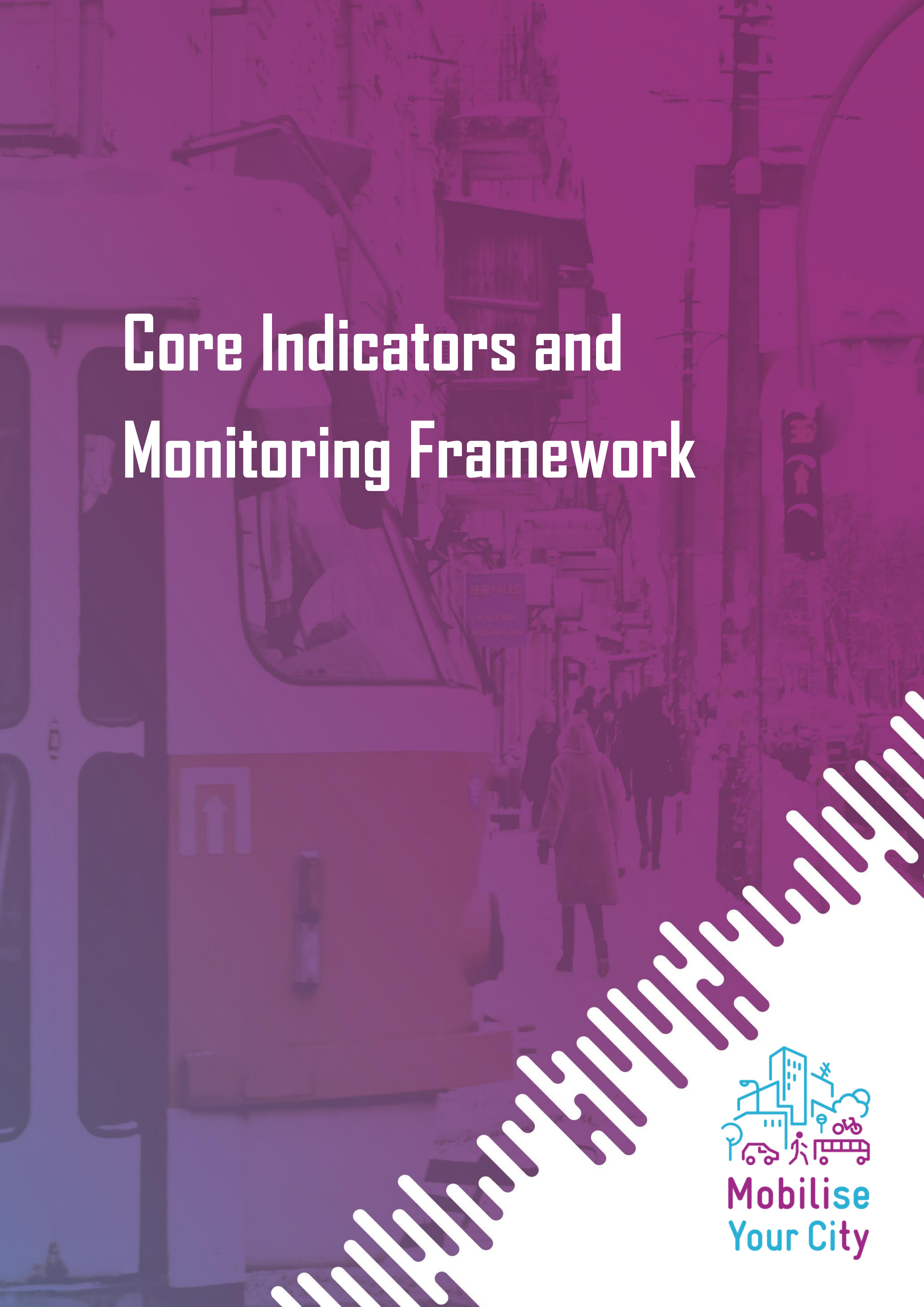


Core Indicators and Monitoring Framework

Mobilise Your City

For more information:

MobiliseYourCity Secretariat, Brussels
www.MobiliseYourCity.net
email: Contact@MobiliseYourCity.net

Title: Core Indicators and Monitoring Framework

Printed and distributed: May 2020

Authors: Urda Eichhorst, Daniel Bongardt, Levent Saran (GIZ), Tristan Morel (MobiliseYourCity Secretariat)

Contributors: Benjamin Fouchard, Damien Verry (Cerema), Réda Souirgi (AFD), André Eckermann (GIZ), Marcel Braun (Rupprecht Consult), Henrik Gudmundsson (CONCITO), Markus Delfs, Vincent Larondelle (MobiliseYourCity Secretariat)

Copyright:

Disclaimer:

The content presented in this document represents the opinion of the authors and is not necessarily representative of the position of the individual partners of MobiliseYourCity or the United Nations Framework Convention on Climate Change (UNFCC).

May 2020

Donors

Implementing partners

Knowledge and Network partners

Part of:

Context of the Publication

This publication has been developed within the MobiliseYourCity Partnership in collaboration with the project “Advancing climate strategies in rapidly motorising countries”, funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.

MobiliseYourCity is a partnership for integrated urban development planning in emerging and developing countries under the UN Marrakesh Partnership for Global Climate Action. MobiliseYourCity supports and engages local and national partner governments in improving urban mobility planning & finance by providing a methodological framework and technical assistance, through capacity building, and by enabling access to funding at both local and national levels. Particular attention has been paid to the methodological and advisory frameworks related to National Urban Mobility Policies and/or Programs (NUMPs) and Sustainable Urban Mobility Plans (SUMPs) that serve as the basis for the promotion of investments and development of attractive mobility services.

MobiliseYourCity is a multi-donor action, jointly co-financed by the European Commission’s Directorate-General for International Cooperation and Development (DG DEVCO), the French Ministry of Ecological Transition and Solidarity (MTES), the French Facility for Global Environment (FFEM), and the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The initiative is implemented by its founding partners ADEME, AFD, CEREMA, CODATU, and GIZ. Besides contribution to the international climate process, MobiliseYourCity contributes to the UN’s Agenda 2030, specifically Sustainable Development Goal (SDG) 11: Make cities inclusive, safe, resilient, and sustainable.

The objectives

- Enable transformational changes towards more inclusive, liveable, and efficient cities.
- Foster more comprehensive, integrated, and participatory urban mobility planning (local & national levels).
- Target reduction of transport related GHG emissions in participating cities (>50% until 2050).
- Link planning with agreement on investments and optional use of financial assistance.
- Make use of innovative planning techniques and digitalization and promote state-of-the-art mobility and transport technologies.

Contents

1. Introduction 6

2. Overview 8

2.1. Impact Indicators 8
2.2. Investment Indicators 9
2.3. Aggregated Monitoring on Partnership Level 10
2.4. Application of the Core Indicator and Monitoring Framework to NUMPs 12
2.5. Availability & Collection of Input Data – Guideline 13

3. Impact Indicator 1: Transport Related GHG Emissions 19

3.1. Definitions 20
3.2. Calculation & Aggregation 26
3.3. Data Availability & Collection 28

4. Impact Indicator 2: Access to Public Transport 36

4.1. Definitions 36
4.2. Calculation & Aggregation 37
4.3. Data Availability & Collection 38

5. Impact Indicator 3: Road Safety 41

5.1. Definitions 41
5.2. Calculation & Aggregation 41
5.3. Data Availability & Collection 43

6. Impact Indicator 4: Air Pollution 45

6.1. Definitions 45
6.2. Calculation & Aggregation 46
6.3. Data Availability & Collection 47

7. Impact Indicator 5: Modal Share of Non-Motorized and Public Transport 48

7.1. Definitions 48
7.2. Calculation & Aggregation 49
7.3. Data Availability & Collection 51

8. Impact Indicator 6: Affordability of Public Transport 54

8.1. Definitions 55
8.2. Calculation & Aggregation 57
8.3. Over 15 points Data Availability & Collection 57

9. Investment Indicators 59

10. Annexes 61

10.1. Indicators Assessing Urban Transportation Systems 61
10.2. Examples of Implementation and Sustainable Mobility Indicators 62
10.3. References 65
10.4. Index of Figures 67
10.5. Index of Tables 67

1. Introduction

The MobiliseYourCity Partnership supports local Governments in developing countries in creating more inclusive, liveable, economically competitive and climate resilient cities. It does so by providing support for the development and implementation of sustainable urban mobility plans (SUMPs) and national urban mobility plans (NUMPs). The Partnership's Beneficiary Partners target at reductions of transport related GHG emissions of more than 50% compared to business as usual.

This publication sets out the indicator framework and monitoring principles for the MobiliseYourCity Partnership. That being said, a rough ex-ante estimate of the Partnership's potential impacts as per its core indicators is already required during the goal setting phase in order to prioritise measures and inform cities whether targets can be achieved. This ex-ante estimate is called the SUMP/NUMP scenario. Figure 1 illustrates how the monitoring and reporting process aligns with the main steps of the SUMP/NUMP process

The SUMP/NUMP Process

Figure 1: Overview of monitoring and reporting steps in the SUMP/NUMP process

In principle, the ex-ante calculations follow the same approach as ex-post, but instead of using real-world (gathered) data, assumptions have to be made on the likely future development of certain parameters (see Figure 2). Whenever assumptions are made, it is important to be transparent and state them explicitly in order to understand the results.

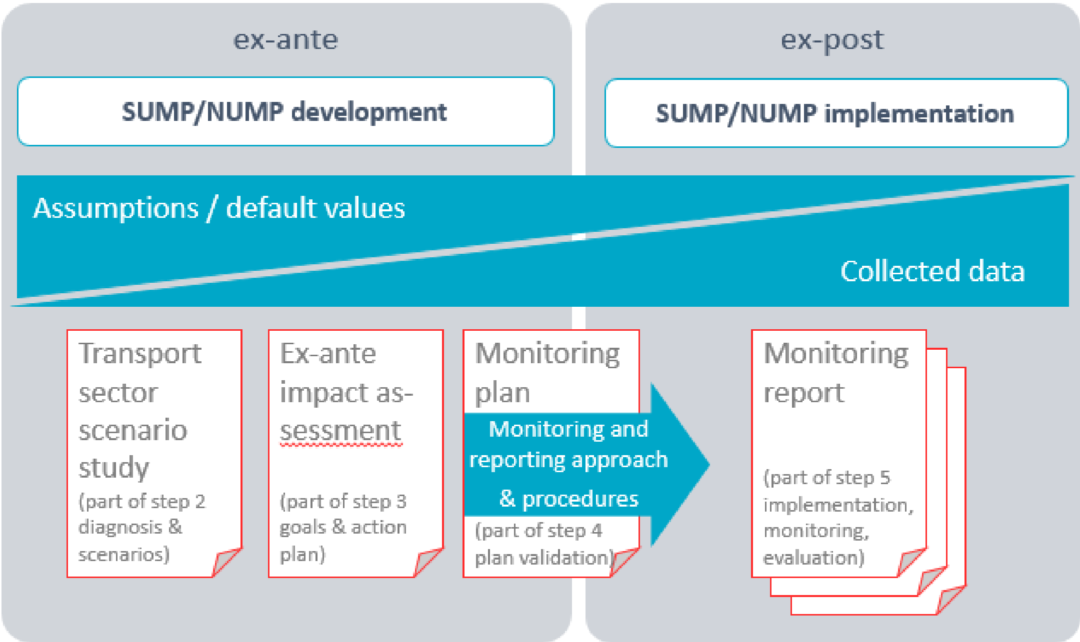


Figure 2: Data collection during SUMP/NUMP development and implementation

2. Overview

The structure of the publication is as follows: The chapter at hand introduces the indicator framework and provides a general understanding of the scope of the document. The subsequent chapters each focus on one indicator out of the framework and give guidance on what kind of information the MobiliseYourCity Partnership requires from its Partners with regards to monitoring and reporting of SUMPs and NUMPs. It is mandatory to monitor and report on all indicators within this publication, except on Impact Indicator 4 – Air Pollution, which is optional.

For the purpose of aggregated reporting against international agendas, the Partnership has defined Core Impact and Investment Indicators, which are to be reported and monitored in those Beneficiary Partners, which receive technical assistance under the Partnership umbrella. As many existing indicator frameworks suffer from complexity, thus requiring a high level of technical knowledge to gather suitable data, the Partnership's core indicators have the objective to be actionable, replicable, and easily understood. This way, SUMP/NUMP progress can be easily communicated not just to people working within the sustainable urban mobility sphere, but also to politicians and community advocates from unrelated fields.

This publication shall offer insights for Beneficiary Partner representatives and consultants on how to gather data in a comparable manner, to ensure methodological coherence over time and to achieve horizontal consistency among MobiliseYourCity Partners. For this purpose, a common methodology, which fulfils the Partnership's minimum recommended requirements, will be put forward for each indicator. Wherever appropriate, a set methodology will be suggested, which may differ in terms of the amount of and detail of data needed. It is essential that the chosen methodology is documented transparently and continuously for entire monitoring and reporting process.

2.1. Impact Indicators

GHG impact

1. **(Expected) GHG emission reductions** (of a 'SUMP/NUMP scenario') (in tCO_2e) against a 'without SUMP/NUMP scenario' (baseline)[1].

Impacts related to Sustainable Development Goals (SDGs)

2. **Access** (Proportion of the population living within 500 meters or less of a public transport stop with a minimum 20-minute service at peak hour, or have access to a shared mobility system with comparable service for money)
3. **Safety** (traffic fatalities (road, rail, etc.) in the urban area per 100.000 inhabitants. As defined by the WHO, a death counts as related to a traffic accident if it occurs within 30 days after the accident)

[1] In order to harmonise reporting, estimated emission reductions must be reported in accumulated form for every 10-year period, and as the average annual reduction over a 10-year reporting period. In addition, the expected annual emission reduction in the target years 2030 and 2050 should also be reported

4. **Air pollution (optional)**: Mean urban air pollution of particulate matter (in mg PM2.5) at road-based monitoring stations
5. **Modal share** (share of public transport and non-motorized modes in trips)
6. **Affordability of public transport**: the proportion, or percentage, of disposable household income spent on public transport for the second quintile household group.

These indicators directly align with the transport related Sustainable Development Goals especially SDG 3 (good health and well-being) and SDG 11 (sustainable cities and communities). They refer to official SDG indicators for Target 3.6: "Halve number of global deaths and road injuries from traffic accidents", Target 3.9: "Reduce deaths and illnesses from pollution", and Target 11.2: "Provide access to safe, affordable, accessible and sustainable transport systems for all".

Further indicators selected individually in Beneficiary Partner Cities may link to the individual SUMP/NUMP targets and can be built upon experiences and tools developed e.g. in the EU specialist sphere about SUMPs/NUMPs. Annex 1 provides an overview of existing indicator sets and can be used as orientation for city-specific indicators for the Partnership's Beneficiary Partners.

2.2. Investment Indicators

In addition to impact indicators, MobiliseYourCity requires from Beneficiary Partners data on five investment indicators:

A. **KM of sidewalks** planned to be built or to be substantially advanced in quality through the SUMP/NUMP
B. **KM of cycle lanes** planned to be built or to be substantially advanced in quality through the SUMP/NUMP
C. **KM of mass rapid transit** planned to be built or to be substantially advanced in quality through the SUMP/NUMP
D. **Number of city centre parking spaces** (for individual cars), which are newly subjected to active parking management through the SUMP/NUMP.
E. **The amount of mobilised public and private funding** for the implementation of the SUMP/NUMP in Euro (€).

Beneficiary Partners may want to define more investment indicators to ensure that individual measures are on track. However, because of strong differences in context, these will vary from Partner to Partner. Examples include the number of low-carbon buses purchased, or the number of bus kilometres offered, as well as indicators that refer to the quality of implementation and use of service, such as parking space or bicycle flows on new routes (see Annex 2 for examples of implementation and sustainable mobility indicators). This should provide an evidence base of city level transport GHG emission developments, i.e. emission reductions compared to the BAU scenario, being related to the implemented measures. These indicators again depend on the measures set out in the SUMP/NUMP.

2.3. Aggregated Monitoring on Partnership Level

All mandatory indicators are used for aggregated reporting on the MobiliseYourCity Partnership. Table 1 summarises how indicators are aggregated in the logical framework (logframe) of the Partnership:

Table 1: Ways to aggregate MobiliseYourCity indicators

Indicator	Aggregation
GHG Impact	
Impact Indicator 1: GHG emission reductions (tCO2e)	- Sum of projected yearly emission reductions in the target years 2030 and 2050 in all Beneficiary Partner contexts - Sum of differences between actual yearly GHG emissions and business-as-usual scenario emissions
SDG Impact	
Impact Indicator 2: Access to PT (Proportion of the population living within 500 meters or less of a public transport stop with a minimum 20-minute service at peak hour)	- Number of Partner Cities that project to improve the access to public transport shares by certain proportion of the total population (by up to 3 additional % points, 3-5 additional % points, 5-10 additional % points, 10-20 additional % points, over 20 additional % points). - Total number of additional people having access to public transport.
Impact Indicator 3: Road Safety (traffic fatalities (road, rail, etc.) in the urban area per 100.000 inhabitants)	Number of partner cities that achieve a projected reduction of their respective fatality rates included in the following ranges. - 0 -5 less deaths/ 100.000 ; - 5-10 less deaths/ 100.000 ; - 10-15 less deaths/ 100.000 ; - Over 15 less deaths/ 100.000 ;
Impact Indicator 4: Air Pollution (mean urban air pollution PM2.5 at a captured number of road-based monitoring stations in a city	Number of Partner Cities that achieve a mean urban air pollution PM2.5 level that lies within the boundaries of the WHO guidelines (i.e.: less than or equal to 10 µg/m³).
Impact Indicator 5: Modal Share (share of public transport and non-motorized modes in trips)	The indicator at Partnership level is the aggregated number of Partner Cities that achieve an increase of their respective modal shares of non-motorized and public transport by an amount included in the following ranges. - 0-5 additional % points - 5-10 additional % points - 10-15 additional % points - Over 15 additional % points

Impact Indicator 6: the proportion, or percentage, of disposable household income spent on public transport for the second quintile household group.	The indicator at Partnership level is the aggregated number of Partner Cities that achieve to lower their affordability index by: - 0-5 points - 5-10 points - 10-15 points - Over 5 points
Investment	
Investment Indicator 1: KM of sidewalks planned to be built or to be substantially advanced in quality through the SUMP/NUMP	Sum of total km of infrastructure planned to be built or to be substantially advanced in quality under MobiliseYourCity SUMPs/NUMPs
Investment Indicator 2: KM of cycle lanes planned to be built or to be substantially advanced in quality through the SUMP/NUMP	Sum of total km of infrastructure planned to be built or to be substantially advanced in quality under MobiliseYourCity SUMPs/NUMPs
Investment Indicator 3: KM of mass rapid transit planned to be built or to be substantially advanced in quality through the SUMP/NUMP	Sum of total km of infrastructure planned to be built or to be substantially advanced in quality under MobiliseYourCity SUMPs/NUMPs
Investment Indicator 4: Number of city centre parking spaces (for individual cars), which are newly subjected to active parking management through the SUMP/NUMP.	Sum of city centre parking spaces (for individual cars), which are newly subjected to active parking management; foreseen in MobiliseYourCity SUMPs/NUMPs
Investment Indicator 5: Total volume of financing leveraged or associated through MobiliseYourCity (planned and secured) available to implement NUMPs and SUMPs.	Sum in Euro (€) of financing leveraged or associated, disaggregated by secured or planned status of financing.

The overall approach to monitoring and reporting in MobiliseYourCity is summarised in the figure below.

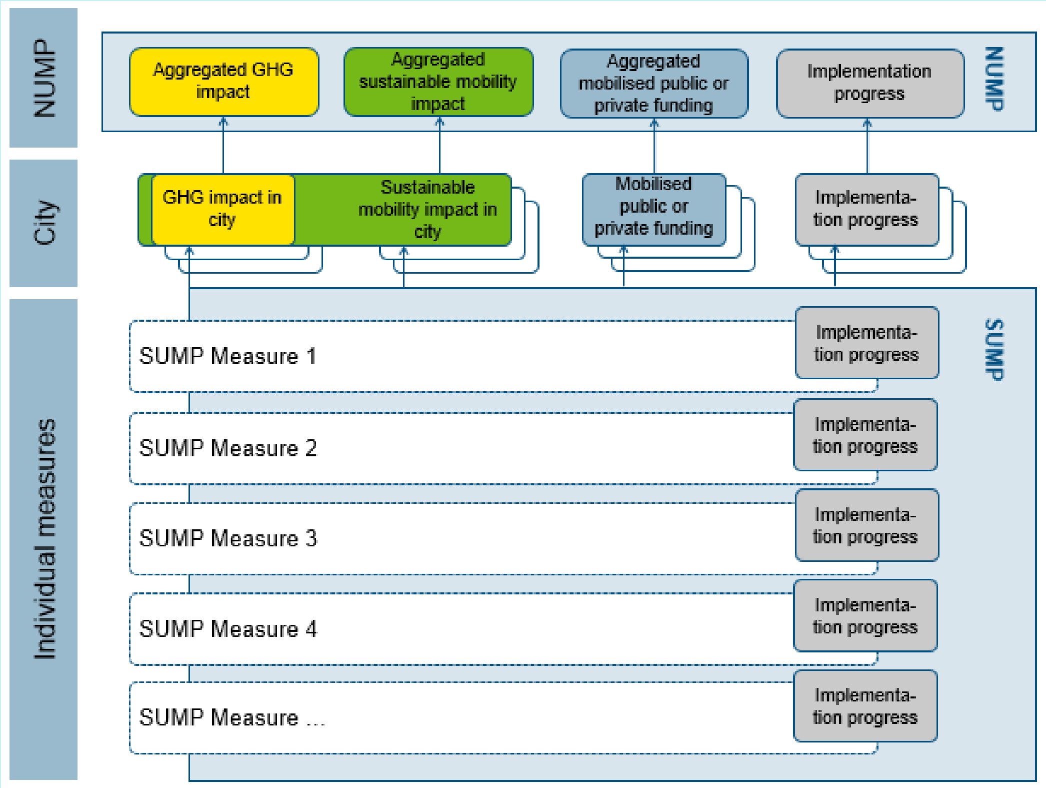


Figure 3: Overall logic of the monitoring and reporting approach in MobiliseYourCity

2.4. Application of the Core Indicator and Monitoring Framework to NUMPs

NUMPs can take on different forms that are defined in Box 1. The Partnership categorizes NUMPs in three main categories:

- Broad investment programmes carried out in a set of cities across a country,
- Sector policies that provide harmonized and incentivising laws and regulations, and
- Specific interventions on one aspect of sustainable urban mobility (e.g.: a scrapping programme).

A NUMP might belong to multiple categories.

Box 1: Definition of a National Urban Mobility Policy and Investment Programme

A **National Urban Mobility Policy or Investment Programme** is a strategic, action-oriented framework for urban mobility, developed by national governments, enacted to enhance the capability of cities to plan, finance and implement projects and measures designed to fulfil the mobility needs of people and businesses in cities and their surroundings in a sustainable manner. It builds on existing policies and regulations and aims at harmonizing relevant laws, norms, sector strategies, investment, and support programs towards an integrated approach for the benefits of cities and their inhabitants. It takes due consideration of participation and evaluation principles.

In general, MobiliseYourCity encourages the monitoring of NUMPs with the help of the indicator framework set out in this publication. As NUMPs can differ considerably in terms of focus and scope, for each NUMP a thorough assessment should be carried out, which determines the set of indicators that can be applied to any specific NUMP on a case by case basis. As a rule of thumb, it is expected that NUMPs in the form of investment programmes can benefit the most from the application of this indicator framework. NUMPs that constitute a very specific intervention may only show limited impact on indicators that are not directly related to that intervention and should only be monitored by a part of the indicators in the framework.

2.5. Availability & Collection of Input Data – Guideline

The very principle of a monitoring, evaluation and reporting system implies that the same fact, the same situation can be characterized at regular intervals to monitor and measure its evolution. The regular measurement of these developments makes it possible, on the one hand, to check whether the planned measures have been implemented (implementation indicators - in the MobiliseYourCity system described here, these are investment indicators - and, on the other hand, whether the measures implemented have produced the expected effects (impact indicators).

If progress in any area targeted by the SUMP/NUMP is recorded by the monitoring and evaluation system, a more precise, qualitative analysis will still have to be carried out to determine the share of this progress attributable to the SUMP/NUMP measures, and that attributable to external factors, such as changes in context, underlying trends, exogenous technological progress, etc. Symmetrically, degradation does not necessarily mean failure of the SUMP/NUMP measurement, which may have mitigated negative exogenous effects. In short, no indicator has any value if it is not interpreted.

A permanent and structured monitoring and evaluation system, combined with resources dedicated to interpreting and promoting its results, constitutes an Observatory - Mobility Observatory in the case of MobiliseYourCity. If this term is not used more in this document, it should be noted, however, that the establishment of a Mobility Observatory in each of the partner territories and cities that have been the subject of a SUMP or NUMP could constitute the ultimate goal of this process.

In each of the following chapters, the data needed to produce the indicators are presented, together with how they are collected and the difficulties that those responsible for collecting them may encounter.

We will quickly notice the extreme diversity of the data sought. All of them have at least one thing in common: their fragility, this term encompassing both the risk of not being able to dispose of them, or not permanently, and the risk, if they are available, of having to carry out detailed investigations to verify their relevance, timeliness, comparability, exhaustiveness, or even more simply their veracity.

We will discuss here two topics prior to the very use of the notion of data in the context of MobiliseYourCity partner cities:

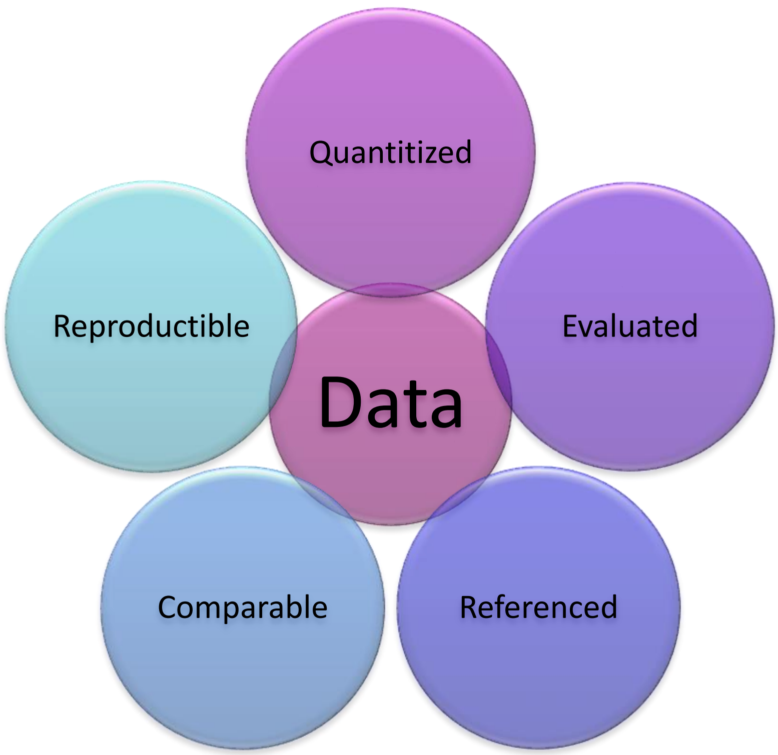
- the characteristics necessary for a data to be usable in a monitoring and evaluation process,
- the main data sources and their intrinsic sources of fragility and robustness.

The necessary characteristics of a data as part of a monitoring and evaluation process

Not all data are necessarily relevant to the monitoring and evaluation process. Most of the data that do not correspond to the characteristics presented in the following diagram are not intended to integrate the process.

Not all data are suitable for participation in a monitoring and evaluation process; indeed, it can be said that most data, which do not have the characteristics presented below, are not intended to integrate the process.

To participate in the device, a data must be:



QUANTITIZED: The data that can be used in a monitoring and evaluation process are obligatory of a digital nature. Even if this still leaves a wide field open, it closes the door to any data in literal form that is unsuitable for statistical processing and comparability purposes.

EVALUATED: A data cannot be used until the validity has been identified of a data set must be systematically evaluated. It is worth considering this notion of validity here. It must be recognized that any data is false, since' no data, even of the best quality, can claim to reproduce the reality of a situation in all its accuracy and complexity. There is therefore no exact data on the one hand and false or unsuitable data on the other, but a continuity of situations between data as close as possible to reality and data that is totally unreliable in terms of validity. The evaluation of a data therefore consists in defining the limits of its credibility and judging whether it is sufficient to be included in the system or not. Unsafe or imperfect data can be integrated into the device under the following four essential conditions: (i) there is no better data, (ii) it is not overly counter-intuitive, (iii) it is essential to the device, and (iv) its degree of uncertainty is systematically reminded at each job.

REFERENCED: For a data to be used, it must have three references: (i) a source, (ii) a date, (iii) a territory. We will not develop here the notion of source, which is a priori well known. The notion of date is obvious; we will limit ourselves here to indicating that the speed of expiry of a data is extremely variable according to the subjects. It can always be harmful to refuse to use data that is about ten or more years old, but that relates to phenomena that evolve relatively slowly; on the other hand, some data no longer make sense beyond a few years (traffic data in particular). This point is one of the evaluation elements referred to in the previous paragraph.

Concerning the territory, if the idea is simple, its application is complex. Indeed, the very definition of a territory can take many forms (e. g. "agglomeration" can refer to half a dozen different definitions), which may also evolve rapidly, or not have the same meaning between two sources. It is therefore necessary to be extremely cautious in controlling the geographical scope of the data used in this field, and not to hesitate, for want of anything better, to carry out pro-rata evaluations (in particular by using GIS tools) to ensure that the data that is to be produced is as appropriate as possible to the territory concerned.

COMPARABLE: In a monitoring and evaluation system, data is not an end in itself, it is not only a "brick" of the local monitoring and evaluation system, it is a tool for defining trends, permanencies and typologies between different situations. This is particularly true in the context of MobiliseYourCity, which brings together agglomerations and countries in a wide range of contexts. It is therefore important that the data used makes sense in other contexts, or even in all contexts. To take an example, in all latitudes Greenhouse Gases correspond to a reality, as do the market shares of each mode of transport (provided that they are not too subcategorized between the multiple forms of informal transport). On the other hand, all the notions related to purchasing power and resources raise comparability issues that are difficult to solve.

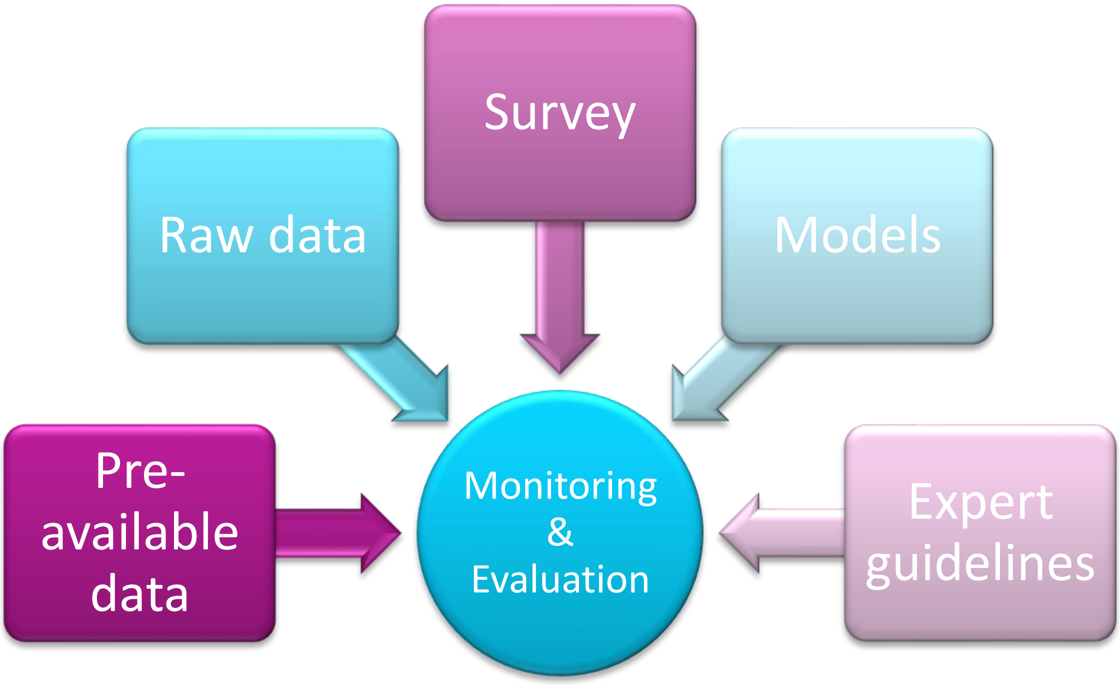
REPRODUCEABLE: If only one validity criterion were to be used, it would be this one. The very principle of "monitoring" implies that the same data can be collected with a comparable meaning at a defined frequency and over a long period of time. This hinders a lot of data, for two main reasons:

- either because the context is too fluid, and the very purpose of the data may disappear or evolve too strongly for continuity to be ensured;
- or because the data collection method is cumbersome or unsustainable and the structures to ensure its reproduction are not in place. On this subject, the special case of household travel surveys (HTS) should be noted. These very heavy devices, but essential to obtain a reliable mapping of flows and modes, are reproduced on average only every 8 to 10 years in most major European cities, and very episodically in the smallest ones. In the context of MobiliseYourCity's partner cities, HTs are generally carried out within the framework of partnership processes for the implementation of SUMPs or comparable procedures. The conditions for ensuring the reproducibility of these surveys therefore seem difficult to meet unless a continuous process of evaluation and renewal of the SUMP can be put in place.

Obviously, the needs of the action and the realities on the ground will necessarily lead the people in charge of these data collections to accept compromises with the principles proposed above. The most important thing is, of course, that the material produced corresponds to the optimum of what could reasonably be expected to be collected, and that the margins of validity of the results presented are clearly stated.

The main data sources and their intrinsic sources of fragility and robustness

The data discussed in the next chapters are, as has been said, very diverse in nature, and therefore can come from a multitude of different sources. These sources can be divided into five sets:



PRE-AVAILABLE DATA

These are "ready-made" data that can be found in structured statistical sources, including:

- the Statistical Offices owned by most of the member countries of MobiliseYourCity of the world, but whose contents and methods are highly variable; all aspects of censuses (population and other) are included here;
- statistics maintained by various public or private professional bodies,
- the activity reports of certain economic agents (e. g. public transport or parking operators),
- previous studies,

This list is far from exhaustive.

RAW DATA

These are files from administrative, economic, or technical systems intended in general for internal use, but which can be retrieved by agreement for statistical processing. For example: mobile operators' data files, registration files, ticketing systems, pollution measurement station records, permanent automatic counts, etc...

SURVEYS (AND COUNTS)

These are data collected by ad hoc field observations, intended to study a phenomenon or situation very precisely, by counting occurrences and/or interviewing selected individuals within a reference population. There are very many types of surveys, which will not be detailed here; some (notably Household Travel Surveys) are presented in detail in the following chapters.

This category includes automatic counts (by pneumatic counters, video recognition, etc.), which are related to the same purpose.

MODELS

Fuelled mainly by surveys and counts on the one hand, and by pre-available data (notably population and employment data) on the other hand, the models make it possible to recreate a reference situation at the scale of a given perimeter, and thus to produce data on places where they are not available, and then to simulate the consequences of such and such changes (demographic trends, changes in motorization, addition or removal of an infrastructure, changes in a CT network, etc.).

Four types of models are mainly used:

- strategic models, which make it possible to reconstruct travel flows from zone to zone and motif to motif at the scale of an urban area or even a region, and to simulate the consequences of fundamental changes, but without assigning them to a network;
- single-modal models (generally VP or TC), allowing to accurately reconstruct the load of a network (road or bus) and travel times at the scale of an agglomeration or even an urban region, and to simulate the consequences of changes in demand or supply;
- multimodal models, aggregating a VP and a TC model and considering the consequences of the evolution from one mode to another,
- microsimulation models, which allow to reconstruct very precisely the functioning of a reduced set (usually a complex crossroads) for all modes (including pedestrians and 2-wheelers) in real time or accelerated and to observe the effects of measures such as a reconfiguration of the crossroads on waiting times, tail strokes and capacity reserves of the crossroads.

The models can be built either as part of a SUMP mission, or by recovering and if possible, updating previous models.

EXPERT GUIDELINES

Where data are lacking, it is still possible to use, as data, an "expert" assessment resulting from the expertise of one or more qualified persons synthesizing indices and partial data. Many data transmitted by the media and entered in our current repositories are often expert statements whose origin and referencing have been quickly forgotten or even misused. Nevertheless, the formulation of a plausible order of magnitude based on extensive experience in both the field and the problem remains a perfectly valid means of feeding a monitoring and evaluation system, as long as it is sourced and evaluated, of course. These expert statements may come either from the development of the SUMP or NUMP, or from previous sources.

The following table attempts to cross-reference these five data sources with the five validity criteria outlined above and identifies sources of fragility or robustness.

Source	Quantized	Evaluated	Referenced	Comparable	Reproduceable
Pre-available data	No specific issue	Tedious assessment of pre-existing data is required	Adaptation to the studied area is often necessary	Assessment needed	Sustainable resources availability is often an issue
Raw data	No specific issue	Usually, evaluation is done along data collection	No specific issue	No specific issue	Sustainable resources availability is often an issue
Survey	No specific issue	Usually, evaluation is done along data collection	No issues, except for older survey data	Comparability of data has to be considered from the design of the survey	Sustainable resources availability is often an issue, especially for costly surveys
Models	No specific issue	No issues for recent models	No specific issue	No specific issues	Sustainable resources availability is often an issue
Expert guidelines	Quantification usually by ranges Not easily usable	Variable	Variable	No specific issue Common purpose of expert guidelines	Necessity to always mobilise the same experts

As can be seen, all sources present risk of data issues. The work of the persons in charge of collecting this data and setting up the monitoring and evaluation dashboard will therefore be, on an ongoing basis, to carry out the necessary arbitrations and adjustments to achieve a data system that is as representative as possible of reality, but above all as sustainable as possible.

3. Impact Indicator 1: Transport Related GHG Emissions

The MobiliseYourCity approach to monitoring and reporting proposes that Beneficiary Partners project and track the development of transport related GHG emissions (particularly CO_2, CH4 and N_2O) and other impacts at city level rather than per measure. The SUMPs form packages of measures that interact with each other and consequently have a bigger impact on emissions than the sum of single measures. MobiliseYourCity Partners are therefore required to account transport GHG emissions for their territory, i.e. direct emissions from mobile sources (tank-to-wheel) – cars, motorbikes, trucks and buses – and indirect emissions from the use of electricity and potentially upstream emissions from fuels (well-to-tank). Accounting for upstream emissions from fuels is particularly relevant wherever measures in the territory affect the type of fuel that is consumed. Once established, the inventories should be updated annually as far as possible.

Box 2: Focus on GHG emission accounting in MobiliseYourCity

Note: Emission monitoring in MobiliseYourCity focuses on GHG emissions, in particular CO2, CH4 and N2O. Monitoring air pollutant emissions is not mandatory but recommended for MobiliseYourCity reporting. Cities that are interested in monitoring transport-related air quality, however, can use the data on transport related GHG emissions as a first step towards calculating local air pollutants. Air pollution assessments essentially follow the same methodology but require more disaggregated data on vehicle fleets than the bottom-up calculation of GHG emissions (see Figure 5).

In order to assess the GHG effect of each SUMP/NUMP, the overall GHG emissions associated with transport in each city territory are compared to a hypothetical business-as-usual scenario, which acts as the baseline (see Figure 4). This scenario describes the transport emissions that would have occurred in the absence of the SUMP/NUMP based on assumptions on travel demand per mode, vehicle efficiency and fuel-related emissions. In particular, assumptions on travel demand are coupled with assumptions on GDP and population developments.

This way emission inventories at the city level can be used to measure and report on the overall impact of the SUMP's/NUMP's measures rather than assessing individual measures, since the GHG impacts cannot easily be isolated from each other.

The rationale for using the entire city territory as the assessment unit is that any measures implemented within the city territory fall into the sphere of influence of local government and can thus be affected by the SUMP. In this way, the assessment unit directly corresponds to the geographical area where the SUMP will have the greatest expected impact.

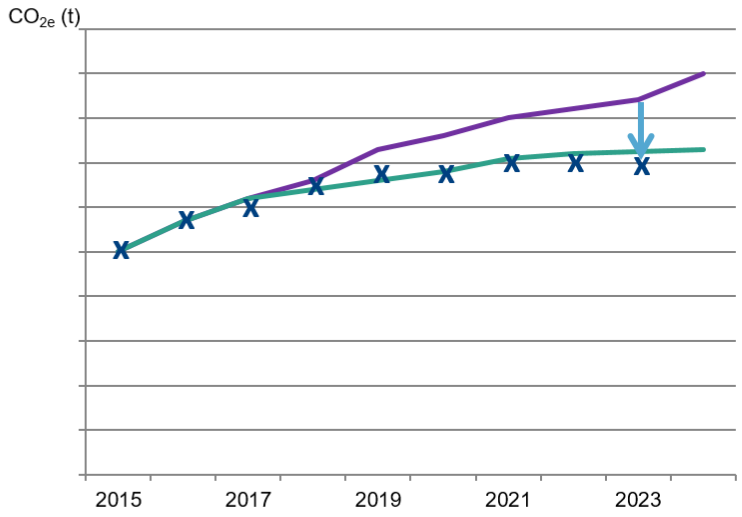


Figure 4: Comparison of real emissions (in year x) with the business-as-usual scenario (purple line) and the SUMP/NUMP scenario (green line)

In addition, the ex-ante SUMP scenario can be used for setting a GHG emission target (in CO2eq) for the target year of the SUMP. Transport related emissions from within the city territory (within the same boundaries as the SUMP) can then be tracked against the pathway to achieve this target. This allows monitoring whether cities are on track to meet their GHG emission reduction goal. The savings can be expressed in total tons CO2e per annum against the originally calculated baseline value in the respective year.

At the national level – in case a national urban mobility policy or programme (NUMP) incentivises SUMP development or implementation – the total GHG emission reductions (compared to the baseline) in all participating cities can be aggregated into the impact of the national policy or programme. In addition, countries interested in developing NUMPs may want to provide national average emission factors, average fleet composition or average annual mileages as default values for cities. This helps cities develop their own inventories and track emission reductions, and also ensures comparability across cities.

3.1. Definitions

Definition of the Transport Related GHG Emissions Indicator:

Yearly GHG emission reductions (in tCO2e) of a 'SUMP/NUMP scenario' against a 'without SUMP/NUMP scenario' (baseline).

System Boundary for GHG Emission Accounting

The GHG emission inventory for urban transport is the sum of all transport-related activities that can be attributed to the city. This attribution can follow different rationales (see Dünnebeil et al., 2012:23f and Box 3). The MobiliseYourCity Partnership follows a **territorial approach** since the city's territory reflects the political and administrative sphere of influence and facilitates the assessment of each city's SUMP. It includes emissions from inhabitants and visitors alike, and addresses all the local stakeholders that influence transport within the city's territory (inhabitants, employers, public services, industry, trade etc.) (IFEU, 2014).

The territorial approach is also recommended by other international guidelines, such as the **Global Protocol for Community-Scale Greenhouse Gas Emission Inventories** (WRI, 2014) or the **Covenant of Mayors**[2], and is therefore in line with state-of-the-art international best practice.

Box 3: System boundaries for emission accounting in urban transport and reasons for a territorial approach

Transport activities can be attributed to a monitoring area using different approaches. This has consequences for the informative value and the further use of the monitoring results. The most common system boundaries for monitoring urban transport emissions are:

1. Territorial: All transport activities of a means of transportation within the territory are covered. The territory can be defined in different ways, e.g. as the whole functional area of a city or city-governed districts only. With this approach, all transport activities within the political sphere of influence of municipal Government are covered. However, further differentiations (e.g. internal vs. origin/destination vs. transit traffic) can help understand the drivers of traffic flows and volumes and identify fields of action.

2. Inhabitants: All traffic related to city inhabitants is included, independent of the place where traffic occurs (e.g. including trips outside of the city or air travel). Contributions to traffic in the city from non-inhabitants (e.g. commuters, tourists, incoming freight transport) are not covered in this approach. Consequently, possible GHG emission reductions in commuter traffic or any other incoming transport are not covered in this monitoring system. At the same time, the inhabitants approach includes travel activities that cannot directly be influenced by municipal Government, such as long-distance travel.

[2] The Covenant of Mayors for Climate & Energy Initiative was launched in 2009. It brings together thousands of local and regional authorities who have voluntarily committed to implementing EU climate and energy objectives within their territory. http://www.covenantofmayors.eu/index_en.html

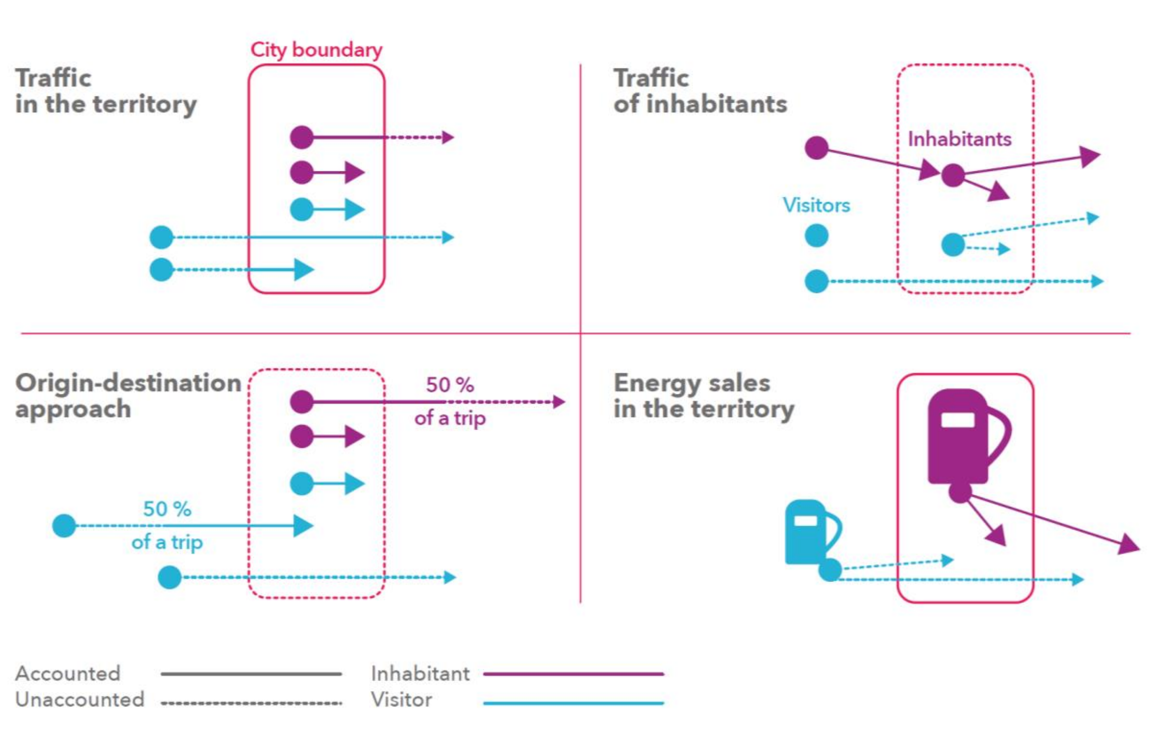


Figure 5: Different system boundaries for urban transport emission accounting

Figure source: IFEU Heidelberg, 2012

3. Origin-destination (OD) approach: All traffic with an origin and/or destination within the city's territory is covered (boundary-crossing traffic: 50% of long-distance trips is counted). This approach reflects urban transport activities very well, but it requires high levels of data availability that only a few cities are able to meet. Furthermore, it still includes 50% of long-distance trips, which city policies has no influence on. Transit traffic is not covered.

4. Energy sales: Emissions are calculated using a top-down approach based on statistics on fuel sales in the city. This approach only allows for a rough estimation since a purely sales-based approach does not provide any information on how much of the purchased fuel is actually used within the city. It also does not provide data on the actual transport activities that are related to the city, or their causes – information which is necessary for transport planning. Using energy sales data alone does not adequately monitor the effects of SUMPs, but it can be used to cross-check bottom-up calculations.

Source: Dünnebeil et al., 2012

In addition to the general approach to system boundary, several other parameters have to be decided on in order to fine-tune the accounting process, namely:

- Which **transport modes** are covered?
- Which **emissions/gases** are accounted for?
- What is the timeframe and **monitoring interval**?

Transport Modes

Ideally, **all motorised modes** (passenger and freight transport) are included in the emissions inventory. This helps paint a complete picture of the transport sector's emission profile in each territory. In reality, however, data may not be readily available for all modes. A pragmatic option is to begin with those modes that are relevant to the scope of the individual SUMP, i.e. those modes directly affected by the measures included in the SUMP. In most cases, this means disregarding aviation emissions (territorial boundary emissions only include take-offs and landings) and emissions of inland shipping if they are not affected by the SUMP and only make up a small share of transport and emissions. This of course depends on each city's specific context. If a city has an airport or a port within the city territory, these emissions could account for a significant portion of transport related emissions and a deliberate decision has to be taken whether or not to include them.

In addition, it is recommended to differentiate the emission profile for transport modes that are under the influence of local administrations (transport within the city boundary or with an origin/destination within the territory, including passenger and freight transport) and those that are hardly affected by local measures (transit traffic, public long-distance transport, such as bus, rail and aviation, as well as rail-bound and inland freight transport) (IFEU, 2014). Such a differentiation enables accounting all emissions in each territory, while highlighting those that are influenced by the SUMP and analysing their emission development separately. In this way, the complete emission profile can be reported, and the SUMP's achievements can be tracked.

Emissions

The MobiliseYourCity approach aims to account for CO2, CH4 and N2O in CO2-equivalents (see Box 4), including direct tailpipe emissions (tank-to-wheel) and upstream emissions that result from the production and transportation of fuels (well-to-tank). Direct tailpipe emissions and upstream emissions should be reported in separate figures and then aggregated. Accounting for upstream emissions ensures the comparability of conventional propulsion systems and electric vehicles (for which emissions only occur upstream), as well as other fuel switch options.

In addition to GHG emissions, black carbon emissions, a component of soot, which is released during diesel fuel combustion, may be monitored. Black carbon has a strong warming effect as well as disastrous impacts on local air quality and public health (see Box 4). Monitoring black carbon emissions can therefore be extremely useful for cities. Unfortunately, due to the complex interactions of black carbon in the atmosphere, its exact global warming potential is still subject to scientific uncertainties. Nonetheless, monitoring black carbon emission developments can help keep track of the order of magnitude and local air quality effects.

Box 4: Transport related emissions and their warming effect

GHG emissions and their global warming potential

GHGs emitted by transport mainly consist of carbon dioxide (CO2), in addition to small amounts of methane (CH4) and nitrous oxide (N2O). In order to compare the warming effects of different GHGs, the global warming potential (GWP) is used. The GWP relates the amount of heat trapped in the atmosphere by a particular GHG to the amount of heat trapped by a similar mass of CO2. In this way, the sum of all GHG emissions can then be indicated as CO2 equivalents.

The global warming potentials (for a time horizon of 100 years) of carbon dioxide, methane and nitrous oxide are as follows (IPCC, 2007):

CO2: 1 CH4: 25 N2O: 298

Black carbon (not calculated in MobiliseYourCity)

Black carbon – a component of soot – is released by burning biomass (wood stoves and biomass burning, as well as natural wildfires), coal and diesel fuels. It is an important component of particulate matter, contributing to air pollution and leading to respiratory diseases like asthma and lung cancer. The World Health Organisation estimates that outdoor air pollution led to 3.7 million premature deaths in the year 2012 alone, of which almost 90% occurred in low- and middle-income countries (WHO, 2014). A lesser known fact is that soot also has a strong warming effect on the climate. In fact, it is the second largest man-made contributor to climate change (Bond et al., 2013). Soot warms in two ways:

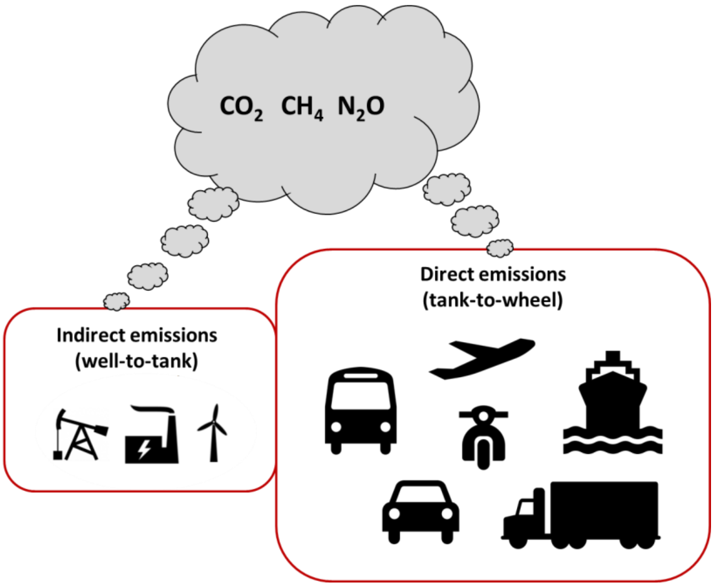
1. Particles in the air absorb sunlight, generating heat in the atmosphere.
2. Winds transport soot particles to the Arctic and the Himalayas, where they settle on ice and snow like a black blanket, stopping the reflection of sunlight. Instead, radiation is absorbed, accelerates the melting of the arctic ice sheet and the Himalayan glaciers, and further intensifies global warming.

In contrast to CO2, which stays in the atmosphere for centuries, black carbon only remains for several weeks. Abating black carbon therefore has a short- term effect on climate change and an immediate effect on local air quality. The main contributors to black carbon from the transport sector are diesel vehicles without particulate filters. This includes trucks, ships, rail, utility vehicles and construction machinery (Eckermann et al., 2015).

Calculating the exact effect of black carbon is a complex and scientifically contested issue. MobiliseYourCity does not require an assessment of black carbon warming effects. It may however be of interest to cities that wish to account for particulate matter out of air quality considerations. In this case, the number of PM can also give an order of magnitude indication to the development of black carbon emissions.

Upstream and downstream emissions from vehicle production are not accounted for since they are small compared to transport related emissions.

The inventory also does not account for construction emissions from major infrastructure projects, such as metros or highways. Metro construction emissions are, however, significant and should be considered in the emission reduction calculations. This is usually done in the form of an ex-ante estimation to get an idea of the total emissions, but it is not monitored during construction in an attempt to keep the data requirements low. Whether or not construction emissions are included in emission reporting is decided on a case-by-case basis. If construction is considered in the accounting system, then it also has to be included in the baseline emission calculations.



Source: Own illustration, adapted from IFEU, 2013[3]

Figure 6: Transport modes and emissions included in the GHG monitoring (ideal case)

Timeframe

MobiliseYourCity suggests a GHG monitoring interval of 1-3 years. For ex-ante emission reduction scenarios, the timeframe has to be adopted to fit into the SUMP's planning cycle. Assuming that the implementation of a SUMP will take approximately 10 years, the minimum time span for the monitoring and reporting system should also be ten years.

In order to harmonise reporting, estimated emission reductions should therefore be reported in accumulated form for every 10-year period, and as the average annual reduction over a 10-year reporting period. However, since the full benefits will not be apparent until the SUMP measures have been implemented, annual emission reduction benefits will increase over time. This means that a longer assessment period, e.g. 20 years, will show larger effects.

In order to provide data that are aggregable at the level of the MobiliseYourCity Partnership, it is required to provide data for the milestone years 2030 and 2050.

[3] Icons created by Viktor Vorobyev, Matthew Hall, Ricardo Ruíz, Edward Boatman, Creative Stall, lastspark from Noun Project https://thenounproject.com/

Once all of the above parameters have been decided upon, the system boundary for monitoring is set. The boundary will always be a compromise between as close a representation of the territorial emission profile as possible and the extent of locally available data and resources. Finding this compromise is a key challenge for good inventories. Often, data needs to be combined from various data sources and data needs to be analysed and processed to meet the defined boundaries.

3.2. Calculation & Aggregation

Calculation

The total transport related GHG emissions depend upon several parameters: Transport demand (travel activity by mode), respective specific energy consumption per mode per travel activity, and specific GHG conversion factor per energy carrier per mode. The emission inventory for the transport sector is calculated using a bottom-up approach that is based on the ASIF framework as described in Figure 7.

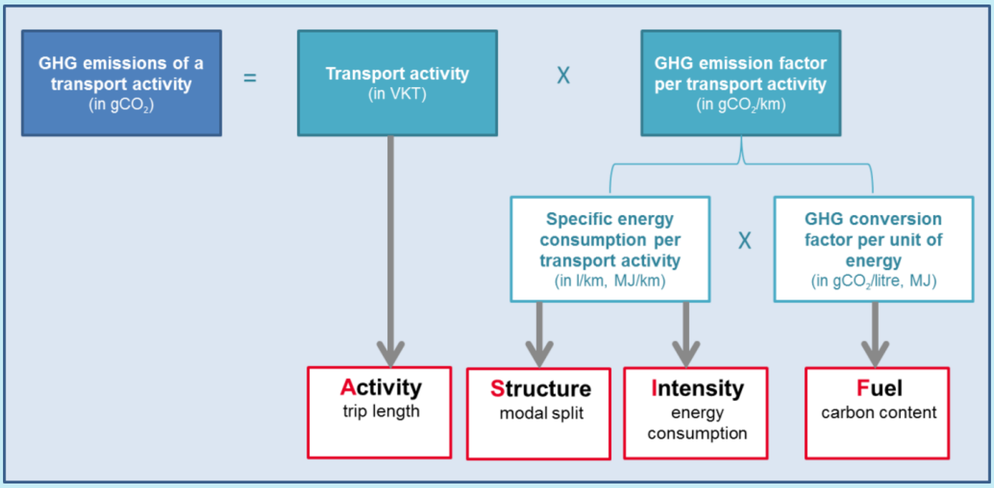


Figure 7: ASIF Framework for the calculation of transport emissions

Ideally, the values for the parameters should be adapted to city-specific circumstances to calculate local transport GHG emission inventories. However, the availability of data and resources for data collection usually does not permit such a level of detail/local adaptation. At the same time, not all parameters are equally dependent on local contexts. For instance, travel activity and modal split usually vary greatly from city to city, depending on their size and level of urbanisation, as well as geographic, economic, and demographic aspects. In contrast, the carbon content of fuels lies outside of the influence of cities, which means that national default factors or even IPCC default values can be used (IFEU, 2014).

The calculation approach must also account for local capacities. Depending on local data availability and resources, inventories can be based on simple calculations and more aggregated data, or on more advanced modelling approaches that allow for emissions from different sources to be monitored in great detail.

In principle, the inventory approach presented here also facilitates the calculation of local air pollutant emissions. However, this requires more information on vehicle characteristics than the calculation of GHG emissions. It is, therefore, more relevant in cities with good data availability.

Box 5: MobiliseYourCity Emission Calculator

The **MobiliseYourCity Emission Calculator**, developed in partnership with the Institute for Energy and Climate Research Heidelberg (ifeu), is a tailored calculation tool for this GHG emissions indicator. Both the tool and the tool's user manual are available online at MobiliseYourCity.net from May 2020.

The MYC Emissions Calculator aims at helping developing countries and cities to calculate transport GHG emissions for a reference year and business-as-usual scenario (BAU) as well as a climate scenario with emission reductions from mitigation measures – the so-called climate scenario. As a result, the tool provides data on the calculated transport demand, energy consumption and GHG emissions. These data give an overview of the relevance of each transport mode regarding the total GHG emissions within the defined territory. It also enables users to quantify and monitor the impact of a bundle of mitigation actions according to the "ASIF" methodology (Avoid, Shift, Improve and Fuel – see for more details the **Monitoring and reporting approach for GHG emissions** (MobiliseYourCity 2017)). This tool does not aim at calculating the impact of individual mitigation actions. For example, the impact of all measures concerning "avoiding" traffic i.e. reduce the need to travel such as home office, removing parking lots, toll systems etc. must be assessed together per designated year e.g. 2020 and 2030. For example, the results of this bundle of measures may be result in a reduction of 2% of car traffic and 3% of delivery truck (both in km). These data are the input required in the climate scenario input sheet.

GHG emissions of a transport activity = **Transport demand** x **Specific energy consumption** x **Specific GHG emission factor**

Bottom-up calculation methodology for transport GHG-emissions

Time Series

Once the GHG emissions of the base year have been obtained, its progress against the target GHG emissions can be monitored in regular intervals. It is therefore required that the SUMP/NUMP provides a robust business as usual scenario against which progress can be observed.

Partnership level aggregation

The MobiliseYourCity Partnership reports both on projected and actual GHG emission reductions.

For projected reduction of GHG emissions, the indicator is the sum of projected yearly emissions reduction in the target years 2030 and 2050, expressed tCO_2eq, against a business-as-usual scenario.

For actual reduction, the indicator is the sum of differences between actual yearly emissions and business-as-usual scenario values.

3.3. Data Availability & Collection

As shown above (Figure 7), the calculation of transport related emissions requires information on each transport mode included in the monitoring boundary and specific GHG emission factors (in gCO_2e per km), which depend on the type of vehicle, as well as fuel consumption and fuel type, i.e. fleet composition. The data collection process for these parameters is explained in the following chapters.

Monitoring Transport by Mode

Transport data has to be collected and determined at city level. National averages do not enable an evaluation of SUMP progress. Typical sources of transport data are summarised in Table 2. If transport data is not yet routinely collected and available from official statistics, a number of options for low-effort data collection exist (cf. Table 3). One of the most common approaches to data collection for private road transport is traffic counts, which should be differentiated according to road type (inner-city road, urban roads and highways) (see Monitoring Greenhouse Gas Emissions of Transport Activities in Chinese Cities – A Step-by-Step Guide to Data Collection, Section 2.1.2).

In addition to assessing transport in general in each territory, transit traffic has to be estimated separately. This is important to distinguish from other types of transport since urban transport policy has – in most cases –little influence over transit traffic.

Cities with travel demand models that are frequently updated can extract transport data from the model by multiplying traffic flow data with the length of the road network. In this case, it is important to compare the geographic boundary of the travel demand model to the assessment territory since some models only cover city centres.

Once transport by mode is known, this needs to be multiplied with the correct emission factors to calculate the urban transport emission inventory. In order to choose the right emission factors, information on the composition of the vehicle fleet is required.

Monitoring Fleet Composition

The composition of a city-specific vehicle fleet strongly influences local transport emissions. The more private cars are on the road and the larger or older the vehicles are, the higher their fuel consumption is and the higher the related GHG emissions are. In other words, GHG emissions depend on the vehicle fleet and on the distribution of VKT across the fleet’s vehicle mix.

Data on the vehicle fleet is generally available from vehicle registration statistics for passenger cars, taxis, trucks, and motorcycles (e-bikes are mostly excluded), which includes technical specifications for the different vehicle types. Once the registered fleet is documented for the base year, e.g. 2015, only newly registered (and deregistered) vehicles have to be monitored each year.

If there are no big differences in the fleet compositions across different cities in a country, using national averages for urban fleet composition may be considered. Where the fleet is known to be quite specific, however, these local characteristics should be accounted for, e.g. prosperous metropolitan areas may have a larger number of new and larger cars than less prosperous mid-sized cities with a smaller but older fleet.

Table 2: Data sources for vehicle fleet composition in cities

Data source	Means of transportation	Type of data	System boundaries	Fleet composition	Traffic situation
Vehicle registration statistics	■ Passenger cars ■ Taxis ■ Trucks ■ Motorcycles (usually no e-bikes)	Vehicle stock by technical characteristics	Inhabitants (= owners of registered vehicles)	Yes, but only for stock, not for VKT	No

Table 3: Data sources for transport in cities

Data source	Means of transportation	Type of data	System boundaries	Fleet composition	Traffic situation
Trip survey (households or companies)	■ Passenger cars ■ Motorcycles ■ Taxi ■ Buses ■ Subway ■ Regional train	Per person: ■ Pkm* * For cars differentiated into driver, co-driver, with chauffeur	Inhabitants	Optional (depending on configuration of the survey)	No
Vehicle activity survey	■ Passenger cars ■ Taxis ■ Motorcycles ■ Trucks	Per vehicle: - VKT or - Number of trips & distances	Inhabitants (= owners of the vehicles)	Optional: Depending on configuration of the survey	No (only if survey includes floating car data
Main inspection data	■ Passenger cars ■ Taxis ■ Trucks	Per car: - VKT from odometer	Inhabitants (owners of the vehicles)	Yes	No
Taximeter information	■ Taxis	Per taxi: - VKT or - Number of trips & trip distances	Territorial: Cruising radius of local taxi fleet (territory might differ to geographical boundaries of the city)	Optional: only if analysed taxis are representative of the entire taxi fleet	No

Data source	Means of transportation	Type of data	System boundaries	Fleet composition	Traffic situation
Floating car data (GPS)	■ -Passenger cars ■ -Taxis ■ -Buses ■ -(Trucks)	Per vehicle: - VKT for single vehicle in analysed time period Extrapolation to total VKT only if analysed vehicles and time period are representative of fleet	Inhabitants (= owners of the vehicles)	Optional: only if analysed vehicles are representative of entire fleet	Yes: Conversion to HBEFA traffic situations is only possible with linkage to GIS data on the road network
Traffic counting with on-road sensors	■ Passenger cars ■ Taxis ■ Buses ■ Motorcycles ■ Trucks	Traffic volumes for analysed road section	Territorial: can be used as basis for calculating travel activity based on street lengths and for calibrating traffic model and estimating VKT development	No	Optional: Some road sensors provide information on vehicle speed
Video monitoring on selected road sections	■ Passenger cars ■ Taxis ■ Buses ■ Motorcycles ■ Trucks	Traffic volume for analysed road section	Territorial: can be used as basis for calculating travel activity based on street lengths for territorial VKT of a city and for calibrating traffic model and updating VKT data	Optional: Licence plate survey and matching with vehicle registration statistics	No
Public transport companies	■ Bus ■ Subway ■ Regional train	For the entire public transport network or for different routes: - Final energy consumption - VKT - Pkm - Transport capacity - Load factors	Territorial: public transport network might differ to geographical boundaries of the city	Optional: - Bus per engine type (and size) - Train per traction	No

Data source	Means of transportation	Type of data	System boundaries	Fleet composition	Traffic situation
Public transport network plans	■ Bus ■ Subway ■ Regional train	Length of each public transport route	Territorial: public transport network might differ to geo-graphical boundaries of the city	No	No
Public transport timetables	■ Bus ■ Subway ■ Regional train	Service frequency of each public transport route (e.g. number of buses per day)	Territorial: public transport network might differ to geo-graphical boundaries of the city	No	No
IC cards	■ Bus ■ Subway	■ Number of passenger trips ■ Pkm (only subway)	Territorial: public transport network might differ to geo-graphical boundaries of the city	No	No
Car hailing apps	■ Taxi	■ Number of passenger trips ■ Pkm	Territorial: public transport network might differ to geo-graphical boundaries of the city	No	No

Selection of Emission Factors

Specific GHG emission factors (CO_2, CH_4, N_2O in gCO_2e/km) apply according to the different transport characteristics. The accuracy of emission factors greatly affects the overall emission calculations.

At vehicle level, the specific energy consumption per kilometre travelled depends on technical parameters and operating conditions. In road transport, considerable differences in energy consumption and related GHG emission factors per kilometre are caused by:

- Different vehicle characteristics, such as engine type, engine capacity, vehicle age and, to a lesser extent, the emission concept (such as Euro 1-6). As emission standards are phased in over time, data on emission concepts can be used as a proxy indicator for vehicle age (based on fleet composition).
- Different traffic characteristics, especially speed, traffic quality and road gradients. These depend primarily on transport infrastructure and traffic volumes, but also on other conditions, such as traffic lights or weather conditions.

Emission factors range from highly disaggregated factors, e.g. specific emission factors for each passenger car differentiated by vehicle size, age, and emission class (e.g. EUR 4), to averaged emission factors, e.g. only one average emission factor for all buses. If average emission factors are used, these should ideally be derived from detailed factors that are aggregated based on average fleet compositions and average driving situations.

Since the many factors that influence fuel consumption vary significantly from country to country, country-specific emission factors are required. Using international default values introduces high uncertainties into emissions calculations, which is not recommended since it does not reflect country-specific circumstances. In addition, improvements that affect emission factors, such as changes in vehicle fleets or improvements in driving conditions, cannot be reflected in emissions calculations if international defaults are used.

Several countries already have national average emission factors based on average national fleet compositions (how many vehicles of a certain size (engine capacity), age and fuel type per vehicle category), average driving conditions on different road types, and ideally also upstream emissions of fuels. If emission factors are only available for tank-to-wheel emissions, a correction factor for upstream emissions can be applied.

If official national emission factors exist, cities must decide whether it is appropriate and sufficient to work with national defaults or whether city-specific adaptations to emission factors are required. This can depend on several factors:

1. Which measures are covered by the SUMP? Can their effects be reflected in national average values or not?
2. Does the local context vary significantly to the national average, e.g. due to a wealthier population in the capital, which affects the fleet composition (e.g. higher number of larger cars)?

For instance, if the national average emission factors are based on an average fleet composition, efficiency improvements in the local municipal fleet will not show up in the city-specific emission calculations. This can also affect public transport fleets. Similarly, if larger cities are interested in traffic flow measures and their effects, local data on driving conditions, such as congestion reduction measures, will need to be collected. This is possible in cities where travel demand models and differentiated emission factors exist, e.g. the Chinese city of Shenzhen.

If no country-specific emission factors exist, international (or possibly regional) default values can be used as a fall-back option, especially for ex-ante calculations. However, MobiliseYourCity recommends striving towards the adaptation of emission factors that are country-specific in order to ensure accurate monitoring. MobiliseYourCity can provide support for this process to participating cities.

Furthermore, it is suggested that emission factors should be differentiated by fuel type within each vehicle category.

Step by Step Approach to GHG Monitoring and Reporting

The previous sections set out the MobiliseYourCity's approach to GHG monitoring and reporting. They also highlighted how these principles fit into the broader monitoring framework, including sustainable mobility and implementation indicators. A rough impact assessment should already be conducted initially to identify each SUMP's emission reduction potential. The following checklist sums up the key elements of a successful Monitoring, Reporting and Verification process during the development and implementation of SUMPs.

Table 4: Monitoring and Reporting Checklist

Checklist Monitoring and Reporting (M+R)	✓
SUMP Step 1: Getting ready to start	
The needs for external support on M+R are assessed	
A budget for M+R is set	
SUMP Step 2: Diagnosis & scenarios	
Transport data availability is checked, and available data collected	
Baseline scenario for transport emission development is calculated and assumptions are agreed upon among relevant stakeholders	
SUMP Step 3: Goal setting and action plan development	
Expected effects of the planned SUMP and actions are described (cause-effect relation/logical framework)	
Scope of the monitoring approach is set (assessment boundaries)	
GHG impact of the SUMP has been calculated ex-ante	
Limitations of the GHG emission quantification are described (uncertainties)	
Sustainable mobility benefits have been assessed ex-ante	
SUMP Step 4: Validation of the action plan	
If necessary, adjust the ex-ante GHG impact calculation to the validated action plan for the SUMP	
Data needs and collection methods have been identified and agreed by relevant stakeholders	

Checklist Monitoring and Reporting (M+R)	✓
Responsibilities for M+R have been assigned	
Precise budget for M+R has been confirmed	
A monitoring plan and procedures have been developed, including quality assurance	
SUMP Step 5: Implementation and monitoring	
Data is collected, processed and quality controlled continuously	
Emission inventory is calculated every 1-3 years	
The baseline scenario is recalculated ex-post and emission reductions are assessed every 1-3 years	
Supporting information to verify the GHG impact can be provided annually Sustainable mobility report is produced every 5 years (mid-term assessment)	

In reality, this process must be adapted to local circumstances and decision-making processes. As a result, timing may vary from city to city.

Data collection and management, as well as emission calculations, are iterative processes that can be improved over time as data availability increases. To ensure consistency and transparency in emission reporting it is important to clearly document all data sources, definitions, and assumptions. If done correctly, monitoring and reporting can greatly improve the information basis for transport planning and vice versa. Most of the data needed for emission calculations must also be collected as part of the development of a sound SUMP. At the same time, monitoring reports can be used to communicate progress, highlight the impacts of SUMP implementation, and help secure ongoing support from stake-holders.

4. Impact Indicator 2: Access to Public Transport

Measuring the provision of high-quality access to public transport, the backbone mode of sustainable urban mobility, is the second main impact indicator of the MobiliseYourCity Partnership. It is also adopted by United Nations Statistical Commission to monitor SDG target 11.2: *By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all […]*.

SDG target indicator 11.2.1 is defined as: *Proportion of population that has convenient access to public transport, by sex, age, and persons with disabilities* (UNSD, 2018). While we strongly encourage to strive for the provision of such disaggregated information, to fulfil MobiliseYourCity's monitoring and reporting requirements for this indicator, we do not request disaggregated data as defined by the UN.

This indicator serves as a means to understand how strongly the public transport system enables economic and social inclusion by providing access to the highest share of population possible. It shall offer decision makers a solid base of evidence for the evaluation of the successful integration of land-use planning with transport planning and give priority to making cities more compact and walkable, putting moving people first.

The following chapter offers guidance regarding MobiliseYourCity's recommended minimum requirements concerning this indicator. As data availability and quality differs widely across our Partner Cities, adhering to these requirements will enable cross-city comparison and the coherent monitoring of improvements over time.

4.1. Definitions

Definition of the Access to Public Transport Indicator:

Both absolute value of the indicator and value relative to the population are to be reported.

Proportion of the population living within 500 meters or less (birds'-eye distance) of a public transport stop with a minimum average 20-minute service in any direction during peak hours (European Commission, 2015), in a SUMP scenario by 2030.

Number of additional people living within 500 meters or less of a public transport stop with a minimum 20 minute service in any direction during peak hours, or have access to a shared mobility system with comparable service for money, in a SUMP scenario by 2030.

Specifications of the 500 m buffer circles:

Each 500 m buffer circle corresponds to 0.785 km^2 of land. The covered area is assumed to be homogenous (UNESCAP, 2017). Physical barriers do not have to be accounted for.

Definition of public transport:

Public transport (PT) includes public bus, bus rapid transit (BRT), tram, rail, scheduled ferry, and similar types of formal transport. It does not include taxi or informal paratransit (auto-rickshaw, irregularly operating mini-busses/tuk-tuk/matatus, etc.).

However, informal collective transport, particularly minibus transport, may be considered for this indicator as PT, if most of the main characteristics are met, defining the purpose of the indicator. These particularly include the following:

- Sufficiently reliable timetable, regular line service
- High service frequency, at least once every 20 minutes between during peak hours
- Demarcated stations or high degree of reliability regarding proven pick-up points
- Operating throughout all working days a week
- Enough capacity of vehicles to meet demand during peak hours
- Quality of service meets minimum standards with respect to safety and comfort
- Being "collective transport" (e.g. each vehicle has sufficient capacity to carry at least 8 passengers in addition to the driver).

4.2. Calculation & Aggregation

Calculation

$$\%\ \boldsymbol{with\ Access\ to\ PT} = 100 * \left(\frac{\sum Population\ within\ 500\ m\ buffer\ circles}{Total\ population\ in\ the\ covered\ aera}\right)$$

Time series

Once the access to public transport of the base year has been obtained, its progress against the target share of access to public transport can be monitored in regular intervals. It is therefore required that the SUMP/NUMP provides a robust business as usual scenario against which progress can be observed. Table 5 offers orientation regarding data collection requirements on the city level.

Disaggregation by population categories

Disaggregation of the population counts is not required but encouraged. If possible, the following category should be used.

- Gender
  - Female
  - Male
  - Other/Unknown
- Age group
- Disabilities

Partnership level aggregation

Aggregated impact is reported at the MobiliseYourCity Partnership level through two aggregated indicators:

- Aggregation of the number of Partner Cities that project to improve the access to public transport shares by certain proportion of the total population (by up to 3 additional % points, 3-5 additional % points, 5-10 additional % points, 10-20 additional % points, over 20 additional % points
- Aggregation of the total number of additional people having access to public transport.

Table 5 Input table example for Impact Indicator 2: Access to Public Transport

	A	B	C	D
1	**Impact Indicator 2: Access to Public Transport (advanced calculation)**			
2	Definition			
3	The proportion of the population living within 500 meters or less (birds'-eye distance) of a public transport stop with a minimum average 20 minutes service in any direction between 6:00 and 20:00 (European Commission, 2015, p. 12).			
4	Reporting period (dd.mm.yyyy)			
5				
6	**General description of and links to material used to collect and derive this indicator**			
7	*Please list all sources here. Clearly indicate to which cell(s) any source pertains.*			
8				
9	*please add as many rows as necessary.*			
10				
11	**Proposed table to calculate this indicator**			
12				
13	Public transport stop (bus, tram, metro, etc.) 1	Average number of departures per hour between 6:00am-8:00pm on a normal work day (at least three per hour needed to qualify)	Specific population density (inh./km2)	Population with access to public transport
14	**Rail Line A (example)**			
15	StopA1(example)			-
16	StopA2			-
17	StopA3			-
18	**BRT Line B**			
19	StopB1			-
20	StopB2			-
21	StopB3			-
22	**BUS line C**			
23	StopC1			-
24	StopC2			-
25	StopC3			-
26	StopC4			-
27	StopC5			-
28	StopC6			-
29	**Sum of population with access to public transport**			0.00
30				
31	**Total population**			
32				
33	**Share of population with access within 500m buffers**			#DIV/0!
34				
35	**Any basic data, calculations, or additional observations**			
36				
37	*please add as many rows as necessary.*			
38				
39				

4.3. Data Availability & Collection

The method to estimate the proportion of the population that has access to PT is based on the following steps:

1. Demarcation of the relevant built-up area
2. Inventory of the public transport stops in the area
3. Estimation of the population with access to PT in the area (UN-HABITAT, 2016)

Step 1 – demarcation of the relevant area

The demarcation of the relevant built-up area must be clearly defined and should be determined by the respective SUMP/NUMP. The final area, however, should be aligned with census enumeration areas that are being used, to make sure that the built-up area matches the demographic data available (UNSD, 2016). UN-HABITAT (2016) provides useful information on how to systematically define city boundaries.

Step 2 – Inventory of public transport stops

To compile the list of eligible public transport stations, obtaining a station database, which indicates stop intervals at each station is necessary. This will typically require consultation with a public transport authority or operator. If it does not exist already, a specific database including all stops and the calculated average frequency per stop may have to be created. The average interval at any station is given by taking all arrivals and departures into account (UNESCAP, 2017). Following the lead of the European Commission, and to ensure better comparability of the compiled data within the MobiliseYourCity Partnership, please consider stops that are located within 50 meters from one another as one cluster of stops and treat it as one station.

In case that the public transport authority or operator is incapable of providing an appropriate map/database, https://www.openstreetmap.org may be consulted to obtain the required information. OpenStreetMap is open source and available across a broad range of geographies around the globe. While there are some flaws in the data because it is crowdsourced, the street network is fairly comprehensive for most large cities around the world; there can be some missing sections in smaller cities in lower-income countries, though (ITDP, 2019). Another source for open maps and mobility data is the website https://www.transitfeeds.com, which has, for instance, been used for the development of ITDP's People Near Transit publication (2016).

Step 3 – Estimation of the population with access to public transport

To calculate the number of inhabitants living in buffer zones within a 500-meter radius of each selected PT station, data may be obtained e.g. via a local census or a population registry at neighbourhood level (UNESCAP, 2017). The percentage of people living within the service areas can be calculated most accurately by using spatial data (GIS) using the Buffer Wizard (e.g. with the software ArcGIS and ArcView). The Buffer Wizard allows rings to be drawn around features (points, lines, or polygons) at a specified distance from that feature. To use the Buffer Wizard, the map must have defined units; otherwise the buffers cannot be processed. The necessary data are two different shape files, one with public transport stops and one with the population density (WBCSD, 2015).

If detailed population data by area is not available it may be necessary to divide the city into area categories and prescribe uniform average population density figures to each zone (UNESCAP, 2017). In some cases, open sources, and community-based maps, which are increasingly recognized as a valid source of information, can be a viable alternative to information from city administrations or service providers (UNSD, 2016). Examples include http://www.digitalmatatus.com/about.html, https://www.whereismytransport.com/ and https://www.worldpop.org, who partners with mobile phone operators to gain insight on mobility patterns and makes those datasets freely available.

Avoiding double counting of population in case of zone overlaps is possible if GIS data is available. This can be done using the ArcGIS intersect tool with the ratio policy of the census data layer turned on for the population field. The resulting file is then summed to find the total number of people in the service area.

The ratio policy is used so that if only a portion of the census tract is within the service area, only a portion of that census tract's population will be counted. For example, if a census tract has 100 people living in it and 43 percent of the census tract is within the service area, only 43 people will be counted as living within the service area. This allows for a better estimate for the indicator (ITDP, 2019).

Finally, the populations in all buffer zones are added and the share of inhabitants living in the buffer zones as a share of the total population is calculated, as defined in chapter 4.2.

5. Impact Indicator 3: Road Safety

This indicator refers to SDG target 3.6: *By 2020, halve the number of global deaths and injuries from road traffic accidents*. SDG target indicator 3.6.1 is defined as: *Death rate due to road traffic injuries* (UNSD, 2018).

The focus on data on traffic fatalities stems from the fact that this data is generally more reliable and available than data on injuries (UNESCAP, 2017). Injury data is mostly not comparable across cities, as neither the sources of data, nor injury definitions are usually consistent between cities (ITF, 2018; ITF 2019).

General caveats that have to be kept in mind regarding this indicator include the following: A dataset restricted to fatalities alone suffers from limited statistical significance due to the variability of small numbers. Hence, one could argue that fatality statistics only capture a fraction of the actual road safety situation (ITF, 2018). Furthermore, in a context of expanding road networks and traffic, such as in many lower middle income countries (LMICs), an increase in the number of road traffic deaths per 100,000 may only reflect the fact that more individuals have become exposed to this risk. (UNSDSN, 2015).

Nevertheless, the indicator can give some important insights into traffic safety and, as mentioned above, is adopted by the UN. Overall, the objective for this indicator has to be, to decrease the total number of fatalities among pedestrians and cyclists, while increasing their modal share.[4]

5.1. Definitions

Definition of the Road Safety Indicator:

Traffic fatalities by all transport accidents (road, rail, etc.) in the urban area covered by the SUMP, per 100.000 inhabitants, per year.

Definition of a traffic fatality:

The international definition for a death related to traffic / a traffic fatality, as adopted by the Vienna Convention in 1968, is “A human casualty who dies within 30 days after the collision due to injuries received in the crash.” (WBCSD, 2015).

5.2. Calculation & Aggregation

Calculation

$$Fatality\ rate\ =\ 100\ 000 * \left(\frac{\sum Traffic\ fatalities}{Total\ population}\right)$$

[4] http://sum4all.org/global-tracking-framework

Time series

Once the fatality rate of the base year has been obtained, its progress against the target reduction can be monitored in regular intervals. It is therefore required that the SUMP/NUMP provides a robust business as usual scenario against which progress can be observed. Table 6 offers orientation regarding data collection requirements on the city level.

Disaggregation by transport mode

Disaggregation of fatalities by transport mode of the victim is encouraged, but not required. If possible, the following category should be used.

- Scooter/moped;
- Motorcycle;
- Cars;
- Taxi;
- Bus;
- Large Goods Vehicle under 3.5 tons;
- Trucks or Heavy Goods Vehicle over 3.5 tons;
- Railway, train, metro, tram or light rail;
- Ferryboats;
- Bicycle including e-bikes;
- Pedestrian;
- Other non-motorised;
- Other motorised;
- Unknown.

Disaggregation by population categories

Disaggregation of the population counts is not required but encouraged. If possible, the following category should be used.

- Gender
    - Female
    - Male
    - Other/Unknown
- Age group
- Disabilities

Partnership level aggregation

The road safety indicator at the Partnership level is the aggregated number of partner cities that achieve a projected reduction of their respective fatality rates included in the following ranges.

- 0 -5 less deaths/ 100.000;
- 5-10 less deaths/ 100.000;
- 10-15 less deaths/ 100.000;

Over 15 less deaths/ 100.000; Table 6 Input table example for Impact Indicator 3: Road Safety

	A	B
1	**Impact Indicator 3: Road Safety**	
2	Definition	
3	Traffic fatalities by all transport accidents (road, rail, etc.) in the urban area covered by a SUMP, per 100.000 inhabitants, per year (MYC MRV Publication, SUMI Indicator 5).	
4	Reporting period (mm.yyyy - mm.yyyy)	
5		
6	General description of and links to material used to collect and derive this indicator	
7	*Please list all sources here. Clearly indicate to which cell(s) any source pertains.*	
8		
9	*please add as many rows as necessary.*	
10		
11	Proposed table to calculate this indicator	
12		
13	Transport mode (passenger or driver)	Number of fatalities during reporting period
14	Scooter/moped	
15	Motorcycle	
16	Cars (including taxi)	
17	Bus	
18	LGV (<3.5 tons)	
19	HGV - Trucks (≥3.5 tons)	
20	Train, metro, tram, lightrail	
21	Ferryboats	
22	Bicycle (including e-bikes)	
23	Pedestrian	
24	Other	
25	Unknown	
26	**Total number of fatalities**	0
27	**Total population**	
28	**Fatalities/100,000 inh.**	#DIV/0!
29		
30	Any basic data, calculations, or additional observations	
31		
32	*please add as many rows as necessary.*	
33		
34		
35		
36		

5.3. Data Availability & Collection

Traffic fatalities are generally relatively well reported in police and hospital statistics. In many countries the police reporting will include a registration of the location of the accident, including within which jurisdiction or city it has occurred (ITF, 2018; UNESCAP, 2017). The task for this indicator will therefore be to access the relevant published data or databases and extract data on the number of fatalities that have occurred within the area covered by the SUMP each year, and then calculate the fatality rate.

Ideally, this impact indicator shall be disaggregated by mode of transport. This would be in line with the World Health Organization (WHO), which tracks deaths of pedestrians, cyclists, drivers of 4-wheeled vehicles, drivers of 2- or 3- wheeled motorized vehicles, etc. in a disaggregated manner (UNSDSN, 2015).

According to the WHO, it is rare that official police statistics and health institution data on traffic accidents can be integrated successfully, even in high income countries. One might even be confronted with separate systems and databases for fatalities in road versus rail in the respective countries. The police may for example not have the responsibility to collect and report data for rail fatalities. In the 'worst case' where data for other modes are not available, the road fatalities may be used alone, as these would often comprise by far the largest element, and one the city should be able to target in its policies (UNESCAP, 2017).

6. Impact Indicator 4: Air Pollution

This indicator refers to SDG target 11.6: B*y 2030 reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality, municipal and other waste management.* SDG target indicator 11.6.2 is defined as: *Annual mean levels of fine particulate matter (e.g. $PM_{2.5}$ and PM_{10}) in cities (population weighted)* (UNSD, 2018).

Air pollution consists of many pollutants, among other fine particulate matter. These particles are able to penetrate deeply into the respiratory tract and therefore constitute a risk for health by increasing mortality from respiratory infections and diseases, lung cancer, and selected cardiovascular diseases. According to the Sustainable Development Goals Report 2018, 90% of urban dwellers worldwide are breathing unsafe air, resulting in millions of deaths (WHO, 2016; UNSD, 2018).

PM_{10} is the concentration of particles with a diameter equal to or less than 10 microns (μ), which are usually produced from construction and mechanical activities, while $PM_{2.5}$ is a subset of PM_{10} and refers to the concentration of particles with a diameter equal to or less than 2.5 microns, usually produced from combustion. These smaller particles are actually more damaging as they permeate the lung more deeply (UNSDSN, 2015). In the context of impact indicator 4 on air pollution, the MobiliseYourCity monitoring framework focuses on mean $PM_{2.5}$ concentrations, as those are emitted by activities of urban mobility (combustion), which are most likely to be impacted by a SUMP.

As mentioned in the chapter on Impact Indicator 1 (Transport Related GHG Emissions), it is not mandatory for Beneficiary Partners to report on the Air Pollution indicator in case no road based air pollution monitoring system is in place prior to the inception of the SUMP/NUMP. Even if the Air Pollution indicator can be measured, it is not required to provide a population weighted measurement as defined by the UN.

6.1. Definitions

Definition of the Air Pollution Indicator:

Mean annual urban air pollution of fine particulate matter (in μg $PM_{2.5}$) at road-based monitoring stations within the area covered by the SUMP.

WHO air quality guidelines (WHO, 2005):

$PM_{2.5}$	10 μg/m³ annual mean 25 μg/m³ 24-hour mean
PM_{10}	20 μg/m³ annual mean 50 μg/m³ 24-hour mean

Appropriate location of road-based monitoring stations:

In line with the EU Commission's Directive 2015/1480, a road based monitoring station (inlet sampling probe) has to fulfil the following criteria:

- the flow around the inlet sampling probe shall be unrestricted (in general free in an arc of at least 270° or 180° for sampling points at the building line) without any obstructions affecting the airflow in the vicinity of the inlet (normally some metres away from buildings, balconies, trees and other obstacles and at least 0.5 m from the nearest building in the case of sampling points representing air quality at the building line)
- in general, the inlet sampling point shall be between 1.5 m and 4 m above the ground. Higher siting may also be appropriate if the station is representative of a large area and any derogations should be fully documented
- for all pollutants, traffic-orientated sampling probes shall be at least 25 m from the edge of major junctions and no more than 10 m from the kerbside. A "major junction" to be considered here is a junction which interrupts the traffic flow and causes different emissions (stop & go) from the rest of the road.

For reasons of long-term comparability and the observation of trends, road based monitoring stations, which had been installed previous to the development of the SUMP and do not fulfil these criteria at all or only to some extent, do not have to be relocated. In this case, however, please document any deviation from the criteria listed above.

6.2. Calculation & Aggregation

Calculation

$$Mean\ annual\ urban\ air\ pollution\ = \frac{\sum Mean\ annual\ air\ pollution\ at\ station\ n}{Total\ number\ of\ stations\ within\ the\ area\ covered\ by\ the\ SUMP}$$

Time series

Once the mean annual urban air pollution of the base year has been obtained, its progress against the target mean can be monitored in regular intervals. It is therefore required that the SUMP/NUMP provides a robust business as usual scenario against which progress can be observed. Table 7 offers orientation regarding data collection requirements on the city level. Templates for each MobiliseYourCity Impact Indicator can be accessed via separate excel sheets. Please contact your MobiliseYourCity counterpart for further information.

Aggregation

The indicator at the partnership level is the aggregated number of Partner Cities that achieve a mean urban air pollution level that lies within the boundaries of the WHO guidelines (i.e.: less than or equal to 10 µg/m³).

Table 7 Input table example for Impact Indicator 4: Air Pollution

	A	B	C
1	**Impact Indicator 4: Air Pollution**		
2	Definition		
3	Mean annual urban air pollution of fine particulate matter (in µg PM2.5) at road based monitoring stations within the area covered by the SUMP.		
4	**Reporting period (dd.mm.yyyy-dd.mm.yyyy)**		
5			
6	**General description of and links to material used to collect and derive this indicator**		
7	*Please list all sources here. Clearly indicate to which cell(s) any source pertains.*		
8			
9	*please add as many rows as necessary.*		
10			
11	**Proposed table to calculate this indicator**		
12			
13	**Number**	**Station** 1	**PM2.5 yearly mean**
14	1	Boulevard A	
15	2	Busy intersection B	
16	3	Street canyon C	
17	4		
18			
19	**Total number of stations**		-
20			
21	**Mean urban air pollution**		#DIV/0!
22			
23	**Any basic data, calculations, or additional observations**		
24			
25	*please add as many rows as necessary.*		
26			
27			

6.3. Data Availability & Collection

Data availability for this impact indicator is highly dependent on the existence of a road-based air quality monitoring system in the Beneficiary Partner context.

In case there is no such system in place, but there's detailed data available on fleet composition, one can rely on vehicle fleet-default parameters to calculate the $PM_{2.5}$ emissions. For further details, please refer to chapter three on Transport Related GHG emissions. In the absence of annual means, measurements covering a more limited period of the year can be used and extrapolated. Stations covering exclusively industrial areas must not be included, unless they are contained in reported city means and cannot be disaggregated (WHO, 2016).

Description of the data acquisition process must be reported along with the indicator values.

7. Impact Indicator 5: Modal Share of Non-Motorized and Public Transport

This indicator is closely related to SDG target 11.2: *By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all […]* (UNSD, 2018). It refers to the actual transport demand distribution within a specific area and time period. Whereas impact indicator 2 sheds light on the accessibility aspect of public transport, this indicator highlights the overall demand distribution of all available transport modes within a specific transport ecosystem.

The indicator refers to the 'SHIFT' strategy in the sustainable mobility paradigm. It monitors the shift of transport demand from unsustainable modes to sustainable modes. Non-motorized and public transport are more resource efficient per *pkm* than individual motorized transport and, hence, may be considered as more sustainable forms of transport. Monitoring this indicator shall lead to the observation of an increase of the share of these sustainable modes.

The modal share can be measured in different units. Most prominently, one can measure the modal share in terms of vehicle kilometres travelled (*vkt*) or in terms of trips. We measure the indicator in terms of trips, to better reflect the accessibility of essential services. A modal share measured in trips helps understand transport mode choices in dense urban areas better than one measured in *vkt*. A modal share measured in *vkt*, on the other hand, would provide more information on the GHG emissions reduction potential of certain shifts in transport demand. This aspect, however, is sufficiently covered by impact indicator 1.

The modal share indicator suffers from comparability limitations. The major reason for this is that each household travel survey is usually different from any other survey in design and execution, resulting in comparisons from region to region that are completely obscured by methodological and implementation differences. This publication provides appropriate standards and guidance, which could go a long way in removing such barriers to comparability (Travel Survey Manual, 2019).

7.1. Definitions

Definition of the Modal Share Indicator

The sum of trips travelled with non-motorized modes and public transport as a share of total trips travelled with all modes. The main mode of a trip is that used for the longest stage of the trip by distance. With stages of equal length, the mode of the last stage is used (CIVITAS CAPITAL, 2016).

Definition of a trip[5]

- Count all trips undertaken on foot, by bicycle or with an electric or motorized vehicle on the specific reporting date/period.
- Trips after midnight, which started before 3 AM, count for the prior day.
- Trips can be undertaken as a driver or as a passenger.
- Each trip has to be connected to one specific purpose.

[5] http://www.mobilitaet-in-deutschland.de/pdf/infas_Wegeblatt_MiD.pdf

- It remains <u>one</u> trip if switching between modes of transportation (e.g.: from bus to tram or from car to subway) does not change the purpose of the trip. Otherwise, count a new trip at every switch.
- Round trips count as two trips (e.g.: going for a walk: (1) first half of the walk's purpose is leisure and (2) the second half of the walk's purpose is getting back to the starting point (e.g.: home) = 2 trips).
- Only private journeys are to be accounted for (e.g.: commute to work or school). Exclude occupational trips (e.g.: if a job with frequent trips is pursued (cab driver, craftsman)).

Example: (Trip 1) From home to work, (2) from work to a restaurant during lunch break, (3) back to work, (4) from work to the supermarket to run some errands and finally (5) from the supermarket back home = 5 trips).

Definition of Non-Motorized Transport (NMT)

Non-motorized transport includes walking, cycling, wheelchair and small-wheeled **transport** (skates, skateboards, push scooters and hand carts) and Wheelchair. Bicycle with electric assistance are included in cycling.

Definition of Public Transport:

Public transport (PT) includes public bus, bus rapid transit (BRT), tram, rail, scheduled ferry, and similar types of formal transport. It does not include taxi nor most of informal paratransit (auto-rickshaw, irregularly operating mini-busses/tuk-tuk/matatus, etc.). Informal transport, particularly minibus transport, is considered for this indicator as PT, if <u>most</u> of the main characteristics are met, defining the purpose of the indicator. These particularly include the following:

- Sufficiently reliable timetable, regular line service
- High service frequency, at least once every 20 minutes during peak hours.
- Demarcated stations or high degree of reliability regarding proven pick-up points
- Operating throughout all working days a week
- Enough capacity of vehicles to meet demand during peak hours
- Quality of service meets minimum standards with respect to safety and comfort
- Being "collective transport" (e.g. each vehicle has sufficient capacity to transport at least 8 passengers in addition to the driver).

7.2. Calculation & Aggregation

Calculation

$$Modal\ share\ of\ NMT\ and\ PT\ =\ 100 * \left(\frac{\sum trips\ NMT + \sum trips\ PT}{Total\ trips}\right)$$

Time series

Once the modal share of non-motorized and public transport of the base year has been obtained, its progress against the target modal share can be monitored in regular intervals. It is therefore required that the SUMP/NUMP provides a robust business as usual scenario against which progress can be observed.

It is advised to monitor and to report modal shares of all modes separately. Table 8 offers orientation regarding data collection requirements on the city level. The following categories are to be considered.

- Scooter/moped;
- Motorcycle;
- Moto-taxi;
- Cars;
- Taxi;
- Public Bus;
- Minibus;
- Large Goods Vehicle under 3.5 tons;
- Trucks or Heavy Goods Vehicle over 3.5 tons;
- Railway, train, metro, tram, or light rail;
- Ferryboats;
- Bicycle including e-bikes;
- Pedestrian;
- Other non-motorised;
- Other motorised;
- Unknown.

Aggregation

The indicator at Partnership level is the aggregated number of Partner Cities that achieve an increase of their respective modal shares of non-motorized and public transport by an amount included in the following ranges.

- 0-5 additional % points
- 5-10 additional % points
- 10-15 additional % points

Over 15 additional % points **Table 8: Input table example for Impact Indicator 5: Modal Share of Non-Motorized and Public Transport**

	A	B	C
1	**Impact Indicator 5: Modal Share of Non-Motorized and Public Transport**		
2	Definition		
3	The sum of trips travelled with non-motorized modes and public transport as a share of total trips travelled with all modes. The main mode of a trip is that used for the longest stage of the trip by distance. With stages of equal length the mode of the last stage is used (CIVITAS CAPITAL, 2016, p. 5).		
4	**Reporting period (dd.mm.yyyy - dd.mm.yyyy)**		
5			
6	**General description of and links to material used to collect and derive this indicator**		
7	*Please list all sources here. Clearly indicate to which cell(s) any source pertains.*		
8			
9	*please add as many rows as necessary.*		
10			
11	**Proposed table to calculate this indicator**		
12			
13	Transport mode (as passenger or driver)	Total number of trips	Subtotals
14	Scheduled bus and minibus		
15	Train, metro, tram		
16	Ferryboat		
17	Other public		
18	**Total public transport**		-
19	Walking		
20	Cycling		
21	**Total non-motorized transport**		-
22	Passenger car		
23	Taxi		
24	Motorcycle		
25	Scooter/moped		
26	Other motorized (trucks,etc)		
27	**Total individual motorized transport**		-
28	**Total public and active transport**		-
29	**Total km travelled during the reporting period**		-
30	**Modal share of non-motorized and public transport**		**#DIV/0!**
31			
32	**Please describe the data collection methodology. This may include any basic data, calculations, or additional observations.**		
33			
34	*please add as many rows as necessary.*		
35			
36			
37			
38			

7.3. Data Availability & Collection

The standard source for trip-by-mode data is a household travel survey, i.e. a survey of the travel activities by mode and purpose of a representative sample of the population. Methods used to collect survey data include telephone interviews, personal interviews, postal questionnaires, web-based questionnaires, self-filled travel diaries, or combinations of those (cf. Table 3: Data sources for transport in cities). The choice of method will depend on available resources (e.g. manpower and time) and the local context (e.g. phone and internet availability in the country) (UNESCAP, 2017).

The World Business Council for Sustainable Development (WBCSD) provides a chapter on representative sampling in its publication concerning sustainable urban mobility indicators (2015, pp. 28-29). When assuming a normal population distribution, to achieve an acceptable margin of error of 5%, respectively a confidence level of 95%, the sample size must be as specified in table 9. Please refer to the WBCSD's publication for further methodological reference.

Table 9: Required sample sizes based on various population sizes

Margin of error 5%; confidence level 95%; response distribution 50%	
Population size	**Sample Size**
1000	278
5000	357
10,000	370
50,000	382
100,000	383
1,000,000	384
1,500,000	385
10,000,000	385

Source: Own illustration, adapted from WBCSD (2015, p. 29).

It can be very practicable to collect relevant data via a web-based questionnaire. This approach reduces the burden of respondents and decreases the human and monetary capital needed to obtain new data. National or regional travel surveys that may have been conducted earlier, could potentially allow an extraction of data to the city level, too.

A travel survey must include at least the following information for each participant and day surveyed:

Name: … … **Date: dd.mm.yyyy**

# of Trip	Time of Departure (24hr format)	Purpose of the Trip	Used mode of transportation (underline main mode)	Approx. distance of the entire trip (in km)	Destination (Address)	Time of arrival
1.	07:45	Commute to work	Cycle, regional train, walk	30 km	Friedrich-Ebert-Allee 38, Bonn	08:45
2.	XX:XX	…	…	… km	…	XX:XX
3.	XX:XX	…	…	… km	…	XX:XX

An alternative and comparably low-cost approach to a web-based survey is making use of smartphone technology. Smartphones are increasingly ubiquitous and versatile loggers. Besides GPS, they generally include a variety of sensing technologies such as accelerometer, Wi-Fi, and GMS, the combination of which may provide more detailed information on travel behaviour (Cottrill et al., 2013). One possible way to incentivise participants may be to offer to cover cell phone/data plan for a month (Travel Survey Manual, 2019). Such incentives must be individualised for each city/country context.

All trips undertaken by each individual in all households that are part of the sample during the given reporting period, depending on the available data collection resources, will have to be considered. Please make sure that a representative reporting period is being chosen, which does not include extreme weather events or public holidays, etc.

It is up to the data collection team that is familiar with specific city circumstances to figure out which data collection approach to pursue. As long as transparently documented and properly carried out, all approaches mentioned in this chapter can be accepted for the Partnership's monitoring and reporting purposes.

8. Impact Indicator 6: Affordability of Public Transport

This indicator is linked to SDG target 11.2: *By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all[...] (UNSD, 2018).*

It focuses on the economic adequacy between the income of the population and the prices of public transport services. It is complementary to the impact indicator measuring the Access to Public Transport of this Publication.

Some large urban areas have a "two-speed" PT networks, including both a modern and efficient system (metro, tramway, BRT) which only the middle and upper classes can afford, and a deteriorating or informal collective transport system which is affordable to low-income population.

The combination of a sustainable selling price and an affordable purchase price depends on multiple factors:

Factors related to the formation of the selling price.

- Operational costs (staff and rolling costs, depreciation of equipment, overheads)
- Level of equipment or operating subsidies received by the operator from the public authorities
- Level of margin practiced by the operator, which is strongly related to the level of competition.

Factors defining the acceptable price level.

- Targeted clientele
- Purchasing power of households
- Diversity of the tariff range, such as the availability of reduced tariffs for targeted categories of population, like children, students, seniors, job seekers, disabled people, etc.

In most cities and countries of the world, public transport is primarily based on a self-supporting economic model emanating from private initiative, with production costs and margins to be covered by the revenues collected from users, without the intervention of the public authorities. This system quickly found its limits in the rail network, which requires much higher maintenance and operating costs than road transport; the scissor effect between the gradual decline in train performance due to deficiencies in maintenance and under-investment, and the increase in the level of household motorisation has led to the disinheritance of many rail networks, including in developed countries, and the need for state intervention elsewhere.

For urban transport networks, a similar phenomenon has been observed in recent decades. Most urban transport networks are at a crossroads:

- Either the traditional system based on a self-supporting economic model, and it is increasingly difficult for operating companies to cope with the rise of motorization and urban development,
- Either a boost is given by the State and local authorities in order to put public transport at the service of sustainable development, which implies heavy investments that cannot generally be covered by tariff revenues.

In most European networks, the rate of coverage of operating expenses (excluding investments in general) by direct revenues varies from about 10% to 40% depending on the size of the agglomerations. The operating deficit and investment costs are borne by the various public authorities (including the

State) through tax resources. To this end, some countries organise with companies the collection of a specific tax.

The affordability of public transport therefore covers two distinct but related topics: the adequacy between the selling price of a transport service and the purchasing power available to the user, and the ability of the public authority to intervene in the economic model, to help lower the transport price for the user and/or to finance the necessary investments. This subject is obviously central to the development of SUMP/NUMP.

MobiliseYourCity's monitoring and evaluation system cannot go into detail on the training of costs and selling prices, and only seeks to trace the final result: the ability, for the most numerous social categories, to access formal public transport networks.

The public transport affordability index therefore brings the cost to a user of a regular trip (1 RA/working day eleven months out of twelve) closer to the disposable income of the popular social categories.

8.1. Definitions

Definition of the transport fare affordability indicator

Fare affordability is measured as the proportion, or percentage, of disposable household income spent on public transport for the second quintile household group. An income quintile is a measure of neighbourhood socioeconomic status that divides the population into 5 income groups (from lowest income to highest income) so that 20% of the population is in each group. The second quintile is the second group, starting from the bottom. The lower the fare affordability is, the more affordable is public transport in the city.

Definition of Public Transport

Public transport (PT) includes public bus, bus rapid transit (BRT), tram, rail, scheduled ferry, and similar types of formal transport. It does not include taxi nor most of informal paratransit (auto-rickshaw, irregularly operating mini-busses/tuk-tuk/matatus, etc.). Informal transport, particularly minibus transport, is considered for this indicator as PT, if <u>most</u> of the main characteristics are met, defining the purpose of the indicator. These particularly include the following:

- Sufficiently reliable timetable, regular line service
- High service frequency, at least once every 20 minutes between 6:00 and 20:00
- Demarcated stations or high degree of reliability regarding proven pick-up points
- Operating throughout all working days a week
- Enough capacity of vehicles to meet demand during peak hours
- Quality of service meets minimum standards with respect to safety and comfort
- Being “collective transport” (e.g. each vehicle has sufficient capacity to transport at least 8 passengers in addition to the driver).

Interurban transport should not be considered.

Definition of a trip[6]

- Count all trips undertaken on foot, by bicycle or with an electric or motorized vehicle on the specific reporting date/period.
- Trips after midnight, which started before 3 AM, count for the prior day.
- Trips can be undertaken as a driver or as a passenger.
- Each trip has to be connected to one specific purpose.
- It remains **one** trip if switching between modes of transportation (e.g.: from bus to tram or from car to subway) does not change the purpose of the trip. Otherwise, count a new trip at every switch.
- Round trips count as two trips (e.g.: going for a walk: (1) first half of the walk's purpose is leisure and (2) the second half of the walk's purpose is getting back to the starting point (e.g.: home) = 2 trips).
- Only private journeys are to be accounted for (e.g.: commute to work or school). Exclude occupational trips (e.g.: if a job with frequent trips is pursued (cab driver, craftsman)).

Example: (Trip 1) From home to work, (2) from work to a restaurant during lunch break, (3) back to work, (4) from work to the supermarket to run some errands and finally (5) from the supermarket back home = 5 trips).

Definition of the average fare

To account for the diversity of fares which may vary according to the distance travelled or to the tariff range, is to use the concept of an average fare.

The average fare is defined as the average amount spent per trip.

Data are obtained either from the reporting system of the public transport operators, either through a household survey.

Average yearly cost per user

The estimated annual cost of fares can be estimated by multiplying the average fare by 440, the number of trips made yearly by a commuter working 220 days a year.

This method is biased if the tariff offer includes frequent travel subscriptions or other advantageous tariffs. The interpretation of the result will have to take tariff ranges into account.

Definition of the average income of the working-class social categories

The level of income of working-class social categories is estimated by the average income, including any social transfers, of the second quintile.

People in situations of extreme poverty have difficulty in accessing all public services and even some basic needs; while their inclusion in the design of mobility policies is essential, they are not directly representative of the public most affected by a public transport development policy.

The proposed indicator of social inequalities to be considered in the analysis is the **interquartile range**.

[6] http://www.mobilitaet-in-deutschland.de/pdf/infas_Wegeblatt_MiD.pdf

8.2. Calculation & Aggregation

Calculation

$$PT\ affordability\ index\ =\ 100 * \left(\frac{440\ X\ average\ fare}{Average\ income\ of\ the\ 2nd\ quintile}\right)$$

Time series

Once the PT affordability index has been obtained, its progress against the target index can be monitored in regular intervals. It is therefore required that the SUMP/NUMP provides a robust business as usual scenario against which progress can be observed.

Aggregation

The indicator at Partnership level is the aggregated number of Partner Cities that achieve to lower their affordability index by:

- 0-5 points
- 5-10 points
- 10-15 points

8.3. Over 15 points Data Availability & Collection

Data are obtained either from the reporting system of the public transport operators, either through a household survey.

In the absence of these two data sources, it is still possible to make an empirical estimate by making assumptions about the distribution of trips between the different fares offered, on the basis of interviews with stakeholders.

Reporting system of the from public transport operators.

If accurate data are available, the preferred calculation method for the average fare, is to divide the annual overall fare revenue from the public transport system operators by the total number of trips.

The annual overall fare revenue can be obtained from the reporting system of the public transport operators, which may include operational, activity and financial reports, data factsheet or dashboards, or other data sources. The availability of a reporting system presupposes that there is a public transport system organised under the control of a public authority, and that operators have reporting obligations.

The total number of trips may also be obtained from the beforementioned reporting system.

It is advised to carry on an assessment of the counting method, which may consist of ticket sales, automatic counts, surveys, or else. Particularly, the distinction has to be made between trips and segments. Counting trips specifically might require the use of a conversion factor based on connections, which is not always easy to establish except for fairly heavy surveys.

Through a Household Travel Survey

If such a survey is organised, it is advised to include questions on the average cost of a trip and the estimated yearly number of trips.

Average income of the second quintile

Concerning the average income of the 2nd quintile, the only available source is the population census, and more generally the country's official statistical documentation.

It is possible that this data may not be available per agglomeration but only for the whole country, in which case it will be up to the persons in charge of collecting this data to choose between keeping a national data (probably erroneous at the level of an important agglomeration) and a method for evaluating the correction to be made, based on clues and evidence at their disposal. In this case, the methodology should be reported along with the indicator values.

It is theoretically possible to consider a specific sample survey, keeping into account the possible issues related to monetary matters being a sensitive topic for many interviewees.

9. Investment Indicators

A core deliverable of SUMPs and NUMPs is a list of actionable investment priorities to enhance the existing urban mobility frameworks. The MobiliseYourCity Partnership therefore requires its Beneficiary Partners to monitor and report on the following investment indicators:

- Investment Indicator 1: KM of sidewalks planned to be built or to be substantially advanced in quality through the SUMP
- Investment Indicator 2: KM of cycle lanes planned to be built or to be substantially advanced in quality through the SUMP
- Investment Indicator 3: KM of mass rapid transit planned to be built or to be substantially advanced in quality through the SUMP
- Investment Indicator 4: Number of city centre parking spaces (for individual cars), which are newly subjected to active parking management through the SUMP.
- Investment Indicator 5: The amount of **leveraged and associated financing secured or planned** for the implementation of the SUMP/NUMP in Euro (€).

For Investment Indicator 5 –Total volume of financing leveraged or associated through MobiliseYourCity (planned and secured) available to implement NUMPs and SUMPs.

Financing figures will include domestic public finance, international public finance, and private sector finance, which will all be tracked separately. Domestic public finance includes budgetary allocations from local/regional/national governments, public loans (from government to sub-national entities or other public equity). International public finance and philanthropy includes loans, equity and grants from international finance institutions, climate finance institutions, international donors (foundations and philanthropies, etc) directly to beneficiary partners or through intermediaries. Private sector finance includes loans or equity from private financing institutions and any kind of financing from "for profit" institutions (corporations, small businesses, individuals, etc.)

Leveraged finance: financing that covers investment or measures in line with the SUMP/NUMP and have been facilitated from the MobiliseYourCity partnership process. This facilitation might come from a better justification for funds toward financers; a better alignment with funders expectative (such as IFIs or climate finance); a stronger advocacy toward local or national authorities (such as MoF, etc.); general awareness raising on urban mobility issues convincing decision makers or financiers, etc..

Associated financing is financing that covers investment or measures in line with the SUMP/NUMP but did not result directly from the MobiliseYourCity partnership process

The respective values for investment indicator 1 to 4 shall be retrieved from the respective SUMP/NUMP and be reported in the following or in a similar manner. Table 10 is a suggested data reporting table format.

Table 10 Reporting on Investment Indicators

Indicator	Base Year (existing infrastructure)	Target Year (existing + new infrastructure)	Change between base and target year (new infrastructure)

KM of sidewalks planned to be built or to be substantially advanced in quality through the SUMP/NUMP			
KM of cycle lanes planned to be built or to be substantially advanced in quality through the SUMP/NUMP			
KM of mass rapid transit planned to be built or to be substantially advanced in quality through the SUMP/NUMP			
Number of city centre parking spaces (for individual cars), which are newly subjected to active parking management through the SUMP/NUMP.			

10. Annexes

10.1. Indicators Assessing Urban Transportation Systems

The MobiliseYourCity SUMP toolkit provides an expanded compilation of indicator sets based on the Annex II of the report Sustainable Transport Evaluation – Developing Practical Tools for Evaluation in the Context of the CSD Process.

10.2. Examples of Implementation and Sustainable Mobility Indicators

Table 11: Indicators to track implementation of single measures

Topic	Infrastructure or services offered	Use of the new infrastructure or service
Public transport	■ PT improvements: length of bus lanes, number of bus priority intersections ■ PT offer (quantity): vehicles x km ■ PT offer (quality): average commercial speed	■ PT usage: number of annual trips, number of boarding/alighting at main stops
Intermodality	■ P & R parking offer	■ Number of combined TER/PT subscribers ■ Number of P & R subscribers
Cyclists	■ Route improvements: length of routes for cycling ■ Parking improvements: number of bicycle parking stands in public space, including secure stands	■ Bicycle flow counts on certain routes ■ Counts of bicycles parked on certain stands
Walking	■ Route improvements: size of pedestrian areas ■ Length of pavements of width <1.40 m ■ Occasional improvements: number of dangerous crossings redeveloped	■ Pedestrian counts on some routes
Powered two-wheelers	■ Number of parking spaces in public car parks	■ PTW flow counts on certain routes
Private vehicular traffic	■ Road prioritisation scheme ■ Speed calming scheme	■ Flow counts on certain routes ■ Average speed
Parking facilities	■ Parking offer on roads by type (free, free limited time, paid) and in car parks	■ Paid hours/space/day on road ■ Road occupancy rate ■ Use of car parks, including subscribers ■ Number of parking fines
Sharing the road network	■ Length of roads converted into traffic calming areas ■ Surface of former road space converted into green areas, parks, pedestrian places	■ Pedestrian and bicycle count in these areas ■ Number of street events (festival, market, exhibition…) using the street space
Mobility management and new services	■ Car-sharing offer ■ Car-pooling offers ■ Initiative for the development of company mobility plans	■ Number of car-sharing subscribers, number of uses/day per car ■ Number of subscribers to carpool portals ■ Number of company mobility plan

Topic	Infrastructure or services offered	Use of the new infrastructure or service
Transportation of goods	■ Number of delivery areas	■ Number of parking fines

Source: Certu (2012)

Sustainable Mobility Indicators	
Transport modal share	■ Mode split between different transport modes
Environmental protection	■ Number of days or hours where permitted pollution thresholds are exceeded (particulate matter, nitrogen oxides, ozone) ■ Average measured noise level ■ Population exposed to different noise levels ■ Surface are of parks in the city ■ Number of trees planted in the parks and streets
Road safety	■ Number of accidents and fatalities, serious injuries and slight injuries recorded by the police during the year, distinguishing pedes-trians, cyclists, motorists, users of PTWs and others
Transport accessibility (all types)	■ Network share accessible to persons with reduced mobility ■ Number of pedestrian crossings equipped for persons with reduced mobility
Integration of transport and urban planning	■ Number of micro-SUMP initiatives/sector plans ■ Number of housing developments, jobs, and amenities near existing PT networks

Source: adapted from Certu (2012)

Another set of 19 sustainable mobility indicators has been developed by the World Business Council on Sustainable Development and has already been tested in four cities in emerging economies:

Set of 19 indicators for the sustainability of urban mobility	Short names of indicators	Dimensions	
Affordability of public transport for the poorest people	Affordability	S	Q
Accessibility for mobility impaired groups	Accessibility for impaired	S	Q
Air polluting emissions	Air pollution	Q	
Noise hindrance	Noise hindrance	Q	
Fatalities	Fatalities	Q	
Access to mobility services	Access	Q	
Quality of public area	Public area	Q	
Urban Functional diversity	Functional diversity	Q	E
Commuting travel time	Travel time	Q	E
Economic Opportunity	Economic Opportunity	Q	E
Net public finance	Public Finance	E	
Mobility space usage	Space Usage	G	E
Emissions of greenhouse gases (GHG)	GHG	G	
Congestion and delays	Congestion	G	S
Energy efficiency	Energy efficiency	G	S
Opportunity for active mobility	Active mobility	G	S
Intermodal integration	Intermodal integration	S	
Comfort and pleasure	Comfort and pleasure	S	Q
Security	Security	S	Q

Table.1: Overview of the 19 Sustainable Urban Mobility Indicators indicating the dimensions of the sustainability of the mobility system. Source: Oran Consulting for WBCSD SMP2.0, 2014

Three dimensions refer to the sustainability of the resource use and/or the impacts of mobility in the city:

- G Global environment
- Q Quality of life
- E Economic success
- S Mobility system performance

Figure 8: Overview of 19 Sustainable Urban Mobility Indicators

For more information on these indicators and how to assess them please see:
https://docs.wbcsd.org/2015/12/SMP2.0_Sustainable-Mobility-Indicators_ENG.pdf

10.3. References

Bond, T. C., Doherty, S.J., Fahey, D.w., Forster, P.M., Berntsen, T., DeAngelo, B.J., Flanner, M.G., Ghan, S., Kärcher, B., Koch, D., Kinne, S., Kondo, Y., Quinn, P.K., Sarofim, M.C., Schultz, M.G., Venkataraman, C., Zhang, H., Zhang, S., Bellouin, N., Guttikunda, S.K., Hopke, P.K., Jacobson, M.Z., Kaiser, J.W., Klimont, Z., Lohmann, U., Schwarz, J.P., Shindell, D., Storelvmo, T., Warren, S.G., Zender, C.S. (2013) *Bounding the role of black carbon in the climate system: A scientific assessment*, in *Journal of Geophysical Research Atmospheres*, 118, 5380–5552, doi:10.1002/jgrd.50171.

Bongardt, D., Eichhorst, U., Dünnebeil, F., and Reinhard, C. (2015) *Monitoring Greenhouse Gas Emissions of Transport Activities in Chinese Cities: A Step-by-step Guide to Data Collection.* Eschborn: GIZ. Available online: http://sustainabletransport.org/?wpdmdl=3797 (accessed 29.04.2019).

Certu (ed.) (2012) L'évaluation des PDU: des convergences d'approches pour une réalité complexe (Assessing SUMPS: Converging approaches for a complex reality). In Mobilité et transports – Pratiques locales, 02. Lyon: Certu.

CIVITAS CAPITAL (2016) City level Sustainable Mobility Indicator Descriptions. Available online: https://civitas.eu/sites/default/files/civitas_capital_ag5_brochure_indicators_final.pdf (accessed: 29.04.2019).

Cottrill, C. D. et al. (2013) *The Future mobility Survey: Experiences in developing a smartphone-based travel survey in Singapore,* in *Transportation Research Record: Journal of the Transportation Research Board,* 2354, 59-67, doi:10.3141/2354-07.

Dünnebeil, F., Knörr, W., Heidt, C., Heuer, C. and Lambrecht, U. (2012) Balancing Transport Greenhouse Gas Emissions in Cities – A Review of Practices in Germany. Beijing: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and Beijing Transportation Research Centre. Available online: http://sustainabletransport.org/?wpdmdl=2974 (accessed 29.04.2019).

Eckermann, A., Henkel, A., Lah, O., Eichhorst, U., Bongardt, D., and Wuertenberger, L. with input from Sutter, D. and Chua, H. (2015) Navigating Transport NAMAs – A practical handbook on Nationally Appropriate Mitigation Actions (NAMAs) in the transport sector, 2nd revised edition. Eschborn: GIZ.

European Commission (2015) Measuring access to public transport in European cities. Available online: https://ec.europa.eu/regional_policy/sources/docgener/work/2015_01_publ_transp.pdf (accessed: 29.04.2019).

European Commission (2015) *Commission Directive (EU) 2015/1480,* in *Official Journal of the European Union.* Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L1480&from=DE (accessed: 29.04.2019).

IFEU (ed.) (2014) Empfehlungen zur Methodik der kommunalen Treibhausgasbilanzierung für den Energie- und Verkehrssektor in Deutschland (Recommendations on the methodology for GHG-accounting in the energy and transport sector in local municipalities in Germany). Heidelberg:

IFEU. Available online: https://www.ifeu.de/wp-content/uploads/Bilanzierungs-Systematik_Kommunal_Kurzfassung.pdf (accessed 29.04.2019).

ITDP – Institute for Transportation and Development Policy (2019) Indicators for Sustainable Mobility. Available online: https://www.itdp.org/wp-content/uploads/2019/01/Indicators-for-Sustainable-Mobility.pdf (accessed 29.04.2019).

ITF – International Transport Forum (2018) Safer City Streets Global Benchmarking for Urban Road Safety. Available online: https://www.itf-oecd.org/sites/default/files/docs/safer-city-streets-global-benchmarking-urban-road-safety.pdf (accessed: 29.04.2019).

Travel Survey Manual (2019). Available online: http://www.travelsurveymanual.org/ (accessed: 29.04.2019).

UNESCAP – United Nations Economic and Social Commission for Asia and the Pacific (2017) Sustainable Urban Transport Index Data Collection Guideline. Available online: https://www.unescap.org/sites/default/files/SUTI%20Data%20Collection%20Guideline.pdf (accessed: 29.04.2019).

UN-HABITAT – United Nations Human Settlement Programme (2016) A guide to assist national and local governments to monitor and report on SDG goal 11+ indicators. Available online: https://UN-HABITAT.org/sdg-goal-11-monitoring-framework/ (accessed: 29.04.2019).

UNSD – United Nations Statistical Division (2016) Metadata on SDG 11.2.1. Available online: https://unstats.un.org/sdgs/metadata/files/Metadata-11-02-01.pdf (accessed 29.04.2019).

UNSD – United Nations Statistical Division (2018) Global indicator framework for the Sustainable Development goals and targets of the 2030 Agenda for Sustainable Development. Available online: https://UNSD.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%20refinement_Eng.pdf (accessed: 29.04.2019).

UNSDSN – United Nations Sustainable Development Solutions Network (2015) Indicators and a Monitoring Framework for the Sustainable Development Goals. Available online: http://unsdsn.org/wp-content/uploads/2015/05/FINAL-SDSN-Indicator-Report-WEB.pdf (accessed: 29.04.2019).

WBCSD – World Business Council for Sustainable Development (2015) Methodology and indicator calculation method for sustainable urban mobility. Available online: https://docs.wbcsd.org/2015/12/SMP2.0_Sustainable-Mobility-Indicators_ENG.pdf (accessed 29.04.2019).

WHO – World Health Organisation (2005) Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur oxide. Available online. https://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf (accessed 29.04.2019).

WHO – World Health Organisation (2014) Ambient (outdoor) air quality and health. Fact sheet N°313. Available online: http://www.who.int/mediacentre/factsheets/fs313/en/ (accessed 29.04.2019).

WHO – World Health Organisation (2016) Ambient air pollution: A global assessment of exposure and burden of disease. Available online: https://apps.who.int/iris/bitstream/handle/10665/250141/9789241511353-eng.pdf?sequence=1 (accessed 29.04.2019).

WRI – World Resources Institute, Iclei – Local Governments for Sustainability, C40 Cities Climate Leadership Group (eds.) (2014) Greenhouse Gas Protocol. Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities. WRI. Available online: https://ghgprotocol.org/sites/default/files/standards/GHGP_GPC_0.pdf (accessed 29.04.2019).

10.4. Index of Figures

Figure 1: Overview of monitoring and reporting steps in the SUMP/NUMP process 5

Figure 2: Data collection during SUMP/NUMP development and implementation 6

Figure 3: Overall logic of the monitoring and reporting approach in MobiliseYourCity 10

Figure 4: Comparison of real emissions (in year x) with the business-as-usual scenario (purple line) and the SUMP/NUMP scenario (green line) 13

Figure 5: Different system boundaries for urban transport emission accounting 15

Figure 6: Transport modes and emissions included in the GHG monitoring (ideal case) 18

Figure 7: ASIF Framework for the calculation of transport emissions 19

Figure 8: Overview of 19 Sustainable Urban Mobility Indicators 49

10.5. Index of Tables

Table 1: Ways to aggregate MobiliseYourCity indicators 9

Table 2: Data sources for vehicle fleet composition in cities 21

Table 3: Data sources for transport in cities 22

Table 4: Monitoring and Reporting Checklist 26

Table 5: Input table example for Impact Indicator 2: Access to Public Transport 30

Table 6: Input table example for Impact Indicator 3: Road Safety 34

Table 7: Input table example for Impact Indicator 4: Air Pollution 38

Table 8: Input table example for Impact Indicator 5: Modal Share of Non-Motorized and Public Transport 41

Table 9: Required sample sizes based on various population sizes 42

Table 10: Reporting on Investment Indicators 45

Table 11: Indicators to track implementation of single measures 47