

The following indicators were used to calculate the impact of the quantitatively appraised projects (refer to Table 6 for a summary):

### ● Congestion

This indicator usually refers to delays in road traffic during peak hours as compared to off-peak hours. The quantitative appraisal of the Istanbul SUMP projects uses 'Total time spent on the network' and does not take into account the difference between peak and off-peak road traffic. The benefits of the projects are expressed in terms of 'travel time saved'.

### ● Environmental sustainability

One of the key indicators for this objective is GHG emissions, which relates to the impact of motorised traffic on climate change. The Handbook on the External Costs of Transport refers to the CO<sub>2</sub> equivalent for this indicator, based on emission characteristics for relevant vehicle types. The emission of PM is an indicator for the impact of motorised transport on local air quality and citizens' health issues.

### ● Road safety

The Istanbul SUMP uses fatal accidents and accidents with severe injuries as indicators. The Handbook on the External Costs of Transport (European Commission) uses a fatal accident equivalent, a unit that combines the cost of life, work power lost and medical costs.

Objective	Indicator	Target for 2040	Indicator used in overall evaluation
Reduce traffic volumes, congestion and automobile dependency	Delays in road traffic during peak hours compared to off-peak travel (private road traffic)	30% – 50% reduction	Time spent on the transportation network
Have an environmentally sustainable transportation system	Per capita well-to-wheel GHG emissions	60% reduction	Well-to-wheel CO <sub>2</sub> equivalent emissions and PM emitted
Improve the safety and security of transport and travelling	Per capita fatal accidents and serious injuries	Zero fatalities in traffic accidents in the central areas (mixed-use) 60% reduction on main arterials 70% reduction in severe injuries	Fatal accident equivalent

**Table 6:** Overall Impact Valuation and Relation with SUMP Targets

## Monetary units as common denominator

For quantitatively appraised projects, costs and benefits need to be calculated in monetary units.

To calculate the monetary value of a benefit, certain assumptions need to be made, such as the value of travel time lost in congestion, the external costs of GHG emissions, health benefits or road accidents. The Istanbul SUMP used the Handbook on the External Costs of Transport (European Commission) and made some assumptions to reflect local prices.

## Baseline Values

Baseline values for the indicators, the current values, are needed to calculate the benefits of the projects in monetary units, for example, actual emissions or hours lost on the network. These are called physical values, for example, road safety is represented by the number of fatal accidents. However, accidents with severe injuries were also considered to calculate a figure for a fatal accidents equivalent.

## Well-to-Tank and Well-to-Wheel Emission Values

For CO<sub>2</sub> emissions, two values were considered: tailpipe emissions and well-to-tank emissions:

- **Tailpipe emissions** are purely related to carbon fuels used in vehicles; consequently, the tailpipe emission of an electric vehicle is zero.
- **The well to tank emissions**, also known as upstream or indirect emissions, shows an average of all GHG emissions into the atmosphere from the production, processing and delivery of a fuel or energy source, up to the point a vehicle is fuelled. In the case of electricity, this depends on the power that is used for electric generation. When it is generated using carbon fuels, the emissions related to production and transport, as well as to power plants, are included. When it is generated by, for instance, hydro or wind power, well-to-tank emissions are zero. In 2015, 32% of Turkey's electricity was generated from renewable sources.<sup>11</sup>

The total CO<sub>2</sub> emissions for transport are the sum of tailpipe and well-to-tank emissions and this sum is referred to as **well-to-wheel**.

The baseline values for external cost calculations are shown in Table 7.

**Table 7:** Baseline External Cost Values (2019)

External cost factor	Baseline physical values per year	Unit cost (TL)	Baseline monetary value per year (Million TL)
Time spent on the network	1,964 million hours	* Car: 38.4/hour * PT: 21.0/hour * Company/School * Bus: 9.0/hour	41,542
Air quality	2,604 tons PM emitted	1,377	843
Well-to-Wheel	10,642,510 tons CO <sub>2</sub> emitted		1,819
Tailpipe emission	8,594,636 tons CO <sub>2</sub> emitted	362 <sup>12</sup>	1,421
Well-to-tank	2,047,874 tons CO <sub>2</sub> emitted		398
Road Safety	346.2 fatal accidents equivalent	7,464,358	3,467

<sup>11</sup>Energy Policies of IEA Countries, Turkey 2016 Review, International Energy Agency, Paris 2016

<sup>12</sup>Derived from 2016 figures (362 TRY) = (100 €/tons tCO<sub>2</sub>-2eq)<sub>2016</sub> x (€/TRY-3.20)<sub>2016</sub> x (2016 – 2021 GDP Growth in International US \$ = 1.13)

## Impact of Business-as-Usual (BaU) Scenario

Significant developments need to be taken into account for a representative scenario of the future of Istanbul in the year 2040, the target year of the Istanbul SUMP, if no additional projects/interventions are implemented. This situation is BaU and developments considered as part of this scenario include:

- The municipality and other authorities have already decided to implement certain plans, irrespective of the implementation of the Istanbul SUMP. Examples of such plans are Metro and other rail projects that are already committed to and projects already being constructed.
- The assumption that the vehicle fleet in Istanbul will gradually change to electric, regardless of the projects proposed in the Istanbul SUMP. The production and sales figures of electric vehicles are rapidly increasing worldwide and the share of electric vehicles will increase in Turkey as well. Turkish authorities can even promote electric vehicles through tax incentives and other price instruments. However, it is considered that this is not within the decision-making power of IMM and therefore it was not considered as a possible project in the Istanbul SUMP.
- Calculations made in the framework of the Istanbul SUMP show that PM emissions in 2040 will be reduced, even if SUMP projects are not implemented, as a result of introducing electric vehicles in Turkey and Istanbul.
- As a result of introducing electric vehicles, CO<sub>2</sub> emissions increase over time, while tailpipe emissions decrease.
- Well-to-tank emissions increase considerably over the plan period. This shows that Turkey produces electricity, mainly using carbon fuels.

The comparisons between BaU and SUMP projects implemented (indicated as SUMP in the graphs) are given in the following graphs. Some graphs also compare the BaU scenario with 2040 targets.

PM emissions for the BaU scenario and the SUMP target are shown in Figures 19 and 20 respectively, and CO<sub>2</sub> emissions are shown in Figure 21.

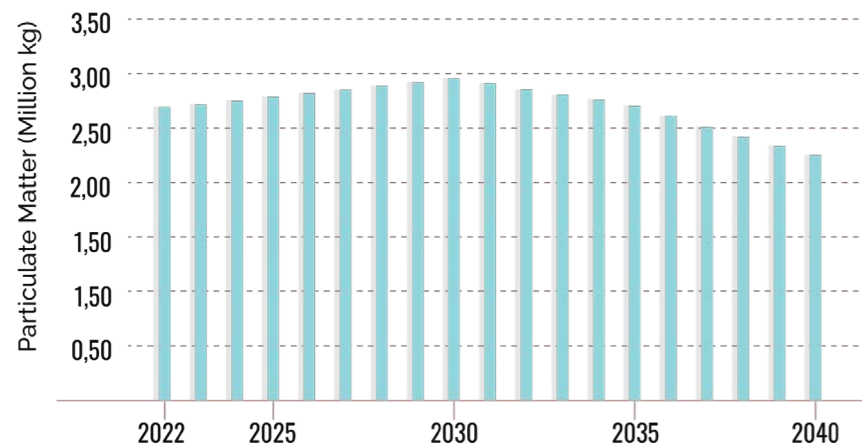


Figure 19: Total PM Emission in BaU Scenario

Figure 20: Per Capita PM Emissions in BaU Scenario and 2040 Emission Target Values

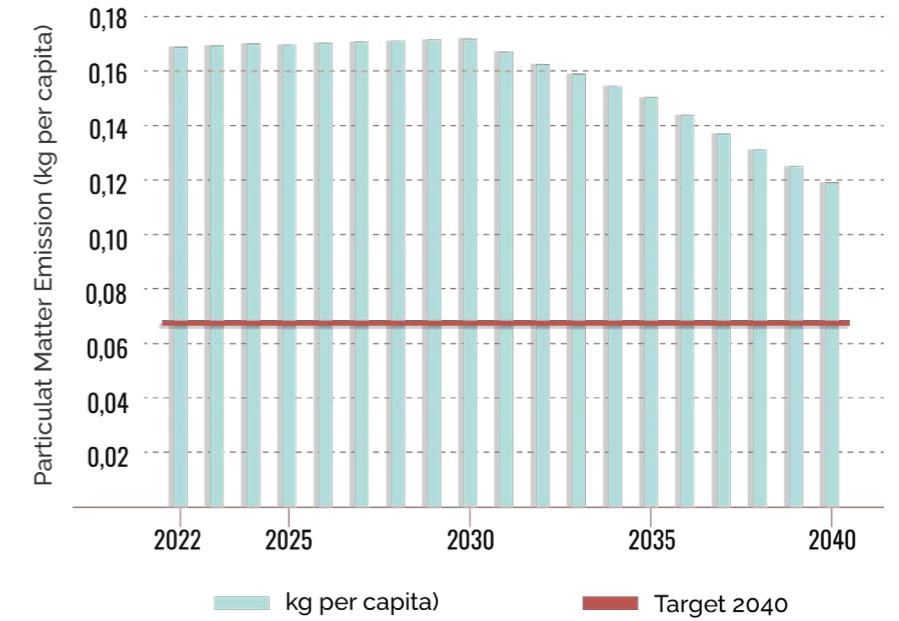


Figure 20 shows the 2040 target for well-to-wheel PM emissions per capita as a straight line (0.07 kg per capita). For PM emissions, it is assumed it will be in line with CO<sub>2</sub> emissions (60% reduction).

Figure 21 shows total tCO<sub>2</sub> emissions per capita in the BaU scenario and the target in 2040. For the total tCO<sub>2</sub> per capita, the baseline value (current) is 0.72 and the target is 0.29 (60% reduction).

Figure 21: Per Capita CO<sub>2</sub> Emissions in BaU Scenario and 2040 Emission Target Values

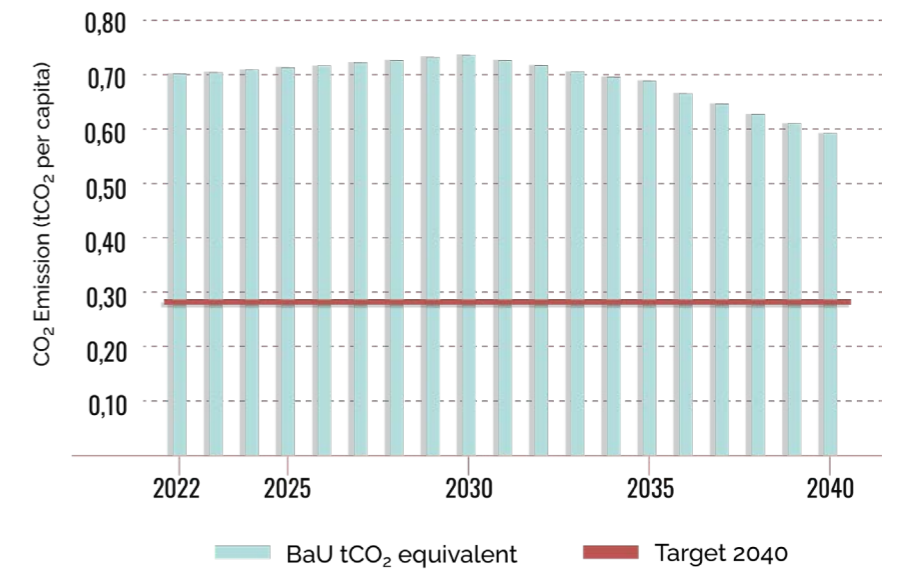


Figure 22 shows total well-to-tank and tailpipe tCO<sub>2</sub> emissions equivalent for the BaU scenario between the base year and 2040. Figure 22 shows that the share of tailpipe emissions in well-to-wheel emissions decreases as 2040 approaches – a result of the market penetration of electric vehicles.

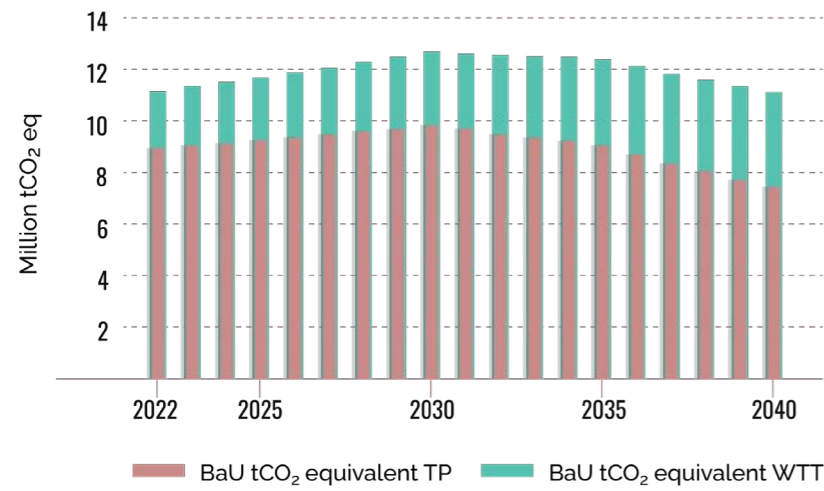


Figure 22: Total CO<sub>2</sub> Emissions in BaU Scenario

Figure 23 shows the expected development in the number of fatalities (expressed in fatal accident equivalent). Without other policies being implemented, the number of fatalities mainly depends on the development of traffic volumes and therefore shows a linear increase.

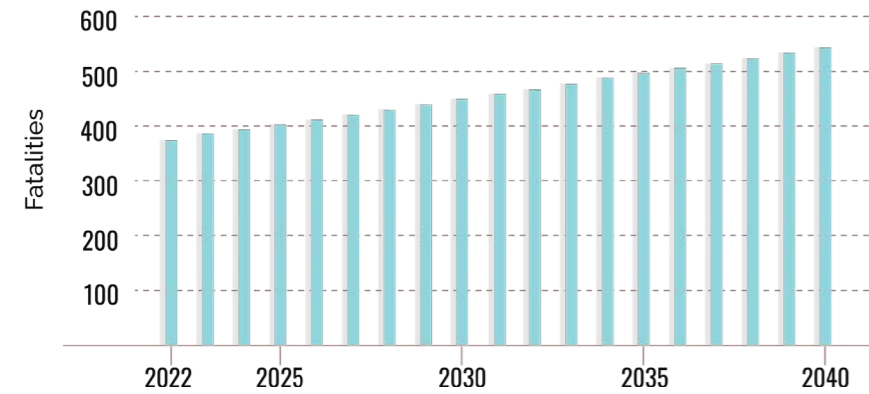


Figure 23: BaU Scenario Road Safety: Development of Fatalities (Total)

Figure 24 illustrates time spent on the network in the BaU scenario and shows a constant increase to 2040. The target for 2040 agreed in the framework preparation for the Istanbul SUMP is a range of 30%–50% reduction.

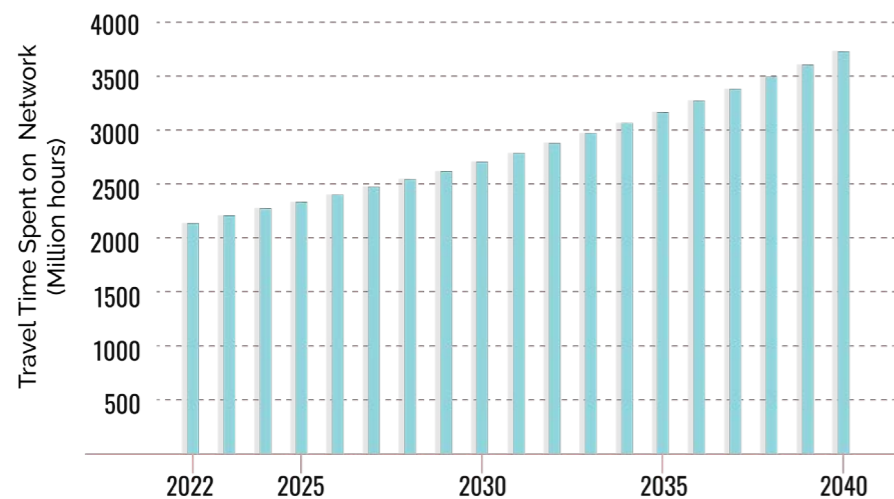
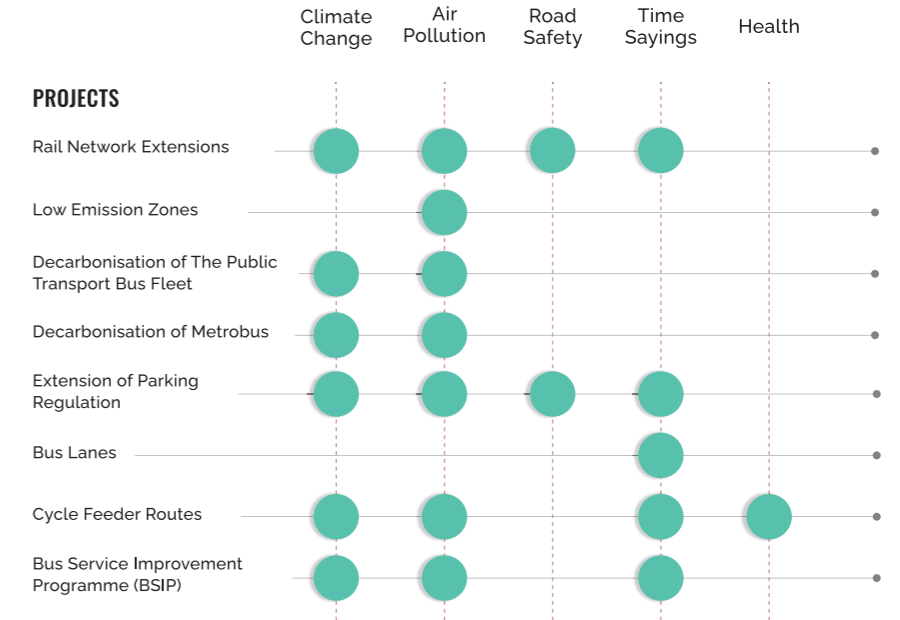


Figure 24: BaU Scenario Congestion: Development of Hours Spent on the Network (Total)

## Project Contributions to Targets

All projects contribute to a certain extent to addressing Istanbul's mobility issues. This section explores the impacts of the quantitatively appraised projects on the indicators selected from the Handbook on the External Costs of Transportation. Not all projects will have an impact on all indicators, which is obvious for some projects, for instance: decarbonisation projects have no impact on congestion or road safety; the introduction of bus lanes is assumed to have a marginal impact on air quality and is therefore not considered. The relation between projects and impacts as considered in the appraisal methodology is shown in Table 8.

Table 8: Project Impact Matrix for the Quantitatively Appraised Projects



## Climate Change and CO<sub>2</sub> Emissions

According to the GHG inventory made within the scope of the Istanbul Climate Change Action Plan, the shares of CH<sub>4</sub> (0.40%) and N<sub>2</sub>O (1.48%) among the emissions from the transportation sector in 2019 are at a very low level compared to the share of CO<sub>2</sub> (98.12%). Therefore, only CO<sub>2</sub> emissions are taken into account within the scope of the Istanbul SUMP.

Figures 25 and 26 show the development of CO<sub>2</sub> emissions in BaU scenario and with 8 projects implemented:

● Figure 25: total tCO<sub>2</sub> emissions (well-to-wheel)

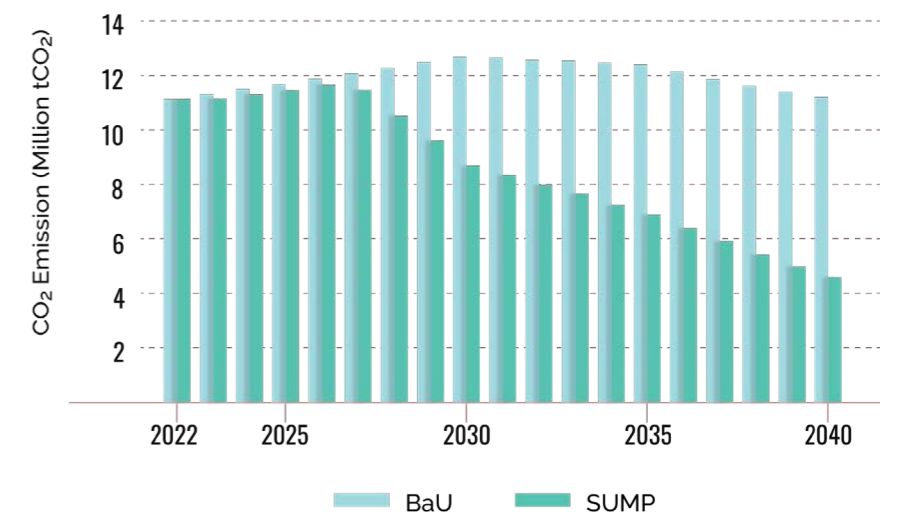
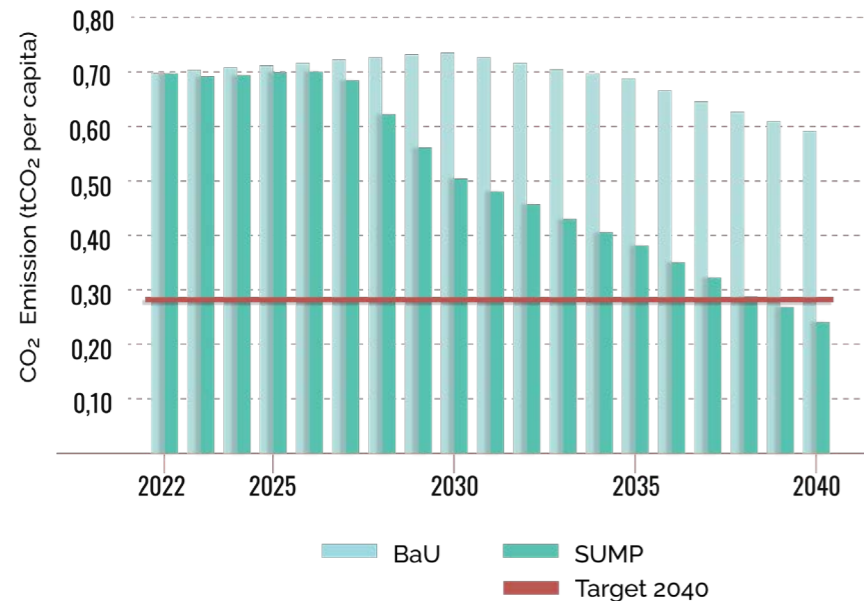


Figure 25: Comparison of Total CO<sub>2</sub> Emission in BaU Scenario and SUMP

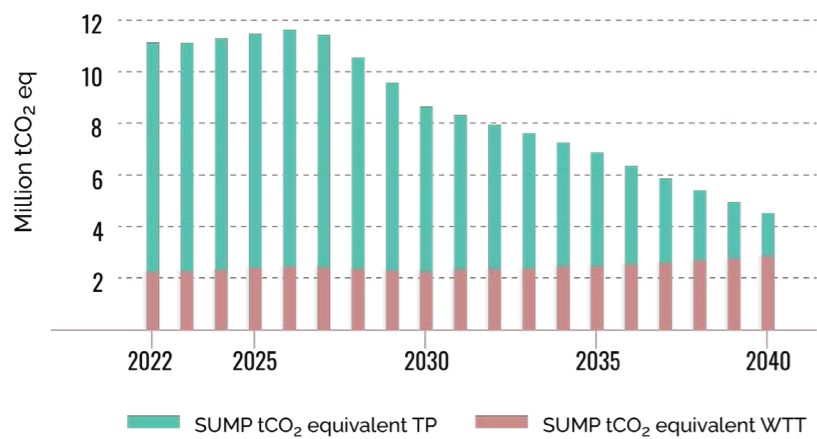
● Figure 26: per capita tCO<sub>2</sub> emissions (well-to-wheel) and the target for 2040 as a straight line.



**Figure 26:** CO<sub>2</sub> Target Emissions and Comparison of Per Capita CO<sub>2</sub> Emissions in BaU Scenario and SUMP

It is seen in Figure 25 that the change in total CO<sub>2</sub> emissions by years and the impact of 8 projects, and in Figure 26, 8 projects evaluated quantitatively will reduce the per capita CO<sub>2</sub> emission value and the target value will be reached by 2040.

Figure 27 shows the contribution of the eight projects to CO<sub>2</sub> emissions for well-to-tank; the contribution of energy production for car fuels and tailpipe emissions. The contribution of well-to-tank increases slightly over the period of the plan, but since the eight SUMP projects considered in this graph have a strong positive impact on emissions, the target will be achieved by 2040.



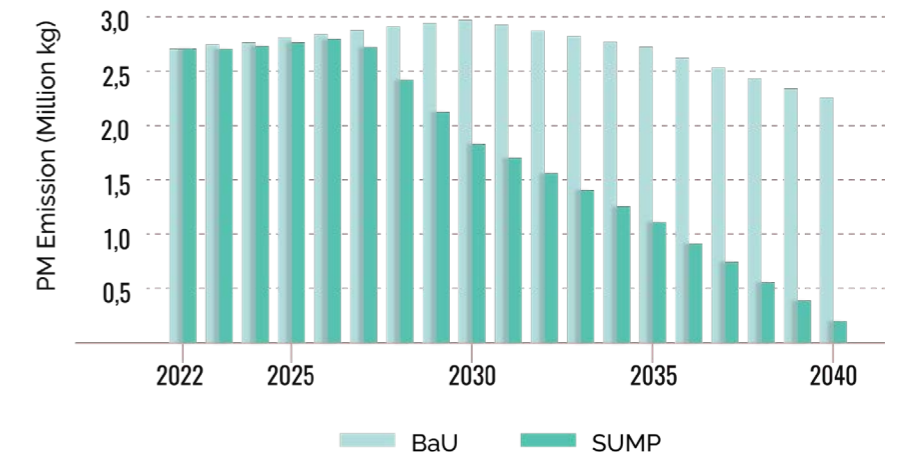
**Figure 27:** Contribution of the 8 Projects to Total Reduction (tailpipe and well-to-tank separated) of CO<sub>2</sub> Emissions

## Air Pollution

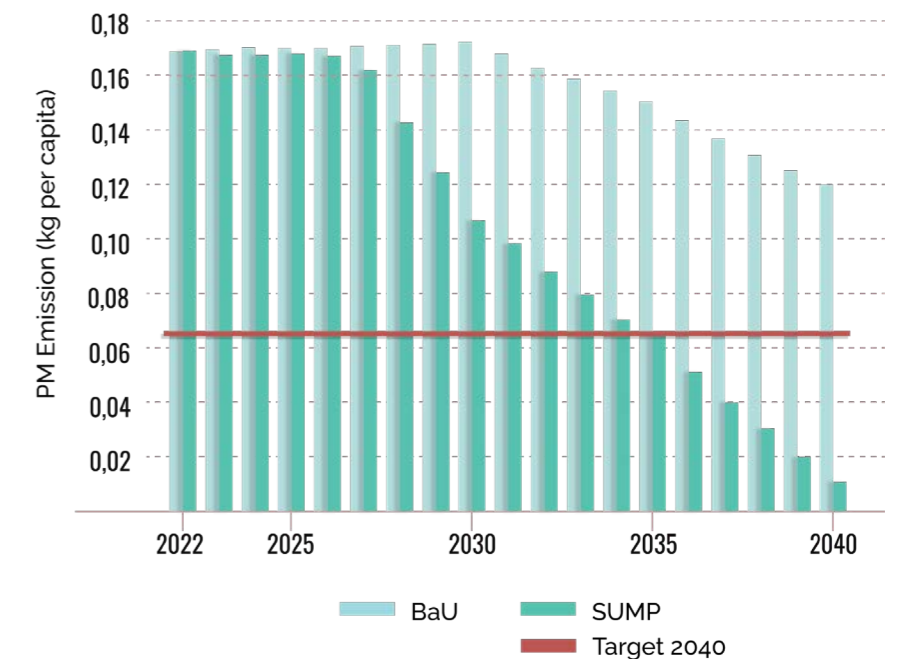
Figure 28 shows the development of PM emissions in two scenarios: with (SUMP) and without (BaU) implementing the quantitatively appraised projects. The BaU scenario shows some decrease in emissions, which results from the introduction of electric vehicles.

Figure 29 shows the development of per capita PM emissions for BaU, with and without the SUMP implementation. It shows that, with the implementation of the quantitatively appraised SUMP projects, the provisional target (0.07 kg per capita) will be achieved by the year 2034.

**Figure 28:** Comparison of Total PM Emission in BaU Scenario and with 8 Projects Implemented in SUMP



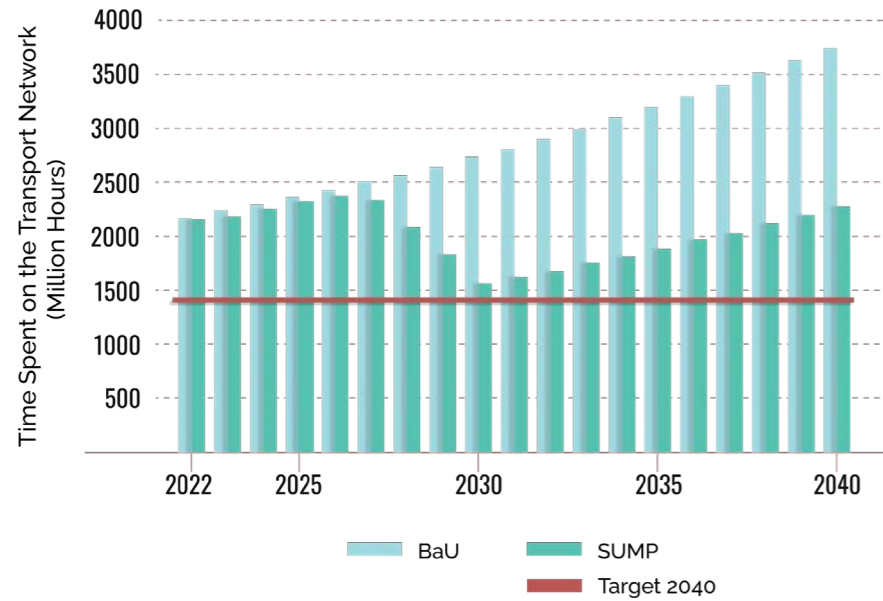
**Figure 29:** Comparison of Per Capita PM Emissions in BaU Scenario and SUMP with and without Projects Implemented and SUMP Target





## Congestion

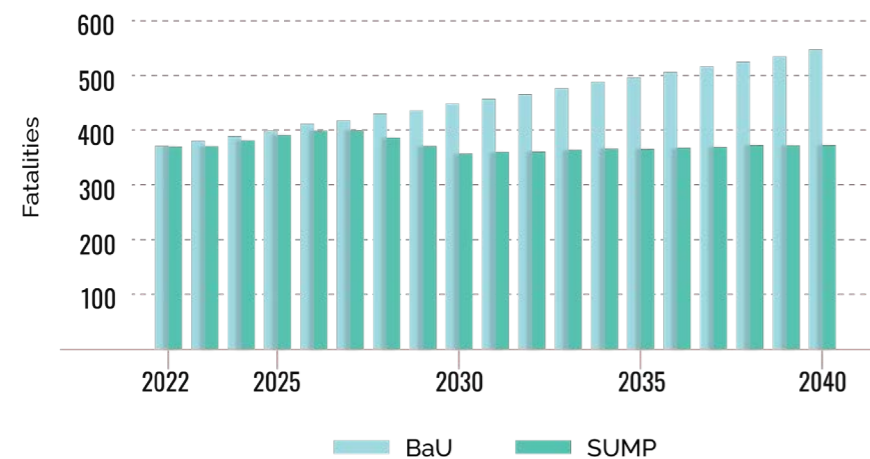
Figure 30 shows the impact of the projects on the hours spent on the transport network (all modes; for BaU with and without the SUMP implementation). The SUMP (with projects) scenario shows a sharp decrease around 2030, when the calculation assumes that significant Metro projects are in operation. This is a simplified presentation, because it assumes that all rail projects will be operational within a short timescale. This and the impact of other projects show a considerable positive impact on congestion, although not enough to achieve the target in 2040 (30% reduction).



**Figure 30:** Comparison of Hours Spent on the Network in BaU Scenario and SUMP with and without Projects Implemented and SUMP Target (million hours/year)

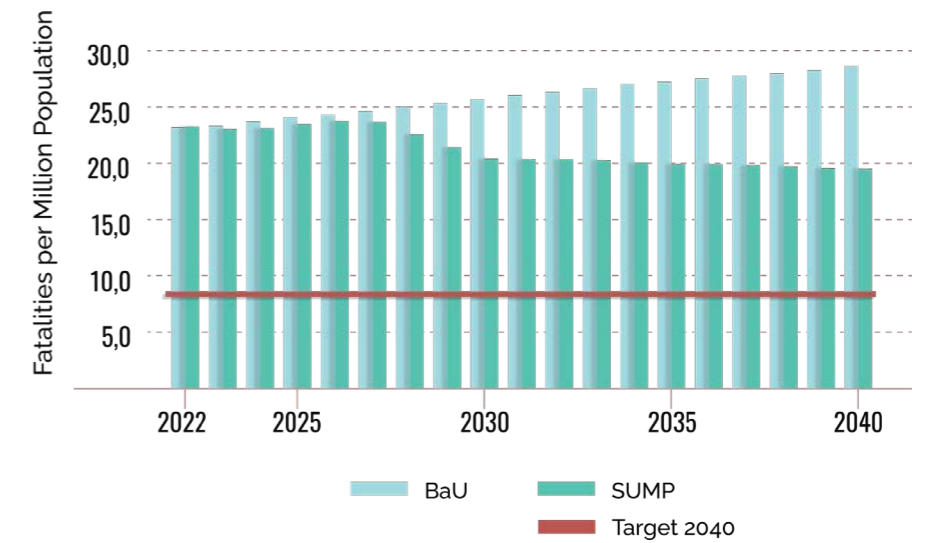
## Road Safety

The number of fatalities after the eight projects are implemented shows a similar trajectory to the one that shows hours spent on the network. This is due to the fact that, in general terms, traffic safety is linked to total vehicle kilometres on the network (Figure 31).



**Figure 31:** Comparison of Fatalities in BaU Scenario and SUMP Depending on Development of Road Safety with and without Projects Implemented

Figure 32 shows the number of fatalities per 1 million population in both SUMP and BaU cases. The target is 9 fatalities per 1 million population in 2040, although the target should be zero deaths. However, the forecasts for traffic volumes, population and vehicle ownership are a serious barrier to achieving that target. Also, it is not possible to reach the envisaged target by implementing the eight projects considered in this evaluation, so more policies focused on traffic safety are needed to achieve the target. The SUMP does plan for the implementation of several projects that will increase road safety, although these were not considered in the quantitative appraisal.



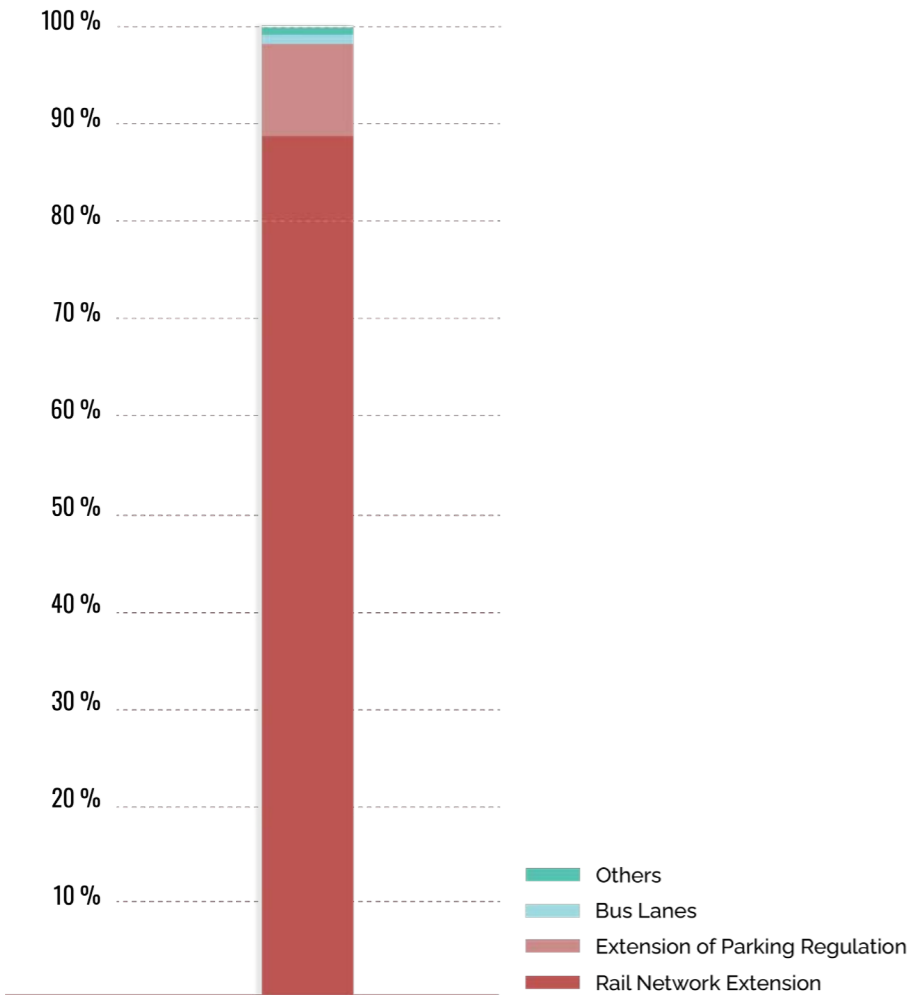
**Figure 32:** Comparison of Fatalities per 1 Million Population in BaU Scenario and SUMP with and without Projects Implemented and SUMP Target

## Cumulative Benefits

As mentioned, physical benefits (e.g. kg emission, number of accidents) can be expressed in monetary terms using the values from the Handbook on the External Costs of Transport to convert physical values to monetary values (see Table 7). This allows a comparison of the impact of projects with different characteristics and an adding up different benefits.

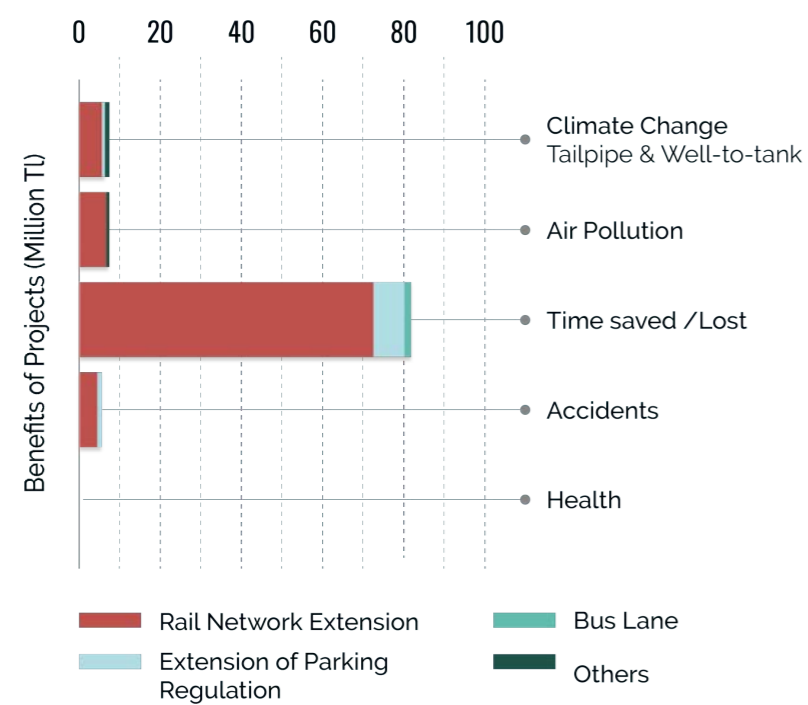
Figure 33 shows the share of monetary value of the quantitatively appraised projects as part of the total benefits calculated. The following remarks apply:

- The most benefits are generated by the **Rail Network Extension** project. It should be kept in mind that this project (in fact a total of 27, which includes 13 ongoing and 14 planned rail line projects) is also very expensive.
- The **Extension of Parking Regulation** and **Bus Lanes** projects generate considerable benefits.
- Other projects deliver fewer benefits because they are limited in scale or in investments and are therefore not shown separately.



**Figure 33:** Relative Comparison of Achieved Benefits from Quantitatively Appraised Projects

Figure 34 shows which benefits originate from which projects. Over 82% of benefits are time savings, which are mostly generated by the implementation of projects in the context of the rail network extension. Benefits for the environment are mostly generated by the decarbonisation projects.



**Figure 34:** Origin of Generated Benefits

As previously noted, some projects generate considerable benefits, but are expensive. The BCR indicates benefits relative to the price of implementation. Figure 35 ranks the quantitatively appraised projects according to their BCR. Most projects are attractive, with a BCR value higher than 1.50. The Low Emission Zones project has the highest BCR (3.25), followed by Bus Lanes (2.49), Extension of Parking Regulations (2.02), and Rail Network Extension (1.95). The Bus Service Improvement Programme (BSIP) project has a relatively lower return on investment, but offers other benefits, such as a positive impact on inclusiveness, which is very hard to quantify. It should be noted that a more detailed cost-benefit analysis needs to be carried out for each project before implementation.

**Figure 35:** Quantitatively Appraised Projects Ranked According to BCR Values

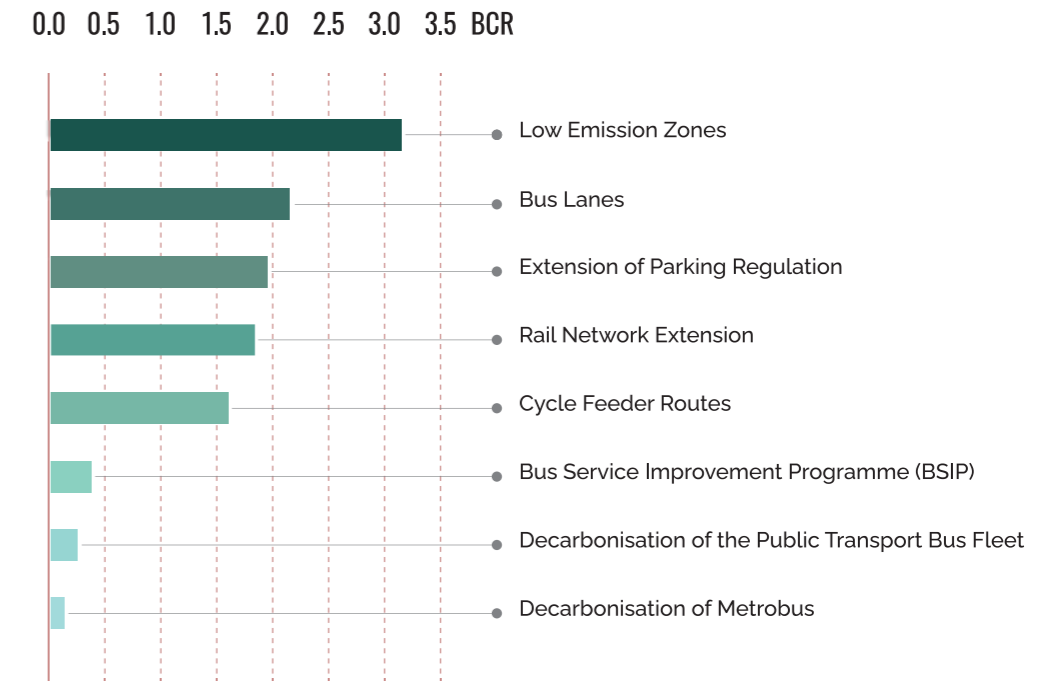
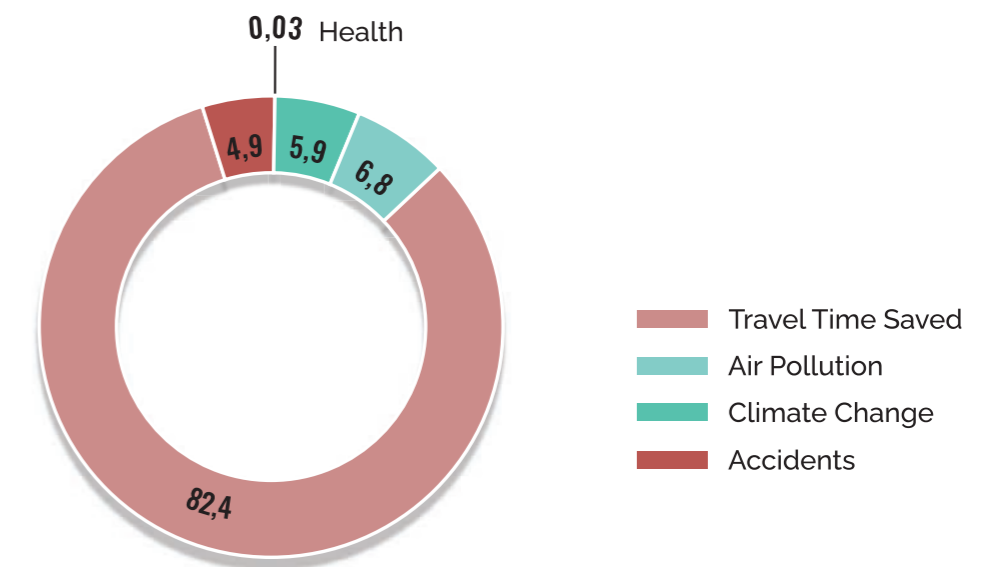


Figure 36 shows the distribution of total benefits of the quantitatively appraised projects; 82.4% of total monetary benefits account for the value of travel time to be saved by the implementation of projects mostly generated by the Rail Network Extension project.

**Figure 36:** Distribution of Benefits of Quantitatively Appraised Projects (%)



# Qualitatively Appraised Projects

The MCA was used to qualitatively appraise 18 SUMP projects. The framework for this assessment was developed by the Project Team. Stakeholders, including the Project Team and the IMM SUMP Team, participated in several surveys to score the qualitatively appraised projects. Besides this scoring, an objective's weighting, determined before the Implementation Plan Roadmap phase by participatory methods, was also taken into account. The weighted scores for each project were determined and named as their MCA score.

As part of this MCA appraisal, every project was scored in terms of its anticipated contribution to nine SUMP objectives and related indicators. These scores were obtained from four separate survey results arranged in different stages. The Project Team and the IMM SUMP Team determined the contribution of the qualitatively appraised projects to selected indicators with the help of a 5-point-Likert scale. All scores were combined with the help of several calculations to derive the final contribution score, which was called an MCA score.

Figure 37 shows that the highest MCA scores belong to five projects: the Extension of Transfer Centres (65.3); Passenger Sea Transport – Fleet Renewal (57.3); Istanbul Network Management Control Centre (INMCC) (48.9); Extension of Real Time Passenger Information and Open Data (31.2); and Minibus Feeder Routes: Arnavutköy District (29.8). These five projects represent 63% of the overall anticipated SUMP impact of qualitative projects. This is presented graphically in Figure 37.

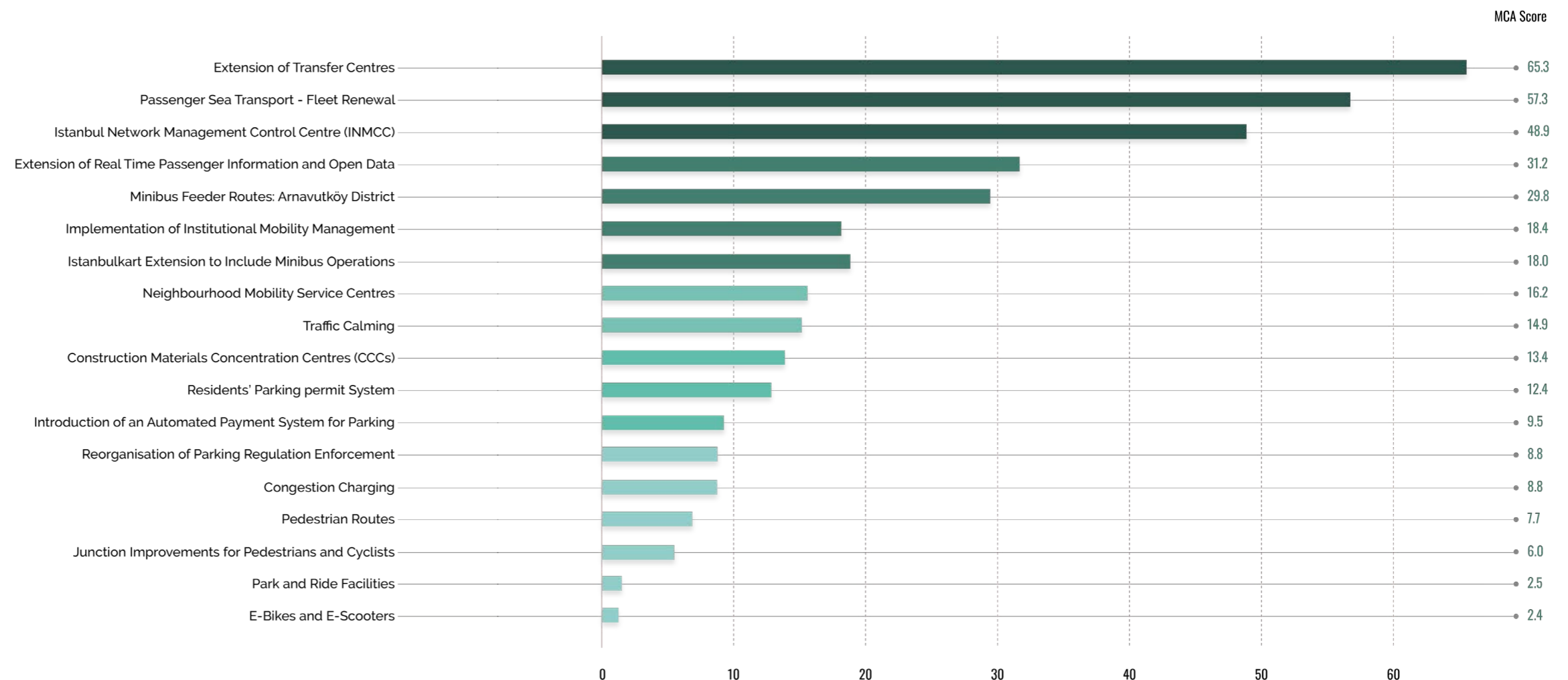


Figure 37: Final MCA Scores of Qualitatively Appraised Projects

Table 9 shows the contribution of qualitatively appraised projects to the 9 objectives of SUMP.



13 projects out of 18 contribute to Objective 7 - "Stimulate the modal shift to active modes (walking and cycling)" through selected indicators according to Table 9. On the other hand, 3 projects contribute to Objective 9 - "Have an efficient city logistics system with minimal negative impact".

## Gender Equality and Social Inclusion (GESI) Benefits

The Istanbul SUMP differs from other SUMP studies in foreign countries in its specific focus on GESI-related issues and it has developed its own GESI appraisal framework to evaluate core projects on social inclusion and gender equality goals, tailored for the Istanbul context. A series of workshops and surveys with the IMM SUMP Team, first, discussed how and why GESI is an important concept in relation to transport policy, second, defined the GESI parameters specific, and third, evaluated the proposed core projects using the GESI parameters. As a result, the IMM SUMP Team evaluated the anticipated GESI impacts of 26 core projects based on 18 parameters related to: social impacts (accessibility, safety,

**Table 9:** Contribution of Qualitatively Appraised Projects to Istanbul SUMP Objectives

**Table 10:** Final GESI Scores of the Projects

empowerment of the underrepresented groups and the feeling of freedom); environment and public health (physical activity, pollution and emissions); economic impacts (travel time, affordability, disaster resilience, land use, local economy, informal transport and wealth); and political impacts on governance and participation. Out of 26 projects, 14 received an above-average GESI score. As it seen on the Table 13, the Rail Network Extension project received the highest GESI score, followed by three active transport-related projects and then projects related to mobility management and public transport (including Extension of Transfer Centres, Passenger Sea Transport – Fleet Renewal, Bus Service Improvement Programme (BSIP) and Bus Lanes).

Project	GESI Score
Rail Network Extension	19.15
Pedestrian Routes	15.08
Cycle Feeder Routes	14.27
Junction Improvements for Pedestrians and Cyclists	13.50
Implementation of Institutional Mobility Management	12.85
Neighbourhood Mobility Service Centres	11.50
Passenger Sea Transport- Fleet Renewal	11.08
Park and Ride Facilities	10.81
Extension of Transfer Centres	10.62
Traffic Calming	10.35
E-Bikes and E-Scooters	10.15
Bus Service Improvement Programme (BSIP)	9.81
Istanbul Network Management Control Centre (INMCC)	9.58
Bus Lanes	9.35
Extension of Parking Regulation	8.46
Low Emission Zones	7.42
Minibus Feeder Routes: Arnavutköy District	6.92
Construction Materials Concentration Centres (CCCs)	6.46
Extension of Real Time Passenger Information and Open Data	6.19
Residents' Parking Permit System	4.77
Congestion Charging	4.69
Istanbulkart Extension to Include Minibus Operations	4.12
Decarbonisation of Metrobus	2.73
Introduction of an Automated Payment System for Parking	2.00
Decarbonisation of The Public Transport Bus Fleet	1.42
Reorganisation of Parking Regulation Enforcement	0.50

While the Istanbul SUMP promotes low-carbon mobility policies (traffic congestion tax, LEZ, etc.) and active mobility, it should refrain from creating gentrified and segregated neighbourhoods that are sterile, homogeneous and where poorer groups cannot reside. In this sense, while transportation policies need to be handled together with housing and other land use policies, it is also necessary to work on soft policies, such as rent control and social assistance for food and other basic needs. Different sectors and responsible units must work together to eliminate transport-based inequalities, and the Istanbul SUMP has created an important platform for such studies.



# Sustainable Development Goals Assessment

The SDGs are key elements of the action plan to ensure sustainable development on a global scale. Developed by the United Nations (UN), they consist of 17 goals and 169 targets<sup>13</sup>.

By using a tailored SDG tool, 80 basic principles (performance criteria) were developed, based on those goals and targets, and adapted for use in the Istanbul SUMP. Most of these basic principles cover more than one SDG, and each principle acts as a combined indicator to monitor the progress towards the related goals. Istanbul SUMP is in line and contributes to the achievement of SDG 1 (No Poverty), SDG 3 (Good Health and Well-Being), SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), SDG 10 (Reduced Inequalities), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 16 (Peace, Justice and Strong Institutions) and SDG 17 (Partnerships for the Goals) given in Figure 38.

Once a phase of the Istanbul SUMP was completed, the principles related to SUMP phases were evaluated to see whether the combined indicators were met to appraise the phase according to the SDGs. Three SDG workshops were held periodically to hear the opinions of IMM officials on compliance with these basic principles. Istanbul SUMP's alignment to the SDGs is shown in Figure 38. In the figure, end-of-the Project targets, phase targets and phase evaluation results are presented together.

Figure 38 shows that according to the results of the third workshop, Istanbul SUMP reached its full potential for SDG 1, SDG 3, SDG 8 and SDG 9. SDG 11. The project's contribution to SDG 11 that is the most benefitting goal from Istanbul SUMP is 96% of its full potential while the project's contribution to rest of the SDGs is over 93%.



Figure 38: Sustainable Development Goals (SDGs) and Istanbul SUMP Assessment Results

Within the scope of all these appraisals, a thorough examination was made for 79 (longlist) policy measures derived from the vision and objectives of the Istanbul SUMP, and 26 core projects developed based on these policy measures. The overall conclusion drawn from appraisals is that the outputs of different phases of the Istanbul SUMP contribute adequately to the SDGs. In other words, the Istanbul SUMP is doing its part in achieving global SDGs in all aspects, from scope to context, vision and projects. As one of the few settlements in the world in terms of its population and many other characteristics, Istanbul makes a significant contribution to the SDGs, thanks to the Istanbul SUMP.

<sup>13</sup><https://www.tr.undp.org/content/turkey/tr/home/sustainable-development-goals.html>

# All Scores Combined

A methodology was developed to arrive at a combined score. This procedure combines BCR, MCA, SDG and GESI scores, along with scores from stakeholder workshops. Since all scores have different characteristics and ratings, they were standardised and weighted for each assessment method. These weights were determined by the Project Team. Combined scores take a maximum value of 1.0.

Table 11 shows the combined scores and ranks projects accordingly.

Table 11: Ranking of the Core Projects According to the Combined Scores

Project	Combined Score
Rail Network Extension	1.00
Extension of Transfer Centres	0.99
Low Emission Zones	0.95
Cycle Feeder Routes	0.95
Passenger Sea Transport- Fleet Renewal	0.91
Istanbul Network Management Control Centre (INMCC)	0.90
Bus Lanes	0.88
Pedestrian Routes	0.84
Extension of Parking Regulation	0.84
Traffic Calming	0.78
Implementation of Institutional Mobility Management	0.76
Junction Improvements for Pedestrians and Cyclists	0.75
Neighbourhood Mobility Service Centres	0.73
Extension of Real Time Passenger Information and Open Data	0.73
Bus Service Improvement Programme (BSIP)	0.64
Istanbulkart Extension to Include Minibus Operations	0.62
Park and Ride Facilities	0.61
Minibus Feeder Routes: Arnavutköy District	0.59
Congestion Charging	0.59
E-Bikes and E-Scooters	0.57
Construction Materials Concentration Centres (CCCs)	0.55
Residents' Parking Permit System	0.54
Decarbonisation of Metrobus	0.50
Decarbonisation of The Public Transport Bus Fleet	0.49
Introduction of an Automated Payment System for Parking	0.48
Reorganisation of Parking Regulation Enforcement	0.47

According to the general overview, it can be concluded that none of the projects received a particularly low score. Two public transport project that are about better connections are at the top of the list. For the rest, there is no clear view on what modes are specifically favoured and there are various public transport projects at different levels in the list, the same goes for active mode projects. It shows that the results are balanced across the different transport modes and environmental impacts.