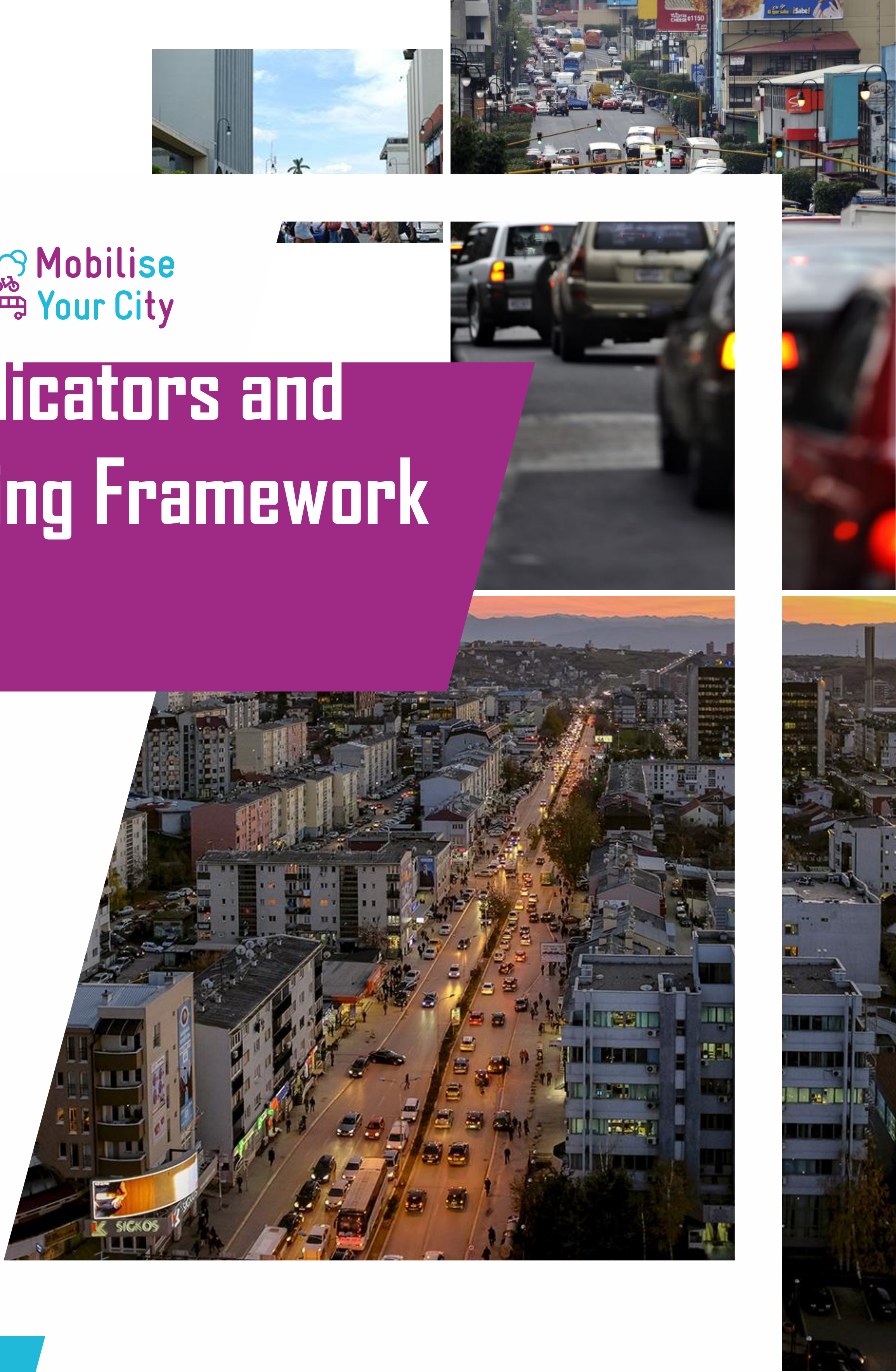
Mobilise Your City

Core Indicators and Monitoring Framework



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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, livable, 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

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.

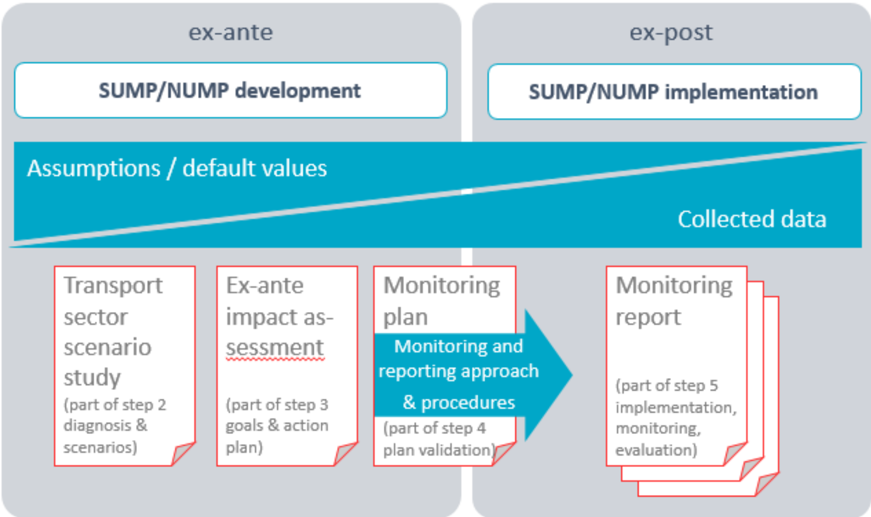


Figure 2: Data collection during SUMP/NUMP development and implementation

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 methodologies 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 minutes 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)

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:

1. **KM of sidewalks** planned to be built or to be substantially advanced in quality through the SUMP/NUMP
2. **KM of cycle lanes** planned to be built or to be substantially advanced in quality through the SUMP/NUMP
3. **KM of mass rapid transit** planned to be built or to be substantially advanced in quality through the SUMP/NUMP
4. **Number of city centre parking spaces** (for individual cars), which are newly subjected to active parking management through the SUMP/NUMP (i.e. payment required in the future for parking, which was previously free of cost).
5. 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 directly 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 ways how to aggregate indicators in the reporting framework of the Partnership:

Table 1: Ways to aggregate MobiliseYourCity indicators

Indicator	Aggregation
GHG Impact	
Impact Indicator 1: GHG emission reductions (tCO2e)	Sum of emission reductions in all Beneficiary Partner contexts
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 minutes service at peak hour)	Number of Partners that improve in the access to public transport shares by certain amounts (e.g.: by up to 3%, 5%, 10%)
Impact Indicator 3: Road Safety (traffic fatalities (road, rail, etc.) in the urban area per 100.000 inhabitants)	Number of Partners that achieve a reduction of their respective fatality rates by certain amounts (e.g.: by up to 5/100000, 10/100000, 15/100000)
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 Partners with mean urban air pollution values below the WHO limit for PM2.5
Impact Indicator 5: Modal Share (share of public transport and non-motorized modes in trips)	Number of Partner Cities that achieve an increase of their respective modal shares of non-motorized and public transport by certain amounts (e.g.: by up to 2%, by up to 5%, by up to 7%).
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 (i.e. payment required in the future for parking, which was previously free of cost).	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: The amount of mobilised public and private funding for the implementation of the SUMP/NUMP in Euro (€).	Sum of mobilised public and private funding under MobiliseYourCity SUMPs/NUMPs in Euro (€)

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

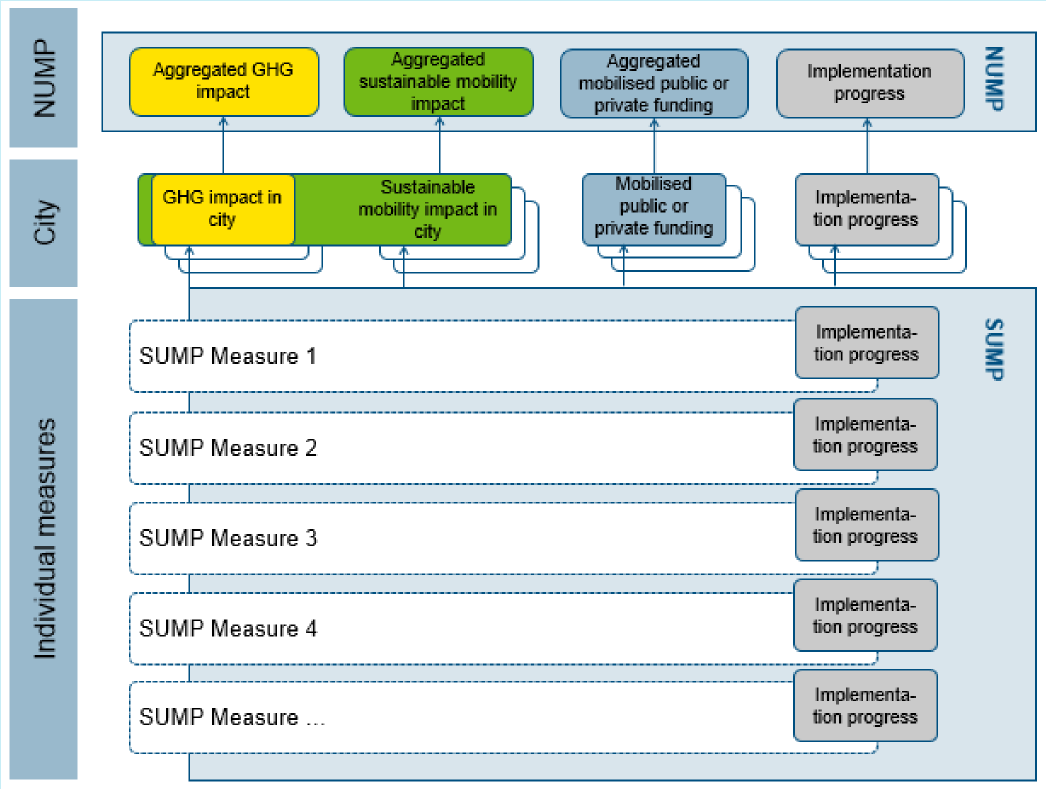


Figure 3: Overall logic of the monitoring and reporting approach in MobiliseYourCity

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).

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.

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 (CO2, CH4 and N2O) 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 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.

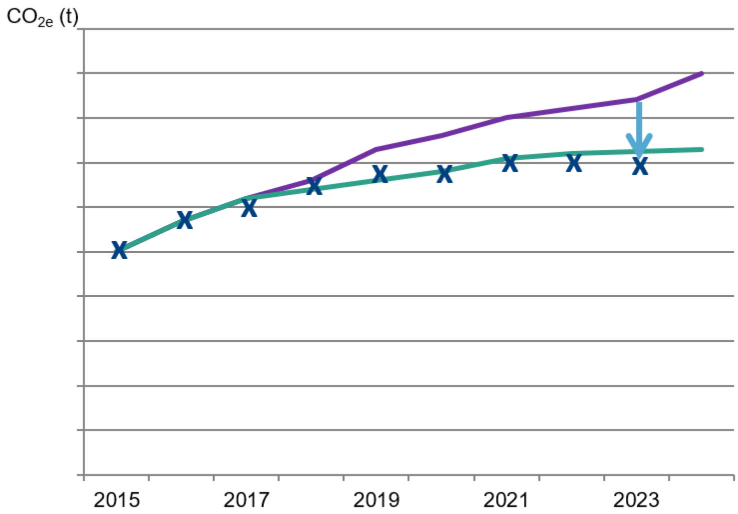


Figure 4: Comparison of real emissions (in year x) with the business-as-usual scenario (purple line) and the SUMP/NUMP scenario (green line)

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.

In addition, the ex-ante SUMP scenario can be used for setting a GHG emission target (in CO2e) 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:

(Expected) GHG emission reductions (of a 'SUMP/NUMP scenario') (in tCO2e) 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 in-coming 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

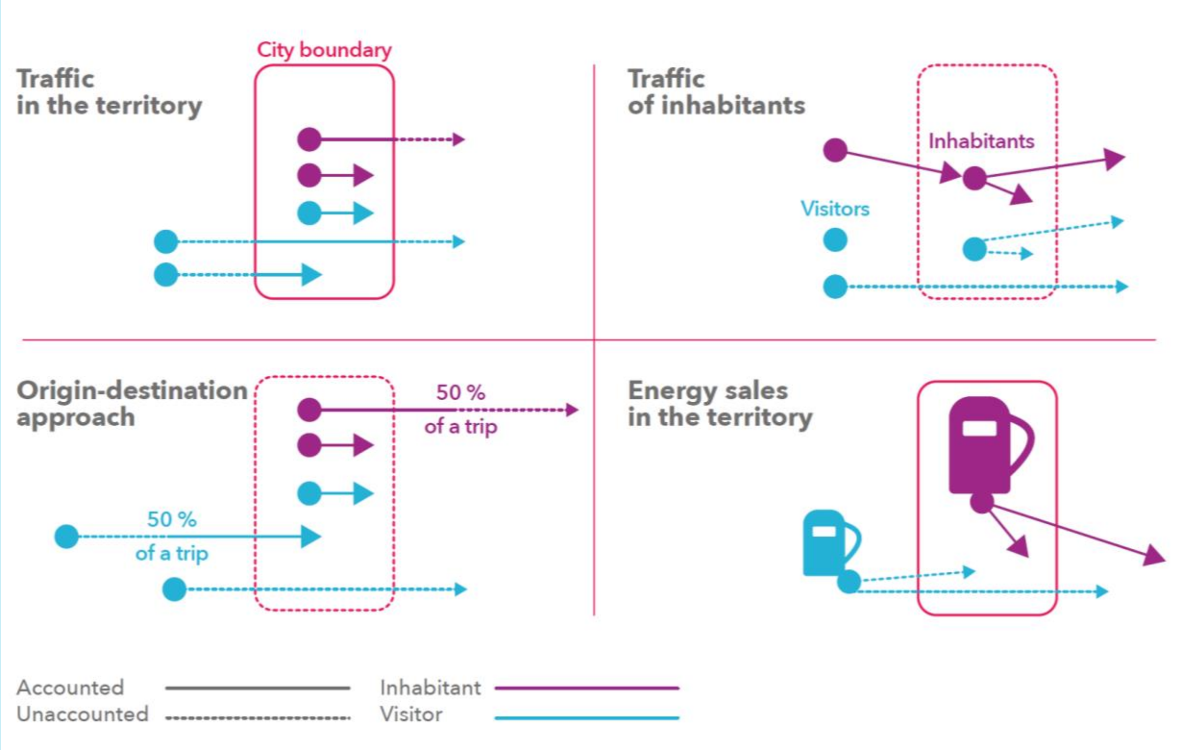


Figure 5: Different system boundaries for urban transport emission accounting

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 wild fires), 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:

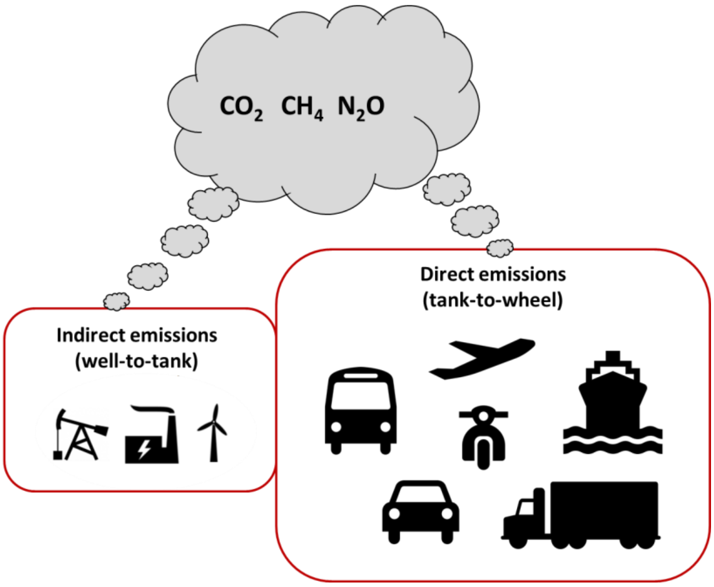
1. Particles in the air absorb sunlight, generating heat in the atmosphere.
2. Winds transport soot particles to the Arctic and the Himalayas, where they settle on ice and snow like a black blanket, stopping the reflection of sunlight. Instead, radiation is absorbed, accelerates the melting of the arctic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

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

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.

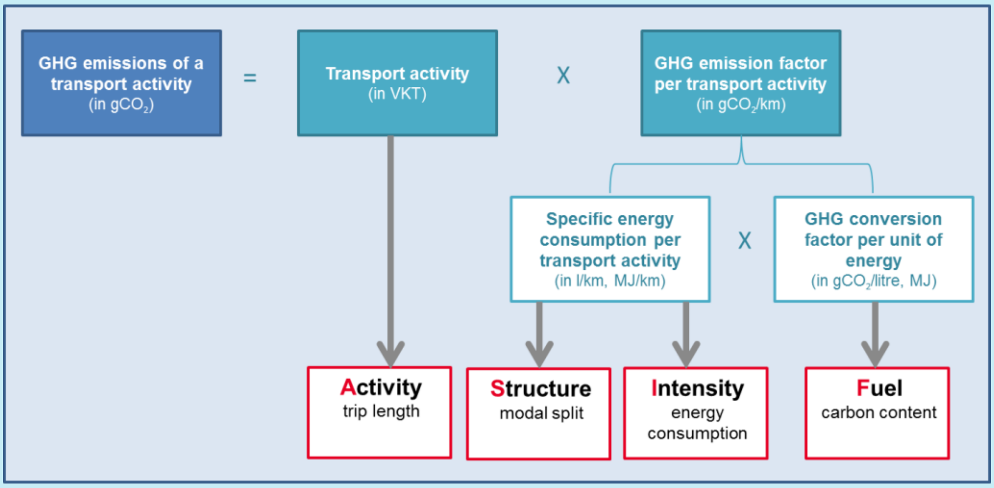


Figure 7: ASIF Framework for the calculation of transport emissions

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.

Aggregation / 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.

On the Partnership level we want to aggregate the sum of emission reductions in all Beneficiary Partner contexts.

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 usually 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

Data source	Means of transportation	Type of data	System boundaries	Fleet composition	Traffic situation
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
Public transport network plans	■ Bus ■ Subway ■ Regional train	Length of each public transport route	Territorial: public transport network might differ to geographical 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 geographical boundaries of the city	No	No
IC cards	■ Bus ■ Subway	■ Number of passenger trips ■ Pkm (only subway)	Territorial: public transport network might differ to geographical boundaries of the city	No	No
Car hailing apps	■ Taxi	■ Number of passenger trips ■ Pkm	Territorial: public transport network might differ to geographical 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 expect 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:

The proportion of 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).

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 para-transit (auto-rickshaw, irregularly operating mini-busses/tuk-tuk/matatus, etc.).

However, informal transport, particularly minibus transport, may be 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 time table, 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 carry at least 8 passengers in addition to the driver).

4.2. Calculation & Aggregation

Calculation

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

Aggregation / 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. Templates for each MobiliseYourCity Impact Indicator can be accessed via separate excel sheets. Please contact your MobiliseYourCity counterpart for further information.

On the Partnership level we want to aggregate the number of Partner Cities that improve the access to public transport shares by certain amounts (e.g.: by up to 3%, 5%, 10%).

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. Carry out spatial analysis to delimit the built-up area of the urban agglomeration
2. Compile an inventory of the public transport stops in the are defined in step one
3. Estimate the proportion of the population with access to PT out of the total population of the city (UN-HABITAT, 2016)

Step 1

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

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. OpenStreetMaps 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

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.

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. 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).

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 death related to traffic:

The usual international definition for a death related to traffic, 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

$$Fatality\ rate\ =\ 100000 * \left(\frac{\sum Persons\ killed\ in\ transport\ mode\ i}{Total\ population\ in\ the\ area\ covered\ by\ the\ SUMP}\right)$$

i = Transport mode (passenger car, freight traffic, tram, bus, train, motorcycle, moped, ferryboat, cyclist, pedestrian, etc.)

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

Aggregation / 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. Templates for each MobiliseYourCity Impact Indicator can be accessed via separate excel sheets. Please contact your MobiliseYourCity counterpart for further information.

On the Partnership level we want to aggregate the number of Partner Cities that achieve a reduction of their respective fatality rates by certain amounts (e.g.: by up to 5/100000, 10/100000, 15/100000).

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, we will focus 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, we do not require 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 air-flow 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 (the breathing zone) 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

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

Aggregation / 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.

On the Partnership level we want to aggregate the 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. Please refer to chapter three for further details.

In the absence of annual means, measurements covering a more limited period of the year can exceptionally 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).

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. We do so to make sure that the indicator reflects the accessibility of essential services accurately. 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, can be covered sufficiently 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. We therefore try to provide appropriate standards and guidance in the following paragraphs, 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.

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

- 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 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 para-transit (auto-rickshaw, irregularly operating mini-busses/tuk-tuk/matatus, etc.).

Informal 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 time table, 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).

7.2. Calculation & Aggregation

Calculation

$$\%\ of\ NMT\ and\ PT\ =\ 100 * (1 - \left(\frac{Trips\ travelled\ with\ an\ individual\ motorized\ transport}{Total\ trips\ travelled\ with\ all\ modes}\right))$$

Aggregation / 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. Table 8 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.

On the Partnership level we want to aggregate the number of Partner Cities that achieve an increase of their respective modal shares of non-motorized and public transport by certain amounts (e.g.: by up to 2%, by up to 5%, by up to 7%).

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, WiFi, 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 taken into account. 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. Investment Indicators

A core deliverable of any SUMP or NUMP is a list of actionable investment priorities to enhance the existing urban mobility frameworks. MobiliseYourCity 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 (i.e. payment required in the future for parking, which was previously free of cost).
- Investment Indicator 5: The amount of **mobilised public and private funding** for the implementation of the SUMP/NUMP in Euro (€).

For Investment Indicator 5 – Total mobilised Funding: For this indicator we assess the average annual budgets spent during the last/current budgetary cycle, comprising of the individual budgets of the several relevant institutions. Against that we compare the future budgets, which might have been positively affected by SUMPs/NUMPs. It is recognized that this indicator rather provides estimates of budget impacts of SUMPs/NUMPs. Please provide values in Euro (€).

The respective values for each investment indicator (except investment indicator 5) shall be retrieved from the respective SUMP/NUMP and be reported in the following or in a similar manner:

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 (i.e. payment required in the future for parking, which was previously free of cost).			

9. Annexes

9.1. 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 boardings/alightings 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 in to green areas, parks, pedestrian places	■ Pedestrian and bicycle counts in these areas ■ Number of street events (festival, market, exhibition…) using the street space

Topic	Infrastructure or services offered	Use of the new infrastructure or service
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
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

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9.3. Index of Boxes

9.4. Index of Figures

9.5. Index of Tables