1.S1.5	Perseverance level	% of players continuously active in the year	%	MUV app
IA1.S2 **Behavioural change**	IA1.S2.1	Sustainable mobility habits	% of kms travelled in a sustainable way (walk/bike/public transport/carpooling) on frequent routes	%	MUV app
	IA1.S2.2	Use of private car	% of kms travelled by private car on frequent routes	%	MUV app
	IA1.S2.3	Modal split	% of kms travelled using each mode (private car, walk, bike, public transport, motorbike, carpooling) on frequent routes (6-elements array)	%	MUV app
	IA1.S2.4	Travel time	average daily time spent traveling on frequent routes	minutes / day	MUV app

Impact sub-area	INDICATOR		SHORT DESCRIPTION	Unit of measurement	Data source
IA1.S3 **Community**	IA1.S3.1	Community cohesion among travellers	level of contact between people living the community, perception of being part of their community. Proxy: average carpooling vehicle occupancy	people / car	MUV app
IA1.S4 **Health and wellbeing**	IA1.S4.1	Physical activity	physical activity performed via active transport (walk and bike) on frequent routes. Proxy: average calories burned on frequent routes	cal / person* week	MUV app
IMPACT AREA 'IA2 - SOCIETY-GOVERNANCE'					
IA2.S1 **Planning**	IA2.S1.1	Planning process	changes in the process to develop mobility plans thanks to MUV, in terms of: strategic level vision, level of public involvement, sector integration, institutional cooperation, monitoring and evaluation, finance, implementation. Linked to the indicator "public investments" (IA3.S2.1)	5-level Likert scale	local decision makers
	IA2.S1.2	Quality of policies, plans and programs	qualitative evaluation of the change in the process to develop policies, plans, and programs	5-level Likert scale	local decision makers
IA2.S2 **Governance**	IA2.S2.1	Rules and regulations	the extent to which MUV has contributed to, or inspired, changes in rules and regulations (i.e. if MUV is able to change the context in which it is applied, by providing a different interpretation of existing rules and regulations)	5-level Likert scale	local decision makers

Impact sub-area	INDICATOR		SHORT DESCRIPTION	Unit of measurement	Data source
	IA2.S2.2	Policies	the extent to which MUV has contributed to, or inspired, changes in the current urban mobility policies (e.g. update SUMP)	5-level Likert scale	local decision makers
	IA2.S2.3	Policy making process	the extent to which MUV has contributed to, or inspired, changes in the process to develop policies and programs, in terms of: strategic level vision, level of public involvement, sector integration, institutional cooperation, monitoring and evaluation, finance, implementation	5-level Likert scale	local decision makers
	IA2.S2.4	Finance	the extent to which MUV has contributed to- or inspired- the development of new forms of financing of mobility solutions	5-level Likert scale	local decision makers
	IA2.S2.5	Cooperation structures with stakeholders	the extent to which MUV has changed the cooperation structures between public and private stakeholders to develop and implement sustainable mobility solutions	5-level Likert scale	local decision makers
IA2.S3 **Open data**	IA2.S3.1	Quality of open data	the extent to which MUV has changed the level of quality of mobility open data	5-level Likert scale	local decision makers
	IA2.S3.2	Open datasets	# of open mobility (government) datasets born thanks to MUV	#	local decision makers

Impact sub-area	INDICATOR		SHORT DESCRIPTION	Unit of measurement	Data source
IMPACT AREA 'IA3 - ECONOMY'					
IA3.S1 **Business network**	IA3.S1.1	Global sponsors involvement	involvement of global sponsors in the community (global sponsor: organization providing goods and services globally or nationally)	%	pilot managers
	IA3.S1.2	Community interaction with global sponsors	level of interaction of the community with the global sponsors. Proxy: # check-in (and all CTA-call-to-action, if any) at global sponsors / # active players	%	MUV app
	IA3.S1.3	Local sponsors involvement	involvement of local sponsors in the community (local sponsor: public or private organization providing goods and services inside the neighborhood)	%	pilot managers
	IA3.S1.4	Community interaction with local sponsors	level of interaction of the community with the local sponsors. Proxy: # check-in (and all CTA-call-to-action, if any) at local sponsors / # active players	%	MUV app
IA3.S2 **Investments**	IA3.S2.1	Public investments	amount of investments of the municipality on new mobility initiatives thanks to MUV	€	local decision makers
	IA3.S2.2	Private investments	amount of investments of the sponsors on MUV and MUV-related initiatives	€	global / local sponsors

Impact sub-area	INDICATOR		SHORT DESCRIPTION	Unit of measurement	Data source
IA3.S3 **Innovation**	IA3.S3.1	Innovative environment	the extent to which MUV increases the level of innovativeness of the urban environment, in terms of exploiting new mobility-related opportunities for helping enterprises to innovate or innovate more	5-level Likert scale	local decision makers
	IA3.S3.2	Economic activity	the extent to which MUV impacts the economic activity of the pilot, in terms of, for instance, job creation and additional economic activity (e.g. creation of leisure-based networks, such as clusters of cycling-related economic activities)	5-level Likert scale	local decision makers
	IA3.S3.3	Open data exploitation	third-party developments: number of apps/services/API calls developed by third parties from MUV open data	#	pilot managers
IMPACT AREA 'IA4 - ENVIRONMENT'					
IA4.S1 **Climate change (GHG)**	IA4.S1.1	CO_2 emissions from road traffic	average emissions of CO_2 per km travelled on frequent routes	g/km	MUV app
	IA4.S1.2	CO_2 level	concentration of CO_2 in the neighbourhood *(still unsure that monitoring stations will measure this value)*	ppm	MUV monitoring stations *(still unsure)*
IA4.S2 **Pollution (emissions / noise)**	IA4.S2.1	Noise level	level of noise in the neighbourhood	dBA	MUV monitoring stations
	IA4.S2.2	NOx emissions from road traffic	average emission factors of NOx per km travelled on frequent routes	g/km	MUV app

Impact sub-area	INDICATOR		SHORT DESCRIPTION	Unit of measurement	Data source
	IA4.S2.3	NO_2 level	average concentration of NO_2 in the neighbourhood	ppm	MUV monitoring stations
	IA4.S2.4	PM2.5 emissions from road traffic	average emissions of PM2.5 per km travelled on frequent routes	mg/km	MUV app
	IA4.S2.5	PM2.5 concentration	average concentration of PM2.5 in the neighbourhood	µg/m3	MUV monitoring stations
	IA4.S2.6	PM10 concentration	average concentration of PM10 in the neighbourhood	µg/m3	MUV monitoring stations
	IA4.S2.7	CO emissions from road traffic	average emissions of CO per km travelled on frequent routes	g/km	MUV app
	IA4.S2.8	CO level	average concentration of CO in the neighbourhood *(still unsure that monitoring stations will measure this value)*	ppm	MUV monitoring stations *(still unsure)*
IA4.S3 **Energy**	IA4.S3.1	Energy consumption from road traffic	average energy consumption per km travelled on frequent routes	kgoe/km	MUV app

Table 2: MUV impact indicators in each impact area

4. MUV scenarios and impact factors

The MUV impact indicators defined in section 3 are common to and relevant for all the MUV pilots. The specific conditions of each neighbourhood, though, make some of those indicators particularly important for some pilots, depending on the objective defined in each pilot and on the scenarios co-created by the stakeholders in each pilot.

The occasion for co-creating scenarios about future configurations for each pilot was offered in Task 2.2, when the pilot were requested to define a theory of change, thus specifying concrete results expected from the MUV measure and connecting them with systemic impacts on the long term.

The theory of change exercise is not properly a scenario planning exercise. Scenario planning is a method for imagining possible futures, on the basis of the analysis of systemic components, including stakeholders, trends or uncertainties [15]. The exercise of building scenarios in this case would aim at capturing the full range of possible futures, in order to articulate a strategy for a company or for the future development of an organisation. While this exercise implies a projection towards the future, the scenario building activity has also been used to project possible or desirable future into the present, in order to orient present actions [16]. This approach has also inspired co-design activities, based on the definition of future scenarios that could orient design activity in the short term future [17].

The above mentioned scenario approach aims at generating a ground for action, in the perspective of a future change, although none of the above has an explicit focus on the evaluation of the action to be undertaken. This specific problem has been explicitly addressed in theory of change, whose approach aims at identifying short, medium and long term indicators of change to provide the evidence base for evaluative judgements [18].

This corresponds to the MUV approach to get to a shared definition of the change each pilot wants to achieve.

In Task 2.2, partners have been asked to complete a theory of change framework, in order to analyse the problem, propose a number of actions and focus on the concrete results they aim at achieving and on systemic outcomes towards the expected change of reducing CO_2 emissions on long term (i.e. several years after the end of MUV project). Therefore, the theory of change description for each pilot, reported in D2.2 provides guidance to understand the relevance of some impact indicators, not only in respect to the future goal and long term impact, but also in respect to more concrete and measurable impacts, related to outputs and outcomes. The identification of the impact for the scope of this deliverable is *flattening* the time component, thus considering as

equally relevant short and longer term effects of the action proposed (i.e. concrete results and systemic impact generated by each output.

By comparing and plotting the MUV impact indicators outlined in the table 2 of this deliverable on the theory of change defined in D2.2, it is possible to have a picture of the indicators that are more relevant in each pilot.

The tables 3 to 13 detail the most relevant indicators for each pilot. For the sake of readability, only the columns related to the outputs and the outcomes for the Theory of Change in each pilot are reported. The full tables are reported in D2.2.

The reader should also notice that a category of indicators about environmental factors are linked to the common goal of a reduction of CO_2 emissions from the uptake of sustainable mobility options and policies, therefore the impact factors related to climate change, pollution and energy are relevant to all the pilots and are not reported in the tables.

4.1. Impact factors related to the theory of change, per pilot

4.1.1. Amsterdam

Perspective: MUV Pilot Coordinator (technical partner)

<table>
<tr><td colspan="4">Presenting Problem:
Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.</td></tr>
<tr><td>Outputs</td><td>Outcomes</td><td>Expected Change</td><td>Most relevant MUV impact indicators</td></tr>
<tr><td>A game that helps them reflect on their mobility behaviour and provides incentives for more sustainable choices.</td><td>A conscious mindset and more awareness on sustainable mobility and moving them towards a more sustainable choice.</td><td rowspan="3">Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies</td><td>Citizens participation
• Awareness
• Involvement
• Activeness

Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal split
• Travel time

Health and wellbeing
• Physical activity</td></tr>
<tr><td>Insights in the behaviour of community. When do they decide to use the car and how can we use this moment of decision in a playful manner to remind them of more sustainable options.</td><td>Creating awareness that there are other options to get to a destination.</td><td>Citizens’ participation
• Awareness
• Involvement</td></tr>
<tr><td>A reward system that links to the sustainable mobility choices that people make.</td><td>The reward system will lead to more sustainable mobility choices.</td><td>Governance
• Policy making process
• Finance
• Cooperation structure with stakeholders

Business network
• Global sponsor involvement</td></tr>
</table>

			• Community interaction with global sponsors • Local sponsors involvement • Local sponsor visibility
Locally collected data on air pollution through the monitoring stations.	Knowledge in community on impact of mobility in neighborhood through the collection of data through.		**Governance** • Policy process • Cooperation structures with stakeholders
Self-organized bottom-up urban planning discussions and identification of challenges in the current infrastructure. More active forums to discuss sustainability and promote behaviour change.	Space for better urban planning options. Space for new mobility options to be implemented. Agency in the community to address the mobility challenges they encounter in their neighborhood.		**Planning** • Planning process • Quality of policies, plans and programs **Governance** • Policy process • Cooperation structures with stakeholders

Table 3: Amsterdam - Perspective: MUV Pilot Coordinator (technical partner)

Perspective: MUV Pilot City (Municipality partner or Representative)

Presenting Problem: Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.			
Outputs	**Outcomes**	**Expected Change**	**Most relevant MUV impact indicators**
A game that, through whatever kind of incentive (awareness, community building, free stuff) stimulates in making sustainable mobility choices.	More sustainable mobility choices, less car kilometres.	Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.	**Behavioural change** • Sustainable mobility habits • Use of private car • Modal Split • Travel time • Community cohesion among travellers
A game or device, that helps people for whom sustainability is not the main objective, still make the more sustainable choice.	More sustainable mobility choices, less car kilometres.		**Behavioural change** • Sustainable mobility habits • Use of private car • Modal Split • Travel time • Community cohesion among travellers
A reward system that connects consumers, through sustainable mobility choices, with the local entrepreneurs.	More sustainable mobility choices, less car kilometers.		**Behavioural change** • Sustainable mobility habits • Use of private car • Modal Split • Travel time • Community cohesion among travellers **Business network** • Community interaction with global sponsors • Community interaction with local sponsors **Innovation** • Economic activity
A tool, a map of hotspots of the area and the	A workable tool with which to address others (politics,		**Governance** • Policy making process

challenges to get there.	public transport agency, owners of the popular destinations) and make them aware of the problems.		• Cooperation structures with stakeholders **Open data** • Quality of open data

Table 4: Amsterdam - Perspective: MUV Pilot City (Municipality partner or Representative)

4.1.2. Barcelona

Perspective: MUV Pilot Coordinator (technical partner)

Presenting Problem: Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.			
Outputs	**Outcomes**	**Expected Change**	**Most relevant MUV impact indicators**
Active community of MUV users.	A conscious mindset do physical activity and more sustainable mobility choices.	Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.	**Citizens' participation** • Awareness • Involvement **Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time **Health and wellbeing** • Physical activity
A reward system that links to the sustainable mobility choices that people make.	The reward system will lead to more sustainable mobility choices.		**Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time
Citizen awareness of environmental impact issues and shift of behaviours towards sustainable mobility choices.	Increase well-being through mobility choices that are coherent with shared values. Social awareness about the relationship between air quality and health problems.		**Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time
Understand businesses points of view, concerns and needs and adapt MUV argues and rewards that people	Show them the real benefits from MUV and new incomes.		**Business network** • Community interaction with sponsors • Local sponsors involvement • Local sponsor visibility

would like to get.			

Table 5: Barcelona - Perspective: MUV Pilot Coordinator (technical partner)

Perspective: MUV Pilot City (Municipality partner or Representative)

<table>
<tr><td colspan="4">Presenting Problem:
Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.</td></tr>
<tr><th>Outputs</th><th>Outcomes</th><th>Expected Change</th><th>Most relevant MUV impact indicators</th></tr>
<tr><td>A game that challenge the users about personal and citizens goals</td><td>Users will get benefits from MUV personal and collective wise through material and nonmaterial rewards.</td><td rowspan="3">Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.</td><td>Citizens participation
• Awareness level
• Involvement level
• Acceptance level
• Perseverance level

Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal splits
• Travel time

Health and wellbeing
• Physical activity</td></tr>
<tr><td>Local businesses are part of MUV</td><td>Though new mobility actions citizens will be engaged by local businesses</td><td>Business network
• Global sponsors involvement
• Community interaction with sponsors
• Local sponsors involvement

Investments
• Private investments</td></tr>
<tr><td>Local data will be available for new purposes</td><td>Mobility managers and local organizations will apply new solutions for the neighborhood</td><td>Governance
• Rules and regulations
• Policies
• Policy process
• Finance
• Cooperation structure with stakeholders

Open Data
• Quality of open data
• Open Datasets

Investments
• Public investments</td></tr>
</table>

Table 6: Barcelona - Perspective: MUV Pilot City (Municipality partner or Representative)

4.1.3. Fundao

Perspective MUV Pilot Coordinator (technical partner)

<table>
<tr><td colspan="4">Presenting Problem:
Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.</td></tr>
<tr><td>Outputs</td><td>Outcomes</td><td>Expected Change</td><td>Most relevant MUV impact indicators</td></tr>
<tr><td>Active community of MUV users.</td><td>People moving more sustainably and with more sustainable behaviors.</td><td rowspan="4">Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.</td><td>Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal splits
• Travel time

Community
• Community cohesion among travellers

Health and wellbeing
• Physical activity</td></tr>
<tr><td>Having active MUV users that like playing the game and their community.</td><td>Active community that will inspire others and create a new mobility paradigm.</td><td>Citizens participation
• Awareness level
• Involvement level
• Acceptance level
• Activeness level
• Perseverance level</td></tr>
<tr><td>Self-organized bottom-up urban planning discussions. More active forums to discuss sustainability and promote behavior change.</td><td>Space for better urban planning options.

Space for new mobility options to be implemented.</td><td>Planning
• Planning process
• Quality of policies, plans and programs

Governance
• Policy process
• Cooperation structures with stakeholders</td></tr>
<tr><td>More people using more sustainable mobility options.</td><td>People spending their time in a better way.</td><td>Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal splits
• Travel time</td></tr>
</table>

Table 7: Fundao - Perspective: MUV Pilot Coordinator (technical partner)

Perspective: MUV Pilot City (Municipality partner or Representative)

Presenting Problem	Outputs	Outcomes	Expected Change	Most relevant MUV impact indicators
Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.	MUV users will be active ambassadors of sustainable mobility options.	Less people using the car, more people enjoying the city.	Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.	**Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time
	Increase visibility of different mobility options.	Higher percentage of pedestrians and bicyclists in daily commute.		**Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time
	Co-creation can lead to more open discussions toward changes in the planning of roads and parking spaces.	More acceptance of new urban interventions.		**Planning** • Planning process • Quality of policies, plans and programs **Governance** • Policy process • Cooperation structures with stakeholders
	Engaged shop owners.	More economic activity in the city center.		**Business network** • Community interaction with sponsors • Local sponsors involvement • Local sponsor visibility

Table 8: Fundao - Perspective: MUV Pilot City (Municipality partner or Representative)

4.1.4. Ghent

Perspective: MUV Pilot Coordinator (technical partner)

<table>
<tr><td colspan="4">Presenting Problem:
Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.</td></tr>
<tr><th>Outputs</th><th>Outcomes</th><th>Expected Change</th><th>Most relevant MUV impact indicators</th></tr>
<tr><td>list of available options
'the best route to follow' feature

a 'tinder' for shared mobility/transport with the neighbours?</td><td>the mixed and combined use of transport meanings is top of mind</td><td rowspan="4">Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.</td><td>Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal splits
• Travel time

Community
• Community cohesion among travellers

Health and wellbeing
• Physical activity</td></tr>
<tr><td>extra value for the shops to participate: advertising + ?
'let's go to the Ikea together'</td><td>local shops and nearby shopping centers give rewards for use of sustainable (shared) transport</td><td>Business network
• Global sponsors involvement
• Community interaction with sponsors
• Local sponsors involvement
• Local sponsor visibility</td></tr>
<tr><td>nice accessible rewards for the people and for the neighbourhood (group rewards) + extra support of city of Ghent?

make the benefits of not using cars tangible: no gasoil, no parking problems, become part of something new (a hype?)</td><td>families become aware of the benefits

a superhip Mobility game!!</td><td>Citizens participation
• Awareness level
• Involvement level
• Acceptance level

Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal splits
• Travel time

Health and wellbeing
• Physical activity</td></tr>
<tr><td>map with personal suggestions, 'my</td><td>schools are promoting the game</td><td>Citizens participation
• Awareness level</td></tr>
</table>

organised trip': daily school route … playgrounds	and do a workshop with the parents to learn to use it children and parents become more confident to use sustainable mobility		• Involvement level • Acceptance level **Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time **Health and wellbeing** • Physical activity

Table 9: Ghent - Perspective: MUV Pilot Coordinator (technical partner)

4.1.5. Helsinki

Perspective: MUV Pilot Coordinator (technical partner)

Presenting Problem: Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.			
Outputs	**Outcomes**	**Expected Change**	**Most relevant MUV impact indicators**
Enhanced services	Alternatives more intriguing, people more likely to choose them	Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.	**Behavioural change** • Sustainable mobility habits • Use of private cars • Modal split • Travel time **Health and wellbeing** • Physical activities
Fine-tuned services	Alternatives more intriguing, people more likely to choose them		**Behavioural change** • Sustainable mobility habits • Use of private cars • Modal split • Travel time
Gamification	Attitudes changed towards more positive		**Citizens' participation** • Awareness level • Involvement level • Acceptance level **Behavioural change** • Sustainable mobility habits • Use of private cars • Modal split • Travel time **Health and wellbeing** • Physical activity

Table 10: Helsinki - Perspective: MUV Pilot Coordinator (technical partner)

Perspective: MUV Pilot City (Municipality partner or Representative)

<table>
<tr><td colspan="4">Presenting Problem:
Use of available mobility options does not favour sustainable choices. Planning for sustainable mobility is thus difficult.</td></tr>
<tr><td>Outputs</td><td>Outcomes</td><td>Expected Change</td><td>Most relevant MUV impact indicators</td></tr>
<tr><td>Pilots of new mobility services</td><td>More alternatives to choose from</td><td rowspan="4">Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.</td><td>Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal split
• Travel time

Community
• Community cohesion among travellers

Health and wellbeing
• Physical activity</td></tr>
<tr><td>Enhanced services</td><td>Alternatives more intriguing, people more likely to choose them</td><td>Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal split
• Travel time

Community
• Community cohesion among travellers

Health and wellbeing
• Physical activity</td></tr>
<tr><td>Fine-tuned services</td><td>Alternatives more intriguing, people more likely to choose them</td><td>Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal split
• Travel time

Community
• Community cohesion among travellers

Health and wellbeing
• Physical activity</td></tr>
<tr><td>Eg Better knowledge</td><td>Attitudes changed towards more positive</td><td>Citizens’ participation
• Awareness level
• Involvement level
• Acceptance level</td></tr>
</table>

			Behavioural change • Sustainable mobility habits • Use of private cars • Modal split • Travel time **Health and wellbeing** • Physical activity

Table 11: Helsinki - Perspective: MUV Pilot City (Municipality partner or Representative)

4.1.6. Palermo

Perspective: MUV Pilot Coordinator (technical partner)

Presenting Problem: Use of available mobility options does not favour sustainable choices.			
Outputs	**Outcomes**	**Expected Change**	**Most relevant MUV impact indicators**
MUV triggers new habit loops able to change the mobility routine.	By changing their habits users create a local discontinuity that can inspire other people.	Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.	**Citizens participation** • Awareness level • Involvement level • Acceptance level • Perseverance level **Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time **Health and wellbeing** • Physical activity
MUV creates a different set of extrinsic motivations that can turn in intrinsic motivation.	Target groups will prefer active mobility and public transportation instead of driving cars.		**Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time **Health and wellbeing** • Physical activity
MUV's players will feel safer even out of the car.	With more pedestrians and bicycles the city will be more vibrant, liveable and safe.		**Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time **Community** • Community cohesion among travellers **Health and wellbeing** • Physical activity
MUVers will approach public transportation with a new mindset.	If they use it more often, the service provider will enhance it.		**Behavioural change** • Sustainable mobility habits • Use of private car • Modal splits • Travel time **Health and wellbeing** • Physical activity

Table 12: Palermo - Perspective: MUV Pilot Coordinator (technical partner)

Perspective: MUV Pilot City (Municipality partner or Representative)

<table>
<tr><td colspan="4">Presenting Problem:
Planning for sustainable mobility is difficult.</td></tr>
<tr><th>Outputs</th><th>Outcomes</th><th>Expected Change</th><th>Most relevant MUV impact indicators</th></tr>
<tr><td>Official fun challenges will be offered by the Municipality to the citizens.</td><td>Citizens will enjoy to change and improve the impact of their trips.</td><td rowspan="3">Reduction of CO_2 emissions from the uptake of sustainable mobility options and policies.</td><td>Citizens participation
• Awareness level
• Involvement level
• Acceptance level
• Perseverance level

Behavioural change
• Sustainable mobility habits
• Use of private car
• Modal splits
• Travel time

Health and wellbeing
• Physical activity</td></tr>
<tr><td>Also the businesses are actively involved in the process.</td><td>By doing their own interests, they will foster citizens to better mobility habits.</td><td>Business network
• Global sponsors involvement
• Community interaction with sponsors
• Local sponsors involvement

Investments
• Private investments</td></tr>
<tr><td>The web dashboard will render in a understandable way the complex information.</td><td>The Municipality will improve its mobility policies.</td><td>Governance
• Rules and regulations
• Policies
• Policy process
• Finance
• Cooperation structure with stakeholders

Open Data
• Quality of open data
• Open Datasets

Investments
• Public investments of the municipality</td></tr>
</table>

Table 13: Palermo - Perspective: MUV Pilot City (Municipality partner or Representative)

5. Conclusions

This document presented the set of indicators for MUV impact evaluation in each pilot.
The resulting set of 40 MUV impact indicators (table 2) is the sequel of a co-creation process that has involved the whole consortium and the pilot managers in the past months, and the set is expected to evolve, if necessary. MUV impact indicators are going to be used in each pilot to measure the impacts of MUV measure on four impact areas: Society-People, Society-Governance, Economy, and Environment.
The set of MUV impact indicators is common to all the pilots in order to guarantee consistency of the evaluation in all the cities. The specific priorities of each pilot can be accounted through a subset of the 40 impact indicators. However, we stress that the set of MUV indicators is unique and common to all the pilots: only the set of 40 impact indicators is considered exhaustive.
The indicators presented in this deliverable will be used in the tasks 7.3 and 7.4, during the monitoring phase and the evaluation activities.

The following deliverables are related to the findings of the current document, and should provide further insights and details:
D2.1 Project Vision and Research framework;
D2.2 Documentation on neighborhoods' mobility baseline and MUV Pilots ecosystems;
D3.4 Community co-creation outcomes - Final release
D7.1 Evaluation Approaches and Tools;
D7.3-D7.4 Impact evaluation: results stemming from monitoring of the pilots;
D7.5-D7.6 Impact evaluation: results stemming from evaluation of the pilots;
D7.7 Triple sustainability analysis.

6. Ethics and security

Ethical Standards

The MUV consortium will ensure that ethical standards are followed in any data-related activity to ensure the respect of human rights and of the values shaping open, pluralistic and tolerant information societies.

Non Discriminatory Attitude

The MUV consortium will maintain a non-discriminatory attitude towards all users involved, which means that prohibits discrimination in all its activities, services, and materials on the basis of race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, familial/parental status, income, political beliefs.

References

1. Jackson Community Council (1999), quoted in Plan Canada.
2. Victoria Transport Policy Institute (2016), "Well Measured: Developing Indicators for Sustainable and Livable Transport Planning".
3. European Commission (2013), "Results and Indicators - EuropeAid - DEVCO 06", https://ec.europa.eu/europeaid/sites/devco/files/19.%20results-and-indicators-10122013_en.pdf, retrieved 6/11/2018.
4. Joumard R., H. Gudmundsson, and L. Folkeson (2011), "Framework for Assessing Indicators of Environmental Impacts in the Transport Sector", Transportation Research Record: Journal of the Transportation Research Board, No. 2242, Transportation Research Board of the National Academies, Washington D.C., pp. 55–63.
5. United Nations Development Programme, "RBM in UNDP: Selecting Indicators", http://web.undp.org/evaluation/documents/methodology/rbm/Indicators-Paperl.doc, retrieved 6/11/2018.
6. EUROSTAT Glossary, retrieved 6/11/2018 from https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Statistical_indicator
7. World Bank, Independent Evaluation Group (2012), "Designing a results framework for achieving results: a how-to guide", Washington D.C..
8. CIVITAS SATELLITE (2017), "D2.3 - Refined CIVITAS process and impact evaluation framework (31.08.2017)", retrieved 6/11/2018 from:

http://exchange-hub.civitas.eu/system/files/satellite_d2.3_refined_evaluation_framework-final_version_2017-08-31.pdf

9. Mainguet C. and A. Baye (2006), "Defining a framework of indicators to measure the social outcomes of learning", in: Desjardins R., T. Schuller (eds.), "Measuring the Effects of Education on Health and Civic Engagement", Proceedings of the Copenhagen Symposium, OECD/CERI, Paris (France), pp. 153-164.
10. European Commission (2009), "Impact Assessment guidelines", http://ec.europa.eu/smart-regulation/impact/commission_guidelines/docs/iag_2009_en.pdf, retrieved 8/11/2018.
11. CIVITAS SATELLITE (2017), "D2.3 - Refined CIVITAS process and impact evaluation framework, Annex A (31.08.2017)", retrieved 8/11/2018 from http://exchange-hub.civitas.eu/system/files/annex_1_-_indicator_definition_and_methodology_sheets.pdf
12. Bosch P. *et al.* (2017), "CITYkeys indicators for smart city projects and smart cities", http://nws.eurocities.eu/MediaShell/media/CITYkeystheindicators.pdf, retrieved 8/11/2018.
13. Ahvenniemi H., A. Huovila, I. Pinto-Seppä, and M. Airaksinen (2017), "What are the differences between sustainable and smart cities?", Cities, volume 60, Part A, pp. 234-245.
14. TrafficO_2, http://www.traffico2.com/data/en/index.html, retrieved 8/11/2018.
15. Schoemaker P. J. H. (1995), "Scenario planning: A tool for strategic thinking", Sloan Management Review, Winter 1995, pp. 25-40.
16. Holmberg J. (1998), "Backcasting: A Natural Step in Operationalising Sustainable Development", Greener Management International, pp. 30-51.
17. Manzini E., F. Jegou, and A. Meroni (2009), "Design Oriented Scenarios. Generating New Shared Version of Sustainable Product Service Systems". In M. Crul, and J. C. Diehl, "Design for Sustainability: a step-by-step approach", United Nations Environment Programme, pp. 15-31.
18. Sullivan H. and M. Stewart (2006), "Who Owns the Theory of Change?", Evaluation, 12(2), pp. 179-199.
19. European Environmental Agency (2016), "EMEP/EEA air pollutant emission inventory guidebook - 2016", https://www.eea.europa.eu/publications/emep-eea-guidebook-2016

Annex 1 - MUV impact indicators definition sheets

For basic indicators (prefixes B and P) please refer to tables 14 and 15 (Annex 2).

For the parameters (prefixes V, D and F), please refer to tables 16, 17 and 18 (Annex 2).

IA1 - Society-People

Sub-area IA1.S1 'Citizens participation'

IA1.S1.1	**Awareness level**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S1 - Citizens participation
Definition	The awareness level relates to the people in the pilot that are aware of MUV. Awareness can be at a variety of levels, e.g. having heard of the project, recognise the logo, understand the aim of the project and its potential benefits. In coherence with the communication and dissemination activities performed within the MUV consortium, people aware of MUV in each pilot are estimated summing the people reached via social media, the people reached in organized events, the people reached via printed communication, and the people actively involved in the project (for the last one, see indicator IA1.S1.2): people_aware (B2) = social_media + participation_events + printed + people_involved The values of 'social_media', 'participation_events' and 'printed' are provided by each pilot manager within T5.3, by filling in a shared worksheet (named 'Local Engagement Diary'). As regards 'people_involved', please see the definition of the impact indicator IA1.S1.2. The awareness level in each pilot is, thus, defined as the percentage of people in the the pilot with knowledge of MUV measure: awareness_level = people_aware / target_population where: • people_aware (B2) = # people aware of MUV action (i.e. reached by dissemination and communication activities) in the pilot. It is proxyed as described above (see table 14 in Annex 2 for further details); • target_population (F9) = # people to which MUV is addressed. It is a parameter varying in each pilot (see the tables 18 and 19 in Annex 2 for further details).
Formula	IA1.S1.1 = B2 / F9

Unit of measurement	%
Frequency of computation	every two months
Data source	pilot managers

IA1.S1.2	**Involvement level**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S1 - Citizens participation
Definition	The involvement level relates to the people in the pilot that are involved in the co-creation activities and/or in other MUV-related activities. In coherence with the communication and dissemination activities performed within the MUV consortium, people involved in MUV in each pilot are estimated summing the people interacting and sharing posts via social media, and the people actively involved in organized events: people_involved (B3) = interactions_social_media + share_social_media + events The values of 'interactions_social_media' + 'share_social_media' + 'events' are provided by each pilot manager within T5.3, by filling in a shared worksheet (named 'Local Engagement Diary'). The involvement level is, thus, defined as the percentage of people in the pilot involved in co-creation activities and/or in other MUV-related activities: involvement_level = people_involved / people_aware where: • people_involved (B3) = # people involved in the co-creation activities and/or other MUV-related activities in the pilot • people_aware (B2) = # people aware of MUV action (i.e. reached by dissemination and communication activities) in the pilot (see IA1.S1.1).
Formula	IA1.S1.2 = B3 / B2
Unit of measurement	%
Frequency of computation	every two months
Data source	pilot managers

IA1.S1.3	**Acceptance level**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S1 - Citizens participation
Definition	Acceptance is about people that, once become aware of MUV, go beyond and decide to go a step further by downloading and registering to the MUV app, thus joining the MUVement. The acceptance level is, thus, defined as the percentage of people in the pilot registered to MUV app: acceptance_level = people_registered / people_aware where: • people_registered (B4) = # people registered to MUV app in the pilot • people_aware (B2) = # people aware of MUV measure (i.e. reached by dissemination and communication activities) in the pilot (see IA1.S1.1) 'people_registered' is obtained by querying the MUV database that collects the app's data.
Formula	IA1.S1.3 = B4 / B2
Unit of measurement	%
Frequency of computation	every week
Data source	MUV app

IA1.S1.4	**Activeness level**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S1 - Citizens participation
Definition	The activeness level is related to the people that not only have joined the MUVement, but heavily embrace MUV values. This has been proxied by means of the active players of MUV game with respect to the people that registered to the app. A player is defined 'active' if he/she registers at least V1 frequent routes per week (as regards the parameter V1, see the table 16 in Annex 2 for further details). The activeness level is, thus, defined as the percentage of active players in the pilot: activeness_level = active_players / people_registered

	where: • active_players (B5) = # MUV active players in the pilot • people_registered (B4) = # people registered to MUV app in the pilot Both 'active_players' and 'people_registered' are obtained by querying the MUV database that collects the app's data and by elaborating such data.
Formula	IA1.S1.4 = B5 / B4
Unit of measurement	%
Frequency of computation	every week
Data source	MUV app

IA1.S1.5	**Perseverance level**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S1 - Citizens participation
Definition	The perseverance is the higher step of citizens' participation in MUV, since it considers not only the activeness of a player, but also his/her constance in time. A player is defined 'perseverant' if he/she is active more than V19 weeks in the year (as regards the parameter V19, see the table 16 in Annex 2 for further details). The perseverance level is, thus, defined as the percentage of continuously active (i.e. perseverant) players in the year in the pilot: perseverance_level = perseverant_players / people_registered where: • perseverant_players (B26) = # MUV perseverant players in the pilot • people_registered (B4) = # people registered to MUV app in the pilot Both 'perseverant_players' and 'people_registered' are obtained by querying the MUV database that collects the app's data and by elaborating such data.
Formula	IA1.S1.5 = B26 / B4
Unit of measurement	%
Frequency of	every year

computation	
Data source	MUV app

Sub-area IA1.S2 'Behavioural change'

IA1.S2.1	**Sustainable mobility habits**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S2 - Behavioural change
Definition	We consider 'sustainable' the mobility behaviours that discourage the use of private motorized transport modes. For this reason, the sustainable mobility habits cover all the transport modes apart from the private car and motorbike, i.e. walk, bike, public transport, carpooling. This indicator in each pilot is defined as the percentage of kms travelled in a sustainable way on frequent routes of that pilot with respect to the total kms travelled on frequent routes: sustainable_mobility_habits = km_sustainable / km_frequent_routes where: • km_sustainable (B6) = # km travelled in a sustainable way on frequent routes in the pilot • km_frequent_routes (B7) = # total km travelled on frequent routes in the pilot We expect an increase in the value of this indicator at the end of the project, since one of the MUV objectives is precisely that of changing the mobility citizens' behaviour towards more sustainable modes of transport.
Formula	IA1.S2.1 = B6 / B7
Unit of measurement	%
Frequency of computation	every week
Data source	MUV app

IA1.S2.2	**Use of private car**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S2 - Behavioural change

Definition	The decision to insert an indicator exclusively dedicated to the measurement of the use of the private car is due to the fact that one of MUV priority objectives is to reduce as much as possible the use of citizens' own car on the frequent routes travelled. This indicator is, thus, strictly related to IA1.S2.1. This indicator in each pilot is defined as the percentage of kms travelled by private car on frequent routes of that pilot with respect to the total kms travelled on frequent routes: use_private_car = km_car / km_frequent_routes where: • km_car (B8) = # km travelled by private car on frequent routes in the pilot • km_frequent_routes (B7) = # total km travelled on frequent routes in the pilot We expect a decrease in the value of this indicator at the end of the project, since one of the MUV objectives is precisely that of reducing the use of private car in favour of more sustainable mobility choices.
Formula	IA1.S2.2 = B8 / B7
Unit of measurement	%
Frequency of computation	every week
Data source	MUV app

IA1.S2.3	**Modal split**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S2 - Behavioural change
Definition	This is one of the most prominent indicator that it is essential to monitor during the MUV initiative. As a matter of fact, from the computation of such indicator it could be possible to derive the *modal shift*, indicating the change of modal split because of the implementation of the MUV measure. A modal shift towards more sustainable transport modes will be a sign of an impact of MUV on citizens' mobility habits, showing that there has indeed been a behavioural change. The six transport modes herewith considered are: walk, bike, public transport, private car, motorbike, carpooling. Modal split is defined as the percentage of kms travelled using each transport mode during a week on frequent routes: modal_split = array(km_car, km_walk, km_bike, km_pt, km_moto, km_carpooling) / km_frequent_routes

	where: • km_car (B8) = # km travelled by private car on frequent routes in the pilot • km_walk (B9) = # km travelled by walk on frequent routes in the pilot • km_bike (B10) = # km travelled by bike on frequent routes in the pilot • km_pt (B11) = # km travelled by public transport on frequent routes in the pilot • km_moto (B12) = # km travelled by motorbike on frequent routes in the pilot • km_carpooling (B13) = # km travelled by carpooling on frequent routes in the pilot • km_frequent_routes (B7) = # total km travelled on frequent routes in the pilot By the end of the project, we expect in each pilot a shift of modal split towards more sustainable transport modes (i.e. walk, bike, public transport).
Formula	IA1.S2.3 = array(B8:B13) / B7
Unit of measurement	%
Frequency of computation	every week
Data source	MUV app

IA1.S2.4	**Travel time**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S2 - Behavioural change
Definition	This indicator is introduced to monitor the average daily time spent travelling on frequent routes by a citizen of each pilot in each transport mode. The initial idea was to insert an indicator about *travel costs*, aimed at measuring how a possible modal shift influences the average mobility costs in each pilot. In doing this, we came across the problem of monetizing travel time, a well-known issue in the literature that mainly sees two schools of thought. The first current holds that travel time is 'lost' time, so the less time it takes to travel, the better (i.e. every minute of travel is spent money). The second current, on the other hand, maintains that travel time can be occupied in various ways (such as reading a book, maintaining social relationships, telephone calls, sightseeing, etc.), and so it is not a question of lost time (and, thus, not a question of lost money). Since the evaluators do not want to take any specific position in this regard, the choice has been to objectively monitor only travel times, without attributing them any economic value.

	This indicator is defined as the average daily time spent by each player travelling on frequent routes by each transport mode: travel_time = time_travelled_per_day / player_transport where: • 'time_travelled_per_day' is a 6-elements array indicating the total minutes travelled in the pilot by using each transport mode (walk, bike, public transport, private car, motorbike, carpooling) in an average day on frequent routes; • 'player_transport' is a 6-elements array indicating the number of players using each transport mode by travelling on frequent routes in that pilot in the week. Both 'time_travelled_per_day' and 'player_transport' are obtained by querying the MUV database that collects the app's data and by elaborating such data.
Formula	IA1.S2.4 = array(B28:B33) / array(B34:B39)
Unit of measurement	minutes / day
Frequency of computation	every week
Data source	MUV app

Sub-area IA1.S3 'Community'

IA1.S3.1	**Community cohesion among travellers**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S3 - Community
Definition	Even though it is not among the primary objectives of MUV, one of the indirect consequences of MUV measure is likely to be an increase in the sense of community within the neighbourhood. For this reason, the evaluators have decided to insert an indicator aimed at measuring the level of contact between people living the community, and their perception of being part of their community. In mobility terms, these concepts can be translated in terms of mobility sharing initiatives and/or in the birth of grassroots community of travellers. Looking at the data available within the project, the choice has been to proxy this indicator by means of carpooling mode: community_cohesion = average_carpooling_vehicle_occupancy where 'average_carpooling_vehicle_occupancy' indicates the average number of people that share the journey by carpooling in

	each pilot. The total number of vehicle-kilometres can be significantly reduced if the car occupancy rate increases (fewer vehicles would be needed to transport the same number of people). 'average_carpooling_vehicle_occupancy' is obtained by querying the MUV database and then elaborating the app's data to estimate the desired value.
Formula	to be better defined once carpooling functionality is implemented in the MUV app
Unit of measurement	person / car
Frequency of computation	every week
Data source	MUV app

Sub-area IA1.S4 'Health and wellbeing'

IA1.S4.1	**Physical activity**
Impact area	IA1 - Society-People
Impact sub-area	IA1.S4 - Health and wellbeing
Definition	Leading an active lifestyle may contribute to maintaining and improving health; using active travel modes helps to support MUV sustainable transport objectives. Ideally all physical activities would be measured in total, with walking and cycling being assessed as part of the total. Since these are mobility-related indicators, the focus on the amount of walking and cycling only is justified, thus focusing on the physical activity performed via active transport. The indicator is defined as the average weekly calories burned on frequent routes in each pilot: physical_activity = cal_burned_freq_routes / players_active_transport where: • cal_burned_freq_routes (B14) = # calories burned via active transport (walk and bike) on frequent routes in the pilot • players_active_transport (B27) = # people using active transport (walk and bike) on frequent routes in the pilot Both 'cal_burned_freq_routes' and 'players_active_transport' are obtained by querying the MUV database that collects the app's data and by elaborating such data. As regards 'cal_burned_freq_routes', the MUV app uses a specific formula to compute the calories burned. The calories burned by a player (of a definite weight and height) while travelling at a certain

	speed for a certain time (travel_time) is computed as: $$calories = \left(level \cdot weight + \frac{speed^2}{height} \cdot 0.029 \cdot weight\right) \cdot traveltime$$ where: • 'level' is a parameter that varies according to the transport modality (bike: level = 0.048; walk: level = 0.035; public transport: level = 0.026; standing/unknown: level 0.008); • 'weight' is expressed in kg; • 'speed' is expressed in m/s; • 'height' is expressed in m; • 'travel_time' is expressed in minutes. Some default values have been set for 'weight' and 'height', to be used in case the player has not entered these values during the registration to MUV app.
Formula	IA1.S4.1 = B14 / B27
Unit of measurement	cal / person*week
Frequency of computation	every week
Data source	MUV app

IA2 - Society-Governance

Sub-area IA2.S1 'Planning'

IA2.S1.1	**Planning process**
Impact area	IA2 - Society-Governance
Impact sub-area	IA2.S1 - Planning
Definition	This indicator is related to the changes in the process to develop mobility plans thanks to MUV, in terms of: strategic level vision, level of public involvement, sector integration, institutional cooperation, monitoring and evaluation, finance, implementation. It is related to the indicator IA3.S2.1 'Public investments'. This is a qualitative indicator, defined in accordance with the following 5-level Likert scale: 1. No impact: MUV measure has not, at any level, inspired changes in the mobility planning process. 2. Little impact: MUV measure has led to an internal discussion about the suitability of the current mobility planning process. 3. Some impact: MUV measure has led to a public discussion, leading to a change in the mobility planning process. 4. Notable impact: MUV measure has led to a public discussion, leading to a change in the mobility planning process. This in its turn has sparked a discussion amongst other administrations about the suitability of the current mobility planning process. 5. High impact: MUV measure has led to a public discussion, leading to a change in the mobility planning process. This in turn has inspired other administrations to reconsider their mobility planning process.
Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA2.S1.2	**Quality of policies, plans and programs**
Impact area	IA2 - Society-Governance
Impact sub-area	IA2.S1 - Planning
Definition	This indicator deals with a qualitative evaluation of the change in the quality of mobility policies, plans, and programs. This is a qualitative indicator, defined in accordance with the following 5-level Likert scale:

	1. No impact: MUV measure has not, at any level, affected the quality of policies, plans and programs. 2. Little impact: MUV measure has led to an internal discussion about the quality of the current policies, plans and programs. 3. Some impact: MUV measure has led to a public discussion, leading to a change in the quality of the current policies, plans and programs. 4. Notable impact: MUV measure has led to a public discussion, leading to a change in the quality of the current policies, plans and programs. This in its turn has sparked a discussion amongst other administrations about the quality of the current policies, plans and programs. 5. High impact: MUV measure has led to a public discussion, leading to a change in the quality of the current policies, plans and programs. This in turn has inspired other administrations to reconsider the quality of the current policies, plans and programs.
Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

Sub-area IA2.S2 'Governance'

IA2.S2.1	**Rules and regulations**
Impact area	IA2 - Society-Governance
Impact sub-area	IA2.S2 - Governance
Definition	This indicator refers to the extent to which MUV has contributed to, or inspired, changes in rules and regulations (i.e. if MUV is able to change the context in which it is applied, by providing a different interpretation of existing rules and regulations). This is a qualitative indicator, defined in accordance with the following 5-level Likert scale: 1. No impact: MUV measure has not, at any level, inspired changes in rules and regulations. 2. Little impact: MUV measure has led to a localised discussion about the suitability of the current rules and regulations. 3. Some impact: MUV measure has led to a public discussion, leading to a change in rules and regulations. 4. Notable impact: MUV measure has led to a public discussion, leading to a change in rules and regulations. This in its turn has sparked a discussion amongst other administrations about the suitability of the current rules and regulations. 5. High impact: MUV measure has led to a public discussion,

	leading to a change in rules and regulations. This in turn has inspired other administrations to reconsider their rules and regulations.
Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA2.S2.2	**Policies**
Impact area	IA2 - Society-Governance
Impact sub-area	IA2.S2 - Governance
Definition	This indicator measures the extent to which MUV has contributed to, or inspired, changes in the current urban mobility policies (e.g. update SUMP). This is a qualitative indicator, defined in accordance with the following 5-level Likert scale: 1. No impact: MUV measure has not, at any level, inspired changes in urban mobility policies. 2. Little impact: MUV measure has led to an internal discussion about the suitability of the current urban mobility policies. 3. Some impact: MUV measure has led to a public discussion, leading to a change in urban mobility policies. 4. Notable impact: MUV measure has led to a public discussion, leading to a change in urban mobility policies. This in its turn has sparked a discussion amongst other administrations about the suitability of the current urban mobility policies. 5. High impact: MUV measure has led to a public discussion, leading to a change in urban mobility policies. This in turn has inspired other administrations to reconsider their urban mobility policies.
Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA2.S2.3	**Policy making process**
Impact area	IA2 - Society-Governance

Impact sub-area	IA2.S2 - Governance
Definition	This indicator qualitatively measures the extent to which MUV has contributed to, or inspired, changes in the process to develop policies and programs, in terms of: strategic level vision, level of public involvement, sector integration, institutional cooperation, monitoring and evaluation, finance, implementation. The indicator is defined in accordance with the following 5-level Likert scale: 1. No impact: MUV measure has not, at any level, inspired changes in the policy process. 2. Little impact: MUV measure has led to an internal discussion about the suitability of the current policy process. 3. Some impact: MUV measure has led to a public discussion, leading to a change in the policy process. 4. Notable impact: MUV measure has led to a public discussion, leading to a change in the policy process. This in its turn has sparked a discussion amongst other administrations about the suitability of the current policy process. 5. High impact: MUV measure has led to a public discussion, leading to a change in the policy process. This in turn has inspired other administrations to reconsider their policy process.
Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA2.S2.4	**Finance**
Impact area	IA2 - Society-Governance
Impact sub-area	IA2.S2 - Governance
Definition	This indicator qualitatively measures the extent to which the MUV measure has contributed to -or inspired- the development of new forms of financing of mobility solutions. The indicator is defined in accordance with the following 5-level Likert scale: 1. No impact: MUV measure has not, at any level, inspired changes in the development of new forms of financing of mobility solutions. 2. Little impact: MUV measure has led to an internal discussion about the suitability of the current forms of financing of mobility solutions. 3. Some impact: MUV measure has inspired new forms of financing of mobility solutions. 4. Notable impact: MUV measure has inspired new forms of

	financing of mobility solutions, leading to a public discussion aimed at developing new forms of financing. 5. High impact: MUV measure has led to the development of new forms of financing of mobility solutions.
Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA2.S2.5	**Cooperation structures with stakeholders**
Impact area	IA2 - Society-Governance
Impact sub-area	IA2.S2 - Governance
Definition	This indicator measures the level of cooperation structures between all public and private stakeholders to develop and implement sustainable mobility solutions. Cooperation could be at different levels: ● in the city (in the city services and with external stakeholders); ● between the city and other government levels (other municipalities, the regional/national level). The indicator is defined in accordance with the following 5-level Likert scale: 1. No impact: MUV measure has not led to any change in the cooperation with the (public and private) stakeholders, neither within the city, nor with other levels of government whatsoever. 2. Little impact: MUV measure has led to a slight increase in the cooperation with other authorities, but this is irregular and very dependent of the people involved. 3. Some impact: MUV measure has led to a slight increase in the cooperation with other authorities (either with other municipalities or other levels of government), which is formalized in a partnership policy. 4. Notable impact: MUV measure has led to a good cooperation with private stakeholders/other municipalities/other levels of government, which is formalized in partnership policies and in process through regular participation in meetings. 5. High impact: MUV measure has led the city to be a driving force in the cooperation with private stakeholders/other municipalities/other levels of government, which is formalized in policy and in process through regular meetings initiated by the city.
Unit of measurement	5-level Likert scale

Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

Sub-area IA2.S3 'Open data'

IA2.S3.1	**Quality of open data**
Impact area	IA2 - Society-Governance
Impact sub-area	IA2.S3 - Open data
Definition	This indicator refers to the level of quality of mobility open data of the pilot. Its definition is based on the average stars across all datasets generated by the MUV project according to the 5-star deployment scheme for Open Data defined by Tim Berners Lee (5stardata.info): 1*: Making data online available in whatever format under an open license. 2*: Making data available as structured data (e.g. Excel instead of image scan of a table). 3*: Making data available in a non-proprietary open format (e.g. CSV). 4*: Use URIs to denote things, so that people can point at your data. 5*: Link your data to other data to provide context. The indicator is defined in accordance with the following 5-level Likert scale: 1. No impact: MUV measure has not led to any change in the level of quality of mobility open data. 2. Little impact: MUV measure has led to a 1*-increase in the level of quality of mobility open data. 3. Some impact: MUV measure has led to a 2*-increase in the level of quality of mobility open data. 4. Notable impact: MUV measure has led to a 3*-increase in the level of quality of mobility open data. 5. High impact: MUV measure has led to a 4*-increase in the level of quality of mobility open data.
Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA2.S3.2	**Open datasets**
Impact area	IA2 - Society-Governance

Impact sub-area	IA2.S3 - Open data
Definition	Open data is data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and sharealike. Open data, especially open government data, is a tremendous resource that is as yet largely untapped. Government is particularly significant in this respect, both because of the quantity and centrality of the data it collects, but also because most of that government data is public data by law, and therefore could be made open and made available for others to use. In a large number of areas, open government data is already creating value, but new combinations of data can create new knowledge and insights, which can lead to whole new fields of application. Since open datasets can stimulate innovation, this indicator measures the number of open government datasets that are generated by the MUV measure. In addition, the quality of the available datasets is measured by IA2.S3.1.
Unit of measurement	#
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA3 - Economy

Sub-area IA3.S1 'Business network'

IA3.S1.1	**Global sponsors involvement level**
Impact area	IA3 - Economy
Impact sub-area	IA3.S1 - Business network
Definition	This indicator refers to the involvement of global sponsors in the community. A *global sponsor* in MUV project is defined as an organization providing goods and services globally or nationally. It is an alternative to local sponsors, which indeed are public or private organizations providing goods and services inside the neighbourhood. The proxy chosen for global sponsors involvement is the *global sponsors conversion rate*, i.e. how many global sponsors are involved in MUV with respect to the total number of global sponsors contacted: global_sponsors_involvement_level = global_sponsors_involved / global_sponsors_lead where: • global_sponsors_involved = # global sponsors that have signed a contract; • global_sponsors_lead = # global sponsors that have been contacted. The values of both 'global_sponsors_involved' and 'global_sponsors_lead' are provided by pilot managers.
Unit of measurement	%
Frequency of computation	every two months
Data source	pilot managers

IA3.S1.2	**Community interaction with global sponsors**
Impact area	IA3 - Economy
Impact sub-area	IA3.S1 - Business network
Definition	This indicator is aimed at measuring the level of interaction of the community with the global sponsors in each pilot. It is defined as: community_interaction_global = check-in_global / active_players

	where: • check-in_global = # check-in and all CTA (call-to-action), if any, at global sponsors; • active_players (B5) = # MUV active players in the pilot. While it is still not clear at the current project timeframe how 'check-in_global' will be provided, 'active players' is obtained by querying the MUV database that collects the app's data and by elaborating such data.
Unit of measurement	1 / player
Frequency of computation	every month
Data source	MUV app

IA3.S1.3	**Local sponsors involvement level**
Impact area	IA3 - Economy
Impact sub-area	IA3.S1 - Business network
Definition	This indicator refers to the involvement of local sponsors in the community. A *local sponsor* in MUV project is defined as a public or private organization providing goods and services inside the neighbourhood. It is an alternative to global sponsors, which indeed are organizations providing goods and services globally or nationally The proxy chosen for global sponsors involvement is the *local sponsors conversion rate*, i.e. how many local sponsors are involved in MUV with respect to the total number of local sponsors contacted: local_sponsors_involvement_level = local_sponsors_involved / local_sponsors_lead where: • local_sponsors_involved = # local sponsors that have signed a contract; • local_sponsors_lead = # local sponsors that have been contacted. The values of both 'local_sponsors_involved' and 'local_sponsors_lead' are provided by pilot managers.
Unit of measurement	%
Frequency of computation	every two months
Data source	pilot managers

IA3.S1.4	**Community interaction with local sponsors**
Impact area	IA3 - Economy
Impact sub-area	IA3.S1 - Business network
Definition	This indicator is aimed at measuring the level of interaction of the community with the local sponsors in each pilot. It is defined as: community_interaction_local = check-in_local / active_players where: • check-in_local = # check-in and all CTA (call-to-action), if any, at local sponsors; • active_players (B5) = # MUV active players in the pilot. While it is still not clear at the current project timeframe how 'check-in_local' will be provided, 'active players' is obtained by querying the MUV database that collects the app's data and by elaborating such data.
Unit of measurement	1 / player
Frequency of computation	every month
Data source	MUV app

Sub-area IA3.S2 'Investments'

IA3.S2.1	**Public investments**
Impact area	IA3 - Economy
Impact sub-area	IA3.S2 - Investments
Definition	This indicator, considered in conjunction with IA3.S2.2, focuses on the economic investments as a result of MUV measure. 'Public investments' measures the amount of investments of the municipality on new mobility initiatives thanks to MUV. Such information is provided by surveying local decision makers of each pilot.
Unit of measurement	€
Frequency of computation	every year

Data source	local decision makers

IA3.S2.2	**Private investments**
Impact area	IA3 - Economy
Impact sub-area	IA3.S2 - Investments
Definition	This indicator, considered in conjunction with IA3.S2.1, focuses on the economic investments as a result of MUV measure. 'Private investments' measures the amount of investments of global and local sponsors on MUV and MUV-related initiatives. Such information is provided by surveying global and local sponsors of each pilot.
Unit of measurement	€
Frequency of computation	every year
Data source	global / local sponsors

Sub-area IA3.S3 'Innovation'

IA3.S3.1	**Innovative environment**
Impact area	IA3 - Economy
Impact sub-area	IA3.S3 - Innovation
Definition	This indicator is aimed at measuring the extent to which MUV increases the level of innovativeness of the urban environment, in terms of exploiting new mobility-related opportunities for helping enterprises to innovate or innovate more (see indicator 'Opportunity-driven entrepreneurship' of European Innovation Scoreboard 2017). As a proxy of innovative environment, we would like to have used the number of new sustainable mobility-related start ups (or innovative enterprises) born in each pilot. Alternatively, since such data is unlikely to be available or known by local decision makers, the indicator is qualitatively defined according to the following 5-level Likert scale: 1. No impact: MUV measure is not part of and does not stimulate an innovative environment. 2. Little impact: MUV measure is somewhat part of an innovative environment. 3. Some impact: MUV measure is part of and somewhat stimulates an innovative environment. 4. Notable impact: MUV measure is part of and stimulates an innovative environment. 5. High impact: MUV measure is an essential part of and stimulates an innovative environment.

Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA3.S3.2	**Economic activity**
Impact area	IA3 - Economy
Impact sub-area	IA3.S3 - Innovation
Definition	This indicator is aimed at measuring the extent to which MUV impacts the economic activity of each neighbourhood/city, in terms of, for instance, job creation and additional economic activity (e.g. creation of leisure-based networks, such as clusters of cycling-related economic activities). The indicator is defined qualitatively according to the following 5-level Likert scale: 1. No impact: MUV measure does not stimulate any economic activity in the pilot (i.e. no job creation, no additional economic activity arise). 2. Little impact: MUV measure poorly stimulates the economic activity in the pilot. 3. Some impact: MUV measure somehow stimulates the economic activity in the pilot. 4. Notable impact: MUV measure stimulates the economic activity in the pilot. 5. High impact: MUV measure highly stimulates the economic activity in the pilot.
Unit of measurement	5-level Likert scale
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	local decision makers

IA3.S3.3	**Open data exploitation**
Impact area	IA3 - Economy
Impact sub-area	IA3.S3 - Innovation
Definition	Open data is data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and sharealike. Open data, especially open government

	data, is a tremendous resource that is as yet largely untapped. Government is particularly significant in this respect, both because of the quantity and centrality of the data it collects, but also because most of that government data is public data by law, and therefore could be made open and made available for others to use. In a large number of areas, open government data is already creating value, but new combinations of data can create new knowledge and insights, which can lead to whole new fields of application. To this aim, this indicator measures the number of apps/services/API calls developed by third parties using MUV open data. Such information is provided by surveying pilot managers.
Unit of measurement	#
Frequency of computation	twice (at the beginning and at the end of the project)
Data source	pilot managers

IA4 - Environment

Sub-area IA4.S1 'Climate change (GHG)'

IA4.S1.1	**CO_2 emissions from road traffic**
Impact area	IA4 - Environment
Impact sub-area	IA4.S1 - Climate change (GHG)
Definition	Greenhouse gases (GHGs) are gases in the atmosphere that absorb infrared radiation that would otherwise escape to space; thereby contributing to rising surface temperatures. There are six major GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) (ISI/DIS 37120, 2013). The warming potential for these gases varies from several years to decades to centuries. CO_2 accounts for a major share of Green House Gas emissions in urban areas. The main sources for CO_2 emissions are combustion processes related to energy generation and transport. CO_2 emissions can therefore be considered a useful indicator to assess the contribution of urban development on climate change. The indicator is defined as the average emissions of CO_2 per km travelled on frequent routes in the pilot, considering the modal split of each player: CO2_emissions = CO2_emis_fact / km_frequent_routes where: • CO2_emis_fact (B18) = total emissions of CO_2 on frequent routes in the pilot; • km_frequent_routes (B7) = # total km travelled on frequent routes in the pilot. Both 'CO2_emis_fact' and 'km_frequent_routes' are obtained by querying the MUV database that collects the app's data and by elaborating such data. We expect a decrease in the value of this indicator at the end of the project, since one of the MUV objectives is precisely that of changing the mobility citizens' behaviour towards more sustainable modes of transport.
Formula	IA4.S1.1 = B18 / B7
Unit of measurement	g / km
Frequency of computation	every week
Data source	MUV app

IA4.S1.2	**CO_2 level**
Impact area	IA4 - Environment
Impact sub-area	IA4.S1 - Climate change (GHG)
Definition	Within the transport sector, road traffic is the most important contributor to urban air pollution. National and EU regulations aimed at automobile emission reductions (such as the introduction of catalytic converters or unleaded petrol) have resulted in considerably lower emissions per vehicle, but the continuous expansion of the vehicle fleet is partly offsetting these improvements. The MUV measure, on the long term, is likely to have an impact not only on the emissions (see IA4.S1.1), but also on the level of air pollutants. For this reason, also air quality indicators are taken into account. This indicator is defined as the average concentration of CO_2 in the pilot measured by the MUV monitoring stations (but it is still unsure that monitoring stations will measure this value).
Formula	to be better defined once understood how monitoring stations save data in the MUV databases
Unit of measurement	g / m^3 (or ppm)
Frequency of computation	every week
Data source	MUV monitoring stations (*still unsure that monitoring stations will measure this value*)

Sub-area IA4.S2 'Pollution (emissions/noise)'

IA4.S2.1	**Noise level**
Impact area	IA4 - Environment
Impact sub-area	IA4.S2 - Pollution (emissions/noise)
Definition	Environmental noise pollution relates to noise caused by road, rail and airport traffic, industry, construction, as well as some other outdoor activities. Prolonged exposure to noise can lead to significant health effects, both physical and mental. This indicator is used to measure the impacts of MUV measure on reducing noise levels, and it is defined as the level of noise in each neighbourhood measured by MUV monitoring stations.
Formula	to be better defined once understood how monitoring stations save data in the MUV databases

Unit of measurement	dBA
Frequency of computation	every week
Data source	MUV monitoring stations

IA4.S2.2	**NOx emissions from road traffic**
Impact area	IA4 - Environment
Impact sub-area	IA4.S2 - Pollution (emissions/noise)
Definition	The term NOx indicates the sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2). Nitrogen oxides are of natural origin, but above all anthropogenic with high temperature combustions, such as those occurring inside the combustion chambers of motor vehicle engines. Other sources of nitrogen oxides are thermoelectric power plants and in general all industrial combustion plants. The increase in vehicular traffic in recent years has generated an increasing level of nitrogen oxide concentrations, especially in urban areas. In case of accidental nitrogen monoxide pollution, the concentration decays in 2-5 days, but in the case of continuous emissions (for example in urban areas with heavy vehicular traffic), there is the activation of a daily cycle that leads to the production of secondary pollutants, such as nitrogen dioxide. Among the nitrogen oxides, only NO_2 has toxicological relevance: it causes irritation of the distal portion of the respiratory system with consequent alteration of pulmonary functions, such as chronic bronchitis, asthma and pulmonary emphysema. NOx also contribute to the formation of acid rain and have important consequences on aquatic and terrestrial ecosystems. The indicator is defined as the average NOx emissions per km travelled on frequent routes in the pilot, considering the modal split of each player: NOx_emissions = NOx_emis_fact / km_frequent_routes where: • NOx_emis_fact (B16) = total emissions of NOx on frequent routes in the pilot; • km_frequent_routes (B7) = # total km travelled on frequent routes in the pilot. Both 'NOx_emis_fact' and 'km_frequent_routes' are obtained by querying the MUV database that collects the app's data and by elaborating such data. We expect a decrease in the value of this indicator at the end of the project, since one of the MUV objectives is precisely that of changing the mobility citizens' behaviour towards more sustainable modes of transport.

Formula	IA4.S2.2 = B16 / B7
Unit of measurement	g / km
Frequency of computation	every week
Data source	MUV app

IA4.S2.3	**NO_2 level**
Impact area	IA4 - Environment
Impact sub-area	IA4.S2 - Pollution (emissions/noise)
Definition	Within the transport sector, road traffic is the most important contributor to urban air pollution. National and EU regulations aimed at automobile emission reductions (such as the introduction of catalytic converters or unleaded petrol) have resulted in considerably lower emissions per vehicle, but the continuous expansion of the vehicle fleet is partly offsetting these improvements. The MUV measure, on the long term, is likely to have an impact not only on the emissions (see IA4.S2.2), but also on the level of air pollutants. For this reason, also air quality indicators are taken into account. Among the nitrogen oxides, only NO_2 has toxicological relevance: it causes irritation of the distal portion of the respiratory system with consequent alteration of pulmonary functions, such as chronic bronchitis, asthma and pulmonary emphysema. NO_2 levels are important to assess air quality both for their own toxicity and for their contribution, under certain conditions, to particulate level. This indicator is defined as the average NO_2 concentration in each pilot measured by the MUV monitoring stations.
Formula	to be better defined once understood how monitoring stations save data in the MUV databases
Unit of measurement	mg / m^3 (or ppm)
Frequency of computation	every week
Data source	MUV monitoring stations

IA4.S2.4	**PM2.5 emissions from road traffic**
Impact area	IA4 - Environment
Impact sub-area	IA4.S2 - Pollution (emissions/noise)
Definition	Particulate matters (PM) are polluting particles in the air we breathe. They are classified according to their size, which can determine a different level of harmfulness. In fact, the smaller these particles are, the more they can penetrate the respiratory system. • The PM10 (diameter less than 10 μm) can be inhaled and penetrate the upper respiratory tract, from the nose to the larynx. • The PM2.5 (diameter less than 2.5 μm) can be breathed and pushed into the deepest part of the apparatus, until reaching the bronchi. One of the main anthropogenic sources of PM is vehicular traffic, both for diesel and petrol vehicles. Epidemiological studies have shown that the higher the concentration of particulate matters in the air, the greater the effect on the health of the population. Acute effects are linked to a short-term exposure (one or two days) at high concentrations of metal-containing PM. This condition can cause inflammation of the respiratory tract, such as an asthma crisis, or disrupt the functioning of the cardiovascular system. Chronic effects, on the other hand, depend on prolonged exposure to high concentrations of PM and may cause respiratory symptoms such as cough and phlegm, decreased pulmonary capacity and chronic bronchitis. This indicator is defined as the average PM2.5 emissions per km travelled on frequent routes in the pilot, considering the modal split of each player: PM_emissions = PM_emis_fact / km_frequent_routes where: • PM_emis_fact (B17) = total emissions of PM2.5 on frequent routes in the pilot; • km_frequent_routes (B7) = # total km travelled on frequent routes in the pilot. Both 'PM_emis_fact' and 'km_frequent_routes' are obtained by querying the MUV database that collects the app's data and by elaborating such data. We expect a decrease in the value of this indicator at the end of the project, since one of the MUV objectives is precisely that of changing the mobility citizens' behaviour towards more sustainable modes of transport.
Formula	IA4.S2.4 = B17 / B7
Unit of measurement	mg / km

Frequency of computation	every week
Data source	MUV app

IA4.S2.5	**PM2.5 concentration**
Impact area	IA4 - Environment
Impact sub-area	IA4.S2 - Pollution (emissions/noise)
Definition	Particulate matters (PM) are polluting particles in the air we breathe. They are classified according to their size, which can determine a different level of harmfulness. In fact, the smaller these particles are, the more they can penetrate the respiratory system. • The PM10 (diameter less than 10 μm) can be inhaled and penetrate the upper respiratory tract, from the nose to the larynx. • The PM2.5 (diameter less than 2.5 μm) can be breathed and pushed into the deepest part of the apparatus, until reaching the bronchi. One of the main anthropogenic sources of PM is vehicular traffic, both for diesel and petrol vehicles. Epidemiological studies have shown that the higher the concentration of particulate matters in the air, the greater the effect on the health of the population. Acute effects are linked to a short-term exposure (one or two days) at high concentrations of metal-containing PM. This condition can cause inflammation of the respiratory tract, such as an asthma crisis, or disrupt the functioning of the cardiovascular system. Chronic effects, on the other hand, depend on prolonged exposure to high concentrations of PM and may cause respiratory symptoms such as cough and phlegm, decreased pulmonary capacity and chronic bronchitis. This indicator is defined as the average PM2.5 concentration in each pilot measured by the MUV monitoring stations.
Formula	to be better defined once understood how monitoring stations save data in the MUV databases
Unit of measurement	μg / m^3
Frequency of computation	every week
Data source	MUV monitoring stations

IA4.S2.6	**PM10 concentration**
Impact area	IA4 - Environment

Impact sub-area	IA4.S2 - Pollution (emissions/noise)
Definition	Particulate matters (PM) are polluting particles in the air we breathe. They are classified according to their size, which can determine a different level of harmfulness. In fact, the smaller these particles are, the more they can penetrate the respiratory system. • The PM10 (diameter less than 10 μm) can be inhaled and penetrate the upper respiratory tract, from the nose to the larynx. • The PM2.5 (diameter less than 2.5 μm) can be breathed and pushed into the deepest part of the apparatus, until reaching the bronchi. One of the main anthropogenic sources of PM is vehicular traffic, both for diesel and petrol vehicles. Epidemiological studies have shown that the higher the concentration of particulate matters in the air, the greater the effect on the health of the population. Acute effects are linked to a short-term exposure (one or two days) at high concentrations of metal-containing PM. This condition can cause inflammation of the respiratory tract, such as an asthma crisis, or disrupt the functioning of the cardiovascular system. Chronic effects, on the other hand, depend on prolonged exposure to high concentrations of PM and may cause respiratory symptoms such as cough and phlegm, decreased pulmonary capacity and chronic bronchitis. This indicator is defined as the average PM10 concentration in each pilot measured by the MUV monitoring stations.
Formula	to be better defined once understood how monitoring stations save data in the MUV databases
Unit of measurement	μg / m^3
Frequency of computation	every week
Data source	MUV monitoring stations

IA4.S2.7	**CO emissions from road traffic**
Impact area	IA4 - Environment
Impact sub-area	IA4.S2 - Pollution (emissions/noise)
Definition	Carbon monoxide (CO) is a primary pollutant with a relatively long residence time (about four months) and a low chemical reactivity. In urban areas carbon monoxide is mainly emitted by car traffic. At high concentrations it is a powerful poison. The effects on humans are related to the interference on the transport of oxygen to the tissues and in particular to the central nervous system. This indicator is defined as the average CO emissions per km

	travelled on frequent routes in the pilot, considering the modal split of each player: CO_emissions = CO_emis_fact / km_frequent_routes where: • CO_emis_fact (B15) = total emissions of CO on frequent routes in the pilot; • km_frequent_routes (B7) = # total km travelled on frequent routes in the pilot. Both 'CO_emis_fact' and 'km_frequent_routes' are obtained by querying the MUV database that collects the app's data and by elaborating such data. We expect a decrease in the value of this indicator at the end of the project, since one of the MUV objectives is precisely that of changing the mobility citizens' behaviour towards more sustainable modes of transport.
Formula	IA4.S2.7 = B15 / B7
Unit of measurement	g / km
Frequency of computation	every week
Data source	MUV app

IA4.S2.8	**CO level**
Impact area	IA4 - Environment
Impact sub-area	IA4.S2 - Pollution (emissions/noise)
Definition	Carbon monoxide (CO) is a primary pollutant with a relatively long residence time (about four months) and a low chemical reactivity. In urban areas carbon monoxide is mainly emitted by car traffic. At high concentrations it is a powerful poison. The effects on humans are related to the interference on the transport of oxygen to the tissues and in particular to the central nervous system. This indicator is defined as the average CO concentration in each pilot measured by the MUV monitoring stations.
Formula	to be better defined once understood how monitoring stations save data in the MUV databases
Unit of measurement	g / m^3 (or ppm)
Frequency of computation	every week

Data source	MUV monitoring stations

Sub-area IA4.S3 'Energy'

IA4.S3.1	**Energy consumption from road traffic**
Impact area	IA4 - Environment
Impact sub-area	IA4.S3 - Energy
Definition	Reduced and effective energy use can create substantial savings and can enhance security of the energy supply. Reducing the energy consumption also reduces greenhouse gas emissions and the ecological footprint, which contribute to combating climate change and achieve a low carbon economy. This indicator shall assess the average energy consumption per km travelled on frequent routes in each pilot, considering the modal split of each user: energy_consumption = energy_cons / km_frequent_routes where: • energy_cons (B19) = energy consumed on frequent routes in the pilot; • km_frequent_routes (B7) = # total km travelled on frequent routes in the pilot. Both 'energy_cons' and 'km_frequent_routes' are obtained by querying the MUV database that collects the app's data and by elaborating such data. We expect a decrease in the value of this indicator at the end of the project, since one of the MUV objectives is precisely that of changing the mobility citizens' behaviour towards more sustainable modes of transport.
Formula	IA4.S3.1 = B19 / B7
Unit of measurement	kgoe / km
Frequency of computation	every week
Data source	MUV app

Annex 2 - MUV basic indicators and parameters

Basic indicators (prefixes B and P)

Basic indicators are intermediate indicators introduced to facilitate the computation of MUV impact indicators.

The prefix for the basic indicators that refer to the pilot is **B** (Table 14).

The prefix for the basic indicators that refer to the player is **P** (Table 15).

Per pilot (B)				
Code	**Name**	**Description**	**Unit of measurement**	**Source of data / method of collection / formula**
B2	people_aware	# people aware of MUV action (i.e. reached by dissemination and communication activities) in the pilot	#	pilot coordinators' estimate (data collected from T5.3 tables - Local Engagement Diary)
B3	people_involved	# people involved in the co-creation activities and/or other MUV-related activities in the pilot	#	pilot coordinators' estimate (data collected from T5.3 tables - Local Engagement Diary)
B4	people_registered	# people registered to MUV app in the pilot	#	sum (players)
B5	active_players	# MUV active players in the pilot	#	sum (players) P1
B6	km_sustainable	# km travelled in a sustainable way on frequent routes in the pilot	km	sum (players) P9
B7	km_frequent_routes	# total km travelled on frequent routes in the pilot	km	sum (players) P10
B8	km_car	# km travelled by private car on frequent routes in the pilot	km	sum (players) P6
B9	km_walk	# km travelled by walk on frequent routes in the pilot	km	sum (players) P3
B10	km_bike	# km travelled by bike on frequent routes in the pilot	km	sum (players) P4
B11	km_pt	# km travelled by public transport on frequent routes	km	sum (players) P5

		in the pilot		
B12	km_moto	# km travelled by motorbike on frequent routes in the pilot	km	sum (players) P7
B13	km_carpooling	# km travelled by car pooling on frequent routes in the pilot	km	sum (players) P8
B14	cal_burned_freq_routes	# calories burned via active transport (walk and bike) on frequent routes in the pilot	cal	sum (players) P11
B15	CO_emis_fact	total emissions of CO on frequent routes in the pilot	g	sum (players) P12
B16	NOx_emis_fact	total emissions of NOx on frequent routes in the pilot	g	sum (players) P13
B17	PM_emis_fact	total emissions of PM2.5 on frequent routes in the pilot	mg	(sum (players) P14) / 1000
B18	CO2_emis_fact	total emissions of CO2 on frequent routes in the pilot	g	sum (players) P15
B19	energy_cons	energy consumed on frequent routes in the pilot	kgoe	sum (players) P16
B26	perseverant_players	# MUV perseverant players in the pilot	#	sum (players) P19
B27	players_active_transport	# players using active transport (walk and bike) on frequent routes in the pilot	people	sum (players) P18
B28	time_travelled_per_day_car	total minutes travelled by car in the pilot in an average day on frequent routes	minutes / day	sum (players) (P20/route_frequency)
B29	time_travelled_per_day_walk	total minutes travelled by walk in the pilot in an average day on frequent routes	minutes / day	sum (players) (P21/route_frequency)
B30	time_travelled_per_day_bike	total minutes travelled by bike in the pilot in an average day on frequent routes	minutes / day	sum (players) (P22/route_frequency)
B31	time_travelled_per_day_pt	total minutes travelled by public transport in the pilot in an average day on frequent routes	minutes / day	sum (players) (P23/route_frequency)
B32	time_travelled_per_day_moto	total minutes travelled by moto in the pilot in an average day on frequent routes	minutes / day	sum (players) (P24/route_frequency)
B33	time_travelled_per_da	total minutes travelled by	minutes	sum (players)

	y_carpooling	carpooling in the pilot in an average day on frequent routes	/ day	(P25/route_frequency)
B34	player_transport_car	# players travelling by car in a week on frequent routes in the pilot	#	sum (players) P26
B35	player_transport_walk	# players travelling by walk in a week on frequent routes in the pilot	#	sum (players) P27
B36	player_transport_bike	# players travelling by bike in a week on frequent routes in the pilot	#	sum (players) P28
B37	player_transport_pt	# players travelling by public transport in a week on frequent routes in the pilot	#	sum (players) P29
B38	player_transport_moto	# players travelling by moto in a week on frequent routes in the pilot	#	sum (players) P30
B39	player_transport_carpooling	# players travelling by carpooling in a week on frequent routes in the pilot	#	sum (players) P31

Table 14: Basic indicators referred to the pilot (prefix B)

Per player (P)				
Code	**Name**	**Description**	**Unit of measurement**	**Source of data / method of collection / formula**
P1	active	Is the player active? (a player is defined active if he/she registers at least V1 frequent routes per week)	binary (0/1)	If (P2>V1) then (P1=1) else (P1=0)
P2	frequent_routes	# frequent routes registered by the player	#	sum (frequent route == 1)
P3	km_walk_player	# km travelled by walk on frequent routes	km	MUV app + further elaboration could be required to align the results to the baseline info about modal split
P4	km_bike_player	# km travelled by bike on frequent routes	km	MUV app + further elaboration could be required to align the results to the baseline info about

				modal split
P5	km_pt_player	# km travelled by public transport on frequent routes	km	MUV app + further elaboration could be required to align the results to the baseline info about modal split
P6	km_car_player	# km travelled by private car on frequent routes	km	MUV app + further elaboration (an algorithm derives this information from MUV app data, as complementar of the collected data on sustainable km travelled)
P7	km_moto_player	# km travelled by motorbike on frequent routes	km	MUV app + further elaboration could be required to align the results to the baseline info about modal split
P8	km_carpooling_player	# km travelled by car pooling on frequent routes	km	MUV app + further elaboration could be required to align the results to the baseline info about modal split
P9	km_sustainable_player	# km travelled in a sustainable way on frequent routes	km	P3+P4+P5+P8*T3
P10	km_frequent_routes_player	# km travelled on frequent routes	km	MUV app + further elaboration could be required to align the results to the baseline info about modal split
P11	cal_burned_freq_routes_player	# calories burned on frequent routes via active transport (walk and bike)	cal	MUV app
P12	CO_emis_fact_player	g CO emitted on frequent routes	g	D1*P6+D2*P7+(F3*P5)/F2+(D1*P8)/T2
P13	NOx_emis_fact_player	g NOx emitted on frequent routes	g	D3*P6+D4*P7+(F4*P5)/F2+(D3*P8)/T2
P14	PM_emis_fact_player	g PM2.5 emitted on frequent routes	g	D5*P6+D6*P7+(F5*P5)/F2+(D5*P8)/T2
P15	CO2_emis_fact_player	g CO2 emitted on frequent routes	g	D9*D7*P6+D10*D8*P7+(F7*F6*P5)/F2+(D9*D7*P8)/T2
P16	energy_cons_player	energy consumed on frequent routes (1 kgoe = 41,868 MJ)	kgoe	P17/41.868

P17	energy_cons_player_MJ	energy consumed on frequent routes in MJ	MJ	D11*P6+D12*P7+(F8*P5)/F2+(D11*P8)/T2
P18	players_active_transport_player	Does the player use active transport modes (walk and/or bike)?	binary (0/1)	
P19	perseverant	Is the player perseverant? (a player is defined perseverant if he is active more than V19 weeks in the year)	binary (0/1)	If (sum(year)P1 > V19) then (P19=1) else (P19=0)
P20	time_travelled_car_player	total minutes travelled by car by the player on frequent routes in a week	minutes / week	MUV app + further elaboration
P21	time_travelled_walk_player	total minutes travelled by walk by the player on frequent routes in a week	minutes / week	MUV app + further elaboration
P22	time_travelled_bike_player	total minutes travelled by bike by the player on frequent routes in a week	minutes / week	MUV app + further elaboration
P23	time_travelled_pt_player	total minutes travelled by public transport by the player on frequent routes in a week	minutes / week	MUV app + further elaboration
P24	time_travelled_moto_player	total minutes travelled by moto by the player on frequent routes in a week	minutes / week	MUV app + further elaboration
P25	time_travelled_carpooling_player	total minutes travelled by carpooling by the player on frequent routes in a week	minutes / week	MUV app + further elaboration
P26	player_transport_car_player	Has the player travelled by car?	binary (0/1)	MUV app + further elaboration
P27	player_transport_walk_player	Has the player travelled by walk?	binary (0/1)	MUV app + further elaboration
P28	player_transport_bike_player	Has the player travelled by bike?	binary (0/1)	MUV app + further elaboration
P29	player_transport_pt_player	Has the player travelled by public transport?	binary (0/1)	MUV app + further elaboration
P30	player_transport_moto_player	Has the player travelled by moto?	binary (0/1)	MUV app + further elaboration
P31	player_transport_carpooling_player	Has the player travelled by carpooling?	binary (0/1)	MUV app + further elaboration

Table 15: Basic indicators referred to the player (prefix P)

Parameters (prefixes V, D and F)

The prefix for the general parameters is **V** (Table 16), for the parameters referred to the player is **D** (Table 17), for the parameters referred to the pilot is **F** (Table 18).

Parameters general (V)				
Code	**Name**	**Description**	**Unit of measurement**	**Source of data / value**
V1	Threshold_activeness	threshold to exceed to be considered an active player	#	3
V3	CO_emis_fact_car	CO emission factors for passenger car (by vehicle type, by fuel type, by legislation category) ~ 50-elements array	g/km	[19] (Table 3.17)
V4	CO_emis_fact_moto	CO emission factors for mopeds and motorcycles (by engine, by cubic capacity, by legislation category) ~ 20-elements array	g/km	[19] (Table 3.25)
V5	CO_emis_fact_bus	CO emission factor for buses (by type, by legislation category) ~ 20-elements array	g/km	[19] (Table 3.23)
V6	NOx_emis_fact_car	NOx emission factors for passenger car (by vehicle type, by fuel type, by legislation category) ~ 50-elements array	g/km	[19] (Table 3.17)
V7	NOx_emis_fact_moto	NOx emission factors for mopeds and motorcycles (by engine, by cubic capacity, by legislation category) ~ 20-elements array	g/km	[19] (Table 3.25)
V8	NOx_emis_fact_bus	NOx emission factor for buses (by type, by legislation category) ~ 20-elements array	g/km	[19] (Table 3.23)
V9	PM_emis_fact_car	PM2.5 emission factors for passenger car (by vehicle type, by fuel type, by legislation category) ~ 50-elements array	g/km	[19] (Table 3.18)
V10	PM_emis_fact_moto	PM2.5 emission factors for mopeds and motorcycles (by engine, by cubic capacity, by legislation category) ~ 20-elements array	g/km	[19] (Table 3.26)
V11	PM_emis_fact_bus	PM2.5 emission factor for buses (by type, by legislation category) ~ 20-elements array	g/km	[19] (Table 3.24)
V12	CO2_emis_fact_fuel	CO2 emission factors for fuel type (~ 7-elements array)	g/kg	[19] (Table 3.12)
V13	FC_car	fuel consumption for passenger car (by vehicle type, by fuel type, by legislation category); g of fuel per km travelled (~ 20-elements array)	g/km	[19] (Table 3.27)
V14	FC_moto	fuel consumption for mopeds and motorcycles (by engine, by cubic capacity, by	g/km	[19] (Table 3.27)

		legislation category); g of fuel per km travelled (~ 10-elements array)		
V15	FC_bus	fuel consumption for buses (by type, by legislation category); g of fuel per km travelled (~ 10-elements array)	g/km	[X] (Table 3.27)
V16	EC_car	energy consumption for passenger car (by vehicle type, by fuel type, by legislation category); MJ per km travelled (~ 20-elements array)	MJ/km	[19] (Table 3.27)
V17	EC_moto	energy consumption for mopeds and motorcycles (by engine, by cubic capacity, by legislation category); MJ per km travelled (~ 10-elements array)	MJ/km	[19] (Table 3.27)
V18	EC_bus	energy consumption for buses (by type, by legislation category); MJ per km travelled (~ 10-elements array)	MJ/km	[19] (Table 3.27)
V19	Threshold_perseverance	threshold to exceed to be considered a perseverant player	#	25

Table 16: General parameters (prefix V)

Parameters per player (D)				
Code	**Name**	**Description**	**Unit of measurement**	**Source of data**
D1	CO_emis_fact_car_player	CO emission factors for the player's car (to be chosen among the values of V3 basing on the player's answer)	g/km	from the initial survey (type of private car used)
D2	CO_emis_fact_moto_player	CO emission factors for the player's motorbike (to be chosen among the values of V4 basing on the player's answer)	g/km	from the initial survey (type of motorbike used)
D3	NOx_emis_fact_car_player	NOx emission factors for the player's car (to be chosen among the values of V6 basing on the player's answer)	g/km	from the initial survey (type of private car used)
D4	NOx_emis_fact_moto_player	NOx emission factors for the player's motorbike (to be chosen among the values of V7 basing on the player's answer)	g/km	from the initial survey (type of motorbike used)
D5	PM_emis_fact_car_player	PM2.5 emission factors for the player's car (to be chosen among the values of V9 basing on the player's answer)	g/km	from the initial survey (type of private car used)
D6	PM_emis_fact_moto_player	PM2.5 emission factors for the player's motorbike (to be chosen among the values of V10 basing on the player's answer)	g/km	from the initial survey (type of motorbike used)
D7	CO2_emis_fact_fuel_car_player	CO2 emission factors for the player's car (to be chosen among the values of V12 basing on the player's answer)	g/kg	from the initial survey (type of private car used)
D8	CO2_emis_fact_fuel_moto_player	CO2 emission factors for the player's motorbike (to be chosen among the values of V12 basing on the player's answer)	g/kg	from the initial survey (type of motorbike used)
D9	FC_car_player	fuel consumption for the player's car; g of fuel per km travelled (to be chosen among the values of V13 basing on the player's answer)	g/km	from the initial survey (type of private car used)
D10	FC_moto_player	fuel consumption for the player's motorbike; g of fuel per km travelled (to be chosen among the values of	g/km	from the initial survey (type of motorbike used)

		V14 basing on the player's answer)		
D11	EC_car_player	energy consumption for the player's car; MJ per km travelled (to be chosen among the values of V16 basing on the player's answer)	MJ/km	from the initial survey (type of private car used)
D12	EC_moto_player	energy consumption for the player's motorbike; MJ per km travelled (to be chosen among the values of V17 basing on the player's answer)	MJ/km	from the initial survey (type of motorbike used)

Table 17: Parameters referred to the player (prefix D)

Parameters per pilot (F)				
Code	**Name**	**Description**	**Unit of measurement**	**Source of data**
F2	average_bus_occupancy	average bus occupancy in the pilot	people / bus	context indicators
F3	CO_emis_fact_bus_pilot	CO emission factor for buses in the pilot (to be chosen among the values of V5 basing on the pilot's answer)	g/km	derived from context indicators
F4	NOx_emis_fact_bus_pilot	NOx emission factor for buses in the pilot (to be chosen among the values of V8 basing on the pilot's answer)	g/km	derived from context indicators
F5	PM_emis_fact_bus_pilot	PM2.5 emission factor for buses in the pilot (to be chosen among the values of V11 basing on the pilot's answer)	g/km	derived from context indicators
F6	CO2_emis_fact_bus_pilot	CO2 emission factor for buses in the pilot (to be chosen among the values of V12 basing on the pilot's answer)	g/km	derived from context indicators
F7	FC_bus_pilot	fuel consumption for buses in the pilot; g of fuel per km travelled (to be chosen among the values of V15 basing on the pilot's answer)	g/km	derived from context indicators
F8	EC_bus_pilot	energy consumption for buses in the pilot; MJ per km travelled (to be chosen among the values of V18 basing on the pilot's answer)	MJ/km	derived from context indicators
F9	target_population	# people to which MUV is addressed. Defined in each pilot as: people aged 15-74 in the neighbourhood + 30% people aged 15-74 out of the neighbourhood (but in the city)	people	context indicators

Table 18: Parameters referred to the pilot (prefix F)

In the case the values of the parameters per pilot (F) (Table 18) were not available in the context indicators collected by pilot managers (see D7.5), they have been estimated either using common sense or using the values of the other pilots. The resulting values are provided in Table 19.

		Amsterdam	Barcelona	Fundao	Ghent	Helsinki	Palermo
F2	average_bus_occupancy	20	20	20	20	20	20
F3	CO_emis_fact_bus_pilot	0.2230	0.6411	2.6700	0.5571	2.6700	2.6700
F4	NOx_emis_fact_bus_pilot	2.4884	6.4385	9.3800	4.1644	9.3800	9.3800
F5	PM_emis_fact_bus_pilot	0.0362	0.0256	0.2070	0.0285	0.2070	0.2070
F6	CO2_emis_fact_bus_pilot	3.1400	2.9181	3.1400	2.9723	3.1400	3.1400
F7	FC_bus_pilot	301.00	382.92	301.00	367.22	301.00	301.00
F8	EC_bus_pilot	12.85	17.66	12.85	16.72	12.85	12.85
F9	target_population	209626	399976	11153	60719	148971	167488

Table 19: Values used for the parameters referred to the pilot