D4.9 Impact assessment and city specific policy response:

Budapest pilot

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Executive summary

One of the main reasons for the decreasing population in the inner cities is the insufficient amount of liveable public spaces. Budapest Sustainable Mobility Plan (SUMP) aims to create more liveable public spaces and an interconnected and safe bicycle network. The regulation of public space use can allow moving towards more efficient and sustainable mobility modes. The SPROUT Budapest team tried to test a proposal for regulating the public space and shared micromobility in the SPROUT project.

In this project, two use cases were analysed: the definition of a traffic-calming zone and the incorporation of 86 reserved spaces for parking shared micromobility vehicles in the downtown area, referred here as Mobility Points.

The focus of the traffic calming was to make the district more liveable and divert- traffic to the main roads bordering it. It aims to facilitate the use of the inner district streets to the cyclists and micromobility users safer and increase the safety level for vulnerable road users.

Mobility Points can help manage the deteriorated public space use caused by the increase in shared micromobility services and provide safer mobility. The Budapest Pilot created the opportunity to consider the advantages of the free-floating shared micromobility services, besides regulating public space use by micromobility vehicles.

The results of the pilot based on a detailed analysis foresee an average increase in modal share of 11.9%. It is 1.9% higher than expected before the implementation.

The stakeholders in Budapest identified the advantages and disadvantages that supportive policy measures can have on the implementation of the Mobility Points. Moreover, they helped understand the effect of introducing supportive policy measures into the use cases above.

In a nutshell, the pilot in Budapest reinforced two key messages: 1) The introduction of traffic-calming zones and the acceptance take time and require political commitment. It showed the real benefits for the whole city, enhanced with green spaces, street furniture and permissions for terraces. 2) Mobility Points plays a crucial for avoiding bad micromobility parking practices and fostering the adoption and acceptance of micromobility vehicles for people either in favour or not.

1 Introduction

1.1 Aim of the deliverable

The deliverable aims to explain the work and results of testing and assessing the pilot's mobility solutions, identify a list of alternative policy responses according to the stakeholders' objectives and users' needs, and define the final city-specific policy response. The work consists of three steps. The first step was the implementation and assessment of the mobility solution. The barriers and problems found together with the sustainability assessment were the basis for the sequential steps and the definition of the city-led policy. By the time the second step started, the City of Budapest was able to find only one problem for one of the use cases. Based on the Stakeholders Based Impact Scoring (SIS) methodology, the pilot identified the veto stakeholders, found their objects and showed the trade-offs all stakeholders have to make. In the last step, Budapest identified a list of alternative policy responses to enhance the mobility solution adoption, scalability and transferability. Finally, the pilot assessed the alternative policy responses implementation and user acceptance and defined the policy measures that harness the implementation of Budapest innovative mobility solutions.

1.2 How this deliverable relates to other deliverables

The development of the task considered previous SPROUT work. More specifically, the pilot followed the steps and methods reported in D4.8 COVID-19- disruptions and other challenges encountered during the pilot implementation forced to adjust the initial set-up as explained in this document. The list of alternative policies identified in D3.3 was essential for identifying alternative policy responses and defining the city-specific policy response. This deliverable and the rest of the pilots' reports (D4.3, D4.7, D4.9 and D4.11) will be the foundation for defining the policy implementation messages in D4.14 and the urban policy system dynamics model in D5.2.

1.3 Task participants and sharing of contribution

Involved participants in the deliverable:

- ZLC – Zaragoza Logistic Center
- Municipality of Budapest
- Municipality of Budapest District 6
- Municipality of Budapest District 7
- BKK - Centre for Budapest Transport
- Budapest Közút - Road operator of Budapest
- Budapest University of Technology and Economics
- Hungarian Cycling Society
- Lime – Shared e-scooter operator

1.4 Structure of deliverable

The deliverable is structured as follows:

- Chapter 2: Pilot activity description

- Chapter 3: T4.3 sustainability assessment
- Chapter 4: T4.4 Formulation and prioritization of alternative policy responses
- Chapter 5: T4.5 City-specific policies for harnessing the impact of new mobility solutions
- Chapter 6: Summary and Outlook
- Annexes

2 Pilot activity description

2.1 Pilot introduction

In the Budapest Mobility Plan, which is the SUMP of the city, one of the main goals is to increase the number of the active and micromobility modes. In the inner city, it is necessary to improve the parking facilities of these micromobility modes and create a safer and human-friendlier network.

The pilot area, which was presented in detail in the deliverable D4.8 (SPROUT team, 2020), is located within Budapest city centre, in Districts 6 and 7. The pilot area chosen - especially Király utca (one of the key locations for the pilot projects) - is very popular with local young people and tourists and is managed by respective District Municipalities. There are several Airbnb properties, hotels, restaurants and pubs in this area. A number of major metro, bus and tram lines can be found around the pilot area. However, public areas are currently car-centric, with parking spaces on both sides of the streets and overcrowded narrow sidewalks. Traffic jams were common along the residential streets. Both sides of the streets were occupied by parking vehicles and sidewalks were packed with pedestrians.

The 6th and 7th District Municipality prohibits leaving shared micromobility vehicles in public areas. In the pilot area, there are a few trolleybus lines. On the bordering streets, there are numerous metros, tram and bus lines.

To address these problems, we decided in the framework of SPROUT to test the implementation of two use cases. To reduce the traffic load in the city centre, calm traffic zones were created and traffic regulation changes were implemented to ensure that only those who have a business there drive into it. With regard to the lack of dedicated places for parking micromobility vehicles, the pilots aimed to create 86 micromobility points and simulated micromobility users' behaviours and movements.

2.2 Use Case 1: Király utca - Planned traffic regulation changes

In "Use Case 1", car traffic along Király utca was restricted on a short section between Rumbach Sebestyén utca (a residential street within the pilot area) and Károly körút (major road at the border of the pilot area). General road traffic was banned and only authorised and freight traffic was permitted within the new pedestrian zone. In addition, approximately 40 parking places were closed. There were no physical barriers installed to avoid through-traffic at the entrance of the street, only traffic signs were used.

In addition to the pilot project, there have been major changes within District 7 in terms of through-traffic management since 2020. This means that traffic was minimised within a wider area in District 7 by reorganising the direction of traffic flow along several residential and arterial roads.

Thanks to through-traffic reduction and the banning of the general traffic at the last section of Király utca, car traffic decreased significantly within the pilot area, while pedestrians and cyclists started to use the road.

The above-mentioned changes were made from 15 August 2020. While the changes were made as part of a pilot project, it is planned by the municipalities to be kept as a permanent design. The testing period is still ongoing, since it was extended twice (in October 2020 and in February 2021), due to the unforeseen impact of the COVID-19 pandemic. In February 2021, the pilot project was extended until the end of the “free-parking time period” + 180 days, starting from 1 March 2021. Free parking has ended on 23th of May, 2021, so the pilot project ended in the 23th of December 2021. The stakeholders decided to keep the pilot changes. The COVID-19 pandemic also affected the pilot urban mobility context, especially from autumn 2020. Due to the strict lockdown and curfew measures, there were no tourists, restaurants and stores were closed. While most people work from home, therefore it is very hard to test a non-COVID traffic situation within the area.

Measuring the impact of the pilot was quite challenging. More specifically, due to the strict lockdown during the pandemic, all restaurants and stores were closed, while gatherings in groups in public spaces were restricted from 8 March 2021, and a curfew between 8 p.m. and 5 a.m. was introduced from 11 November 2020. That means that although the initial scope of the pilot was within the new pedestrian zone at Király utca to turn car parking spaces into public spaces that would be equipped with public and restaurant-owned chairs, benches, trees, etc. and then measure the acceptance of the measure by the public and the improvement in the quality of life, the pandemic related restrictions prevented people from testing the measure. This is the reason why besides the extension of the testing period, the city decided to scale up the measures to additional areas in Budapest.

Therefore, the project also included in the analysis three additional streets in Budapest, which have very similar layouts to the one proposed in Király utca: public space, green areas, traffic calming/pedestrian zones. The three additional streets are Tompa utca, Ráday utca and Lövőház utca, the latter being in Buda. The following aspects were compared throughout the project:current design, parking lots on the street, underground parking space capacity, green areas, number of benches, number of restaurants and terraces, facilities and traffic data on cars, micromobility devices, etc.

2.3 Use Case 2: Creation of micromobility points

In Budapest, a strategic goal is to develop modal shift opportunities between public transport and shared mobility services. To this end, in recent years, BKK has developed a system for setting up mobility access points based on international examples (for example: London (Kilraine, 2021), Tel Aviv, Paris (Connexion France, 2019), etc.). The purpose of designing these sites is to make shared mobility services reliably available in a concentrated area. In this case, a pilot process was simulated relating to the shared micromobility vehicles that can be parked solely at (micro) Mobility Points. The Budapest Mobility Plan define the city structure of Budapest divided into five zones, which has an impact on the development of Mobility Points. As there are greater mobility needs in the city centre, the aim of this use case was to create a denser network of Mobility Points within a maximum 1-2-minute walk in this area. In the transition zone, this would increase to a 4-5-minute walk. These stations can be used with privately owned vehicles, too.

Based on the service level, we distinguished three types of Mobility Points:

- (Micro) Mobility Point: in densely populated areas, at every 150 metres for micromobility vehicles only (bicycle, scooter, cargo bicycle)
- Mobility Point: in a densely populated area next to micromobility vehicles, dedicated carsharing and shared scooter parking at every 250-300 metres
- Mobility Station: at larger intermodal/transport hubs, a more extensive Mobility Point for shared modes of transport along with additional services (for example: delivery pick-up point, luggage storage, etc.).

In this pilot action, 86 Mobility Points were planned for micromobility vehicles originally in District 6 of Budapest by BKK and Budapest Közút in cooperation with the Municipality of District 6. The pilot's scope was limited in the D4.8 to the busiest area bordered by the following streets: Andrássy út – Nagymező utca – Király utca – Károly körút – Bajcsy-Zsilinszky út. But the Budapest Team focused on the final pilot action to the whole area with all the 86 Mobility Points. By creating these Mobility Points, the project aims to react to the unregulated appearance of the micromobility services, especially e-scooters, and understand if the already overloaded public space by motorist traffic is getting worse (mainly due to street parking).

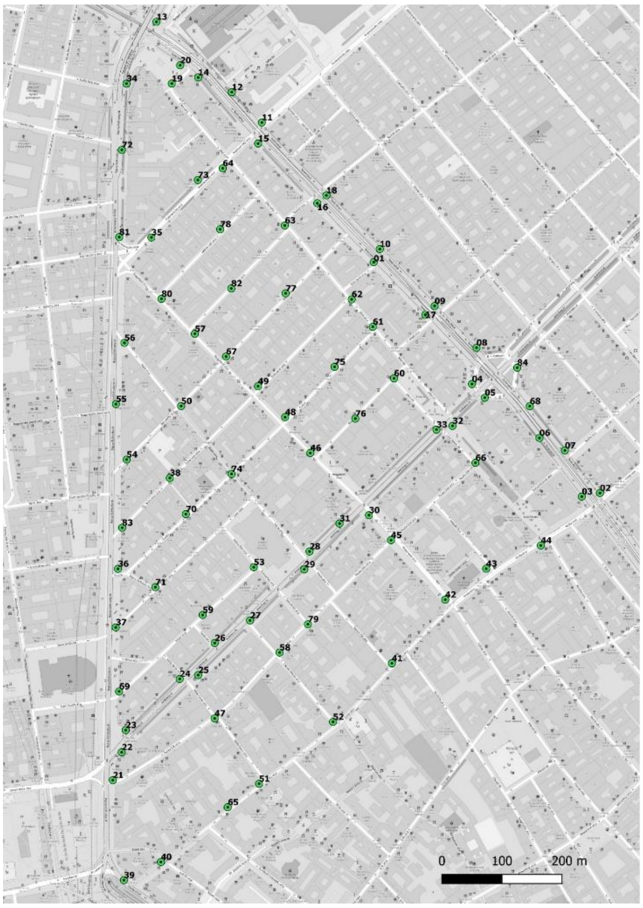

Figure 1. Use Case 2: Location of the Mobility Points

The original plan was to finish the implementation of the micromobility points by October 2020. However, due to the COVID-19 situation, the reduced financial capability of the city of Budapest and the local municipalities, the road operator (Budapest Közút) did not have capacity to implement these points. The Municipality of Budapest and District 6 arranged in

June 2021 the financial support of the Mobility Points. Currently, the project is in the implementation phase and the mobility points are going to be finished at the beginning of 2022.

The project was delayed due to the lack of capacity and the coordination between the different stakeholders. The first micromobility points were finally implemented in November-December 2021. As a result of the delay, there was not sufficient time to analyse user behaviour and data, thus traffic models were used instead. (see Annex 1: The point-to-point assignment of modelling micromobility in the framework of the SPROUT project)

As in “Use Case 1”, the COVID-19 pandemic affected the pilot urban mobility context, especially from autumn 2020. The mobility patterns situation also changed: while more people use cars due to the pandemic and free parking, more people use micromobility modes as well (bike usage increased by 15% in 2020).

3 T4.3 Sustainability assessment of the pilots impacts

3.1 Use Case 1: Planned traffic regulation changes

In Use Case 1, the Budapest team scope was restricted to *Király utca* between *Rumbach Sebestyén utca* and *Károly körút (Figure 2)*. Before starting the public place reallocation pilot, this street was overcrowded because of transit vehicle traffic. More information about this use case is available in the *D4.8 SET-UP report Budapest* document.

Use Case 1 had many traffic regulation changes around the pilot area. As the Budapest team expected, they had a big impact on the pilot area. At the pilot area, the road traffic is banned, so as a result, a new pedestrian zone has developed where only freight and authorised traffic is allowed to enter. Nearly 40 parking places were closed. These changes started on 15 August 2020. Because of the success of the pilot, the two neighbouring districts decided to rebuild this section in the next few years in order to create a permanent pedestrian zone.

Different data collection methods were used. This included Gehl's stationary activity mapping in order to measure the usage of public space. Usual traffic counting was used to measure the different types of vehicles. To measure the changes of air pollution within the pilot area, data was collected on airborne dust and NOx concentration levels. In addition, surveys were made and local workshops were organised to measure citizens' and users' acceptance of the pilot project. Data was also collected on how cargo loading methods and behaviours were changed.

Data is stored in a spreadsheet system. Data comparison and data estimation were utilised as analysis methods.

It is important to mention that the COVID-19 pandemic had no effect on traffic calming. The planned traffic changes had been made. However, COVID-19 did have an effect on the usage of public spaces. There are a lot of changes in traffic behaviours and several employers allow employees to work from home several days a week, so it is hard to measure the effect of the traffic calming. In the current phase, we are only able to estimate the "after" data.

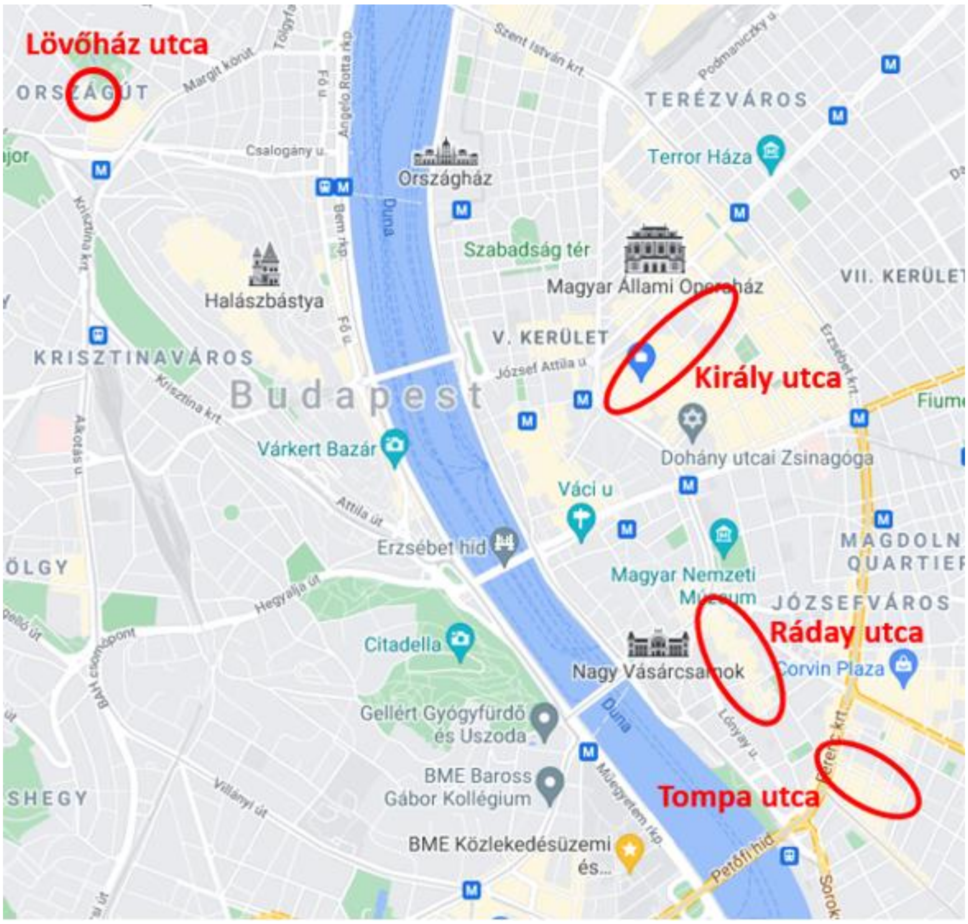

Figure 2. Use Case 1: Locations involved in traffic counting

3.1.1 Data collection

<u>Traffic measurement</u>

Budapest team collected data for Király utca three times from April 2021 to June 2021 and extended the measurement sites with three similarly designed public spaces: Lövőház utca, Ráday utca and Tompa utca (Figure 2 shows the locations). The dates selected were in connection with the reopening stages after the third wave of COVID-19. The measurements took place from 16:30 to 18:30. The traffic situation was compared before and after the reopening of the terraces in April and later in June without significant restrictions.

The criteria for selecting the venues were: a small proportion of road traffic, pedestrian and bicycle traffic should be more dominant through a traffic-calmed zone, and initially, only the effect of terrace openings after COVID-19 restrictions should be characterised by a larger number of restaurants. After the terrace openings in April (the first step in lifting the COVID-19 restrictions), the analysis team saw an overall 20-25% increase in traffic on 28 April 2021 compared to the situation on 21 April 2021. As the Table 1 shows, the largest increase - about 30% - was measurable in pedestrian traffic. By June 2021, during the third wave of the pandemic in Hungary, most of the epidemiological restrictions were lifted. At the beginning of June, the traffic at the four locations was almost double than that of the initial data in April (before the terraces opened). In three locations (Tompa utca, Ráday utca, Lövőház utca), the increase in traffic was more moderate, while in the case of Lövőház utca, there was a sudden, multiple (more than 3.5-fold) increase in traffic. Once again, pedestrian traffic showed the highest increase, more than doubling.

1. Table - Traffic growth after Terrace opening is allowed

Location	Pedestrian	Cyclist	E-scooter	Other Micromobility	Disabled person	Private vehicle
Ráday u.	680 → 1 066	178 → 161	48 → 34	16 → 18	3 → 26	58 → 28
Tompa u.	1 035 → 1 698	160 → 226	22 → 34	31 → 23	88 → 102	128 → 143
Király u.	1 471 → 1 902	79 → 101	22 → 19	9 → 2	22 → 20	241 → 306
Lövőház u.	1 223 → 4 673	41 → 168	1 → 17	17 → 50	37 → 107	7 → 0
Sum:	**4 409 → 9 339**	**458 → 656**	**93 → 104**	**73 → 93**	**150 → 255**	**434 → 477**

Iterative Traffic Calming in District 7

Although there were some changes compared to the initial plans, these changes did not affect the pilot area directly. According to final plans (Figure 3 shows the final version of traffic calming), as the SPROUT team analysis proposed the municipality will install a camera at the front of the pilot street to check permits, until then they will control this section through public space controllers. The municipality plans to allow the entire population of the zone (Király utca – Károly körút – Rákóczi út – Erzsébet körút) to drive through. During the pilot, the traffic calming area was monitored, not just Király utca. Several meetings with the stakeholders and public forums were organised where local residents stated their positions.

There was strong criticism about the project at the very early stage. Local residents and visitors complained at the district municipality about the difficulties when entering the area by private car. However, within a few months, the amount of criticism decreased and locals started to support the project, as they realised streets became calmer, safer and more liveable. Several decision-makers who opposed the project in the beginning, also changed their minds about the project. There are now plans to extend the traffic-calmed area and create a so-called “super block” with streets only open to pedestrians, cyclists and authorised vehicles.

Figure 3. Use Case 1: Final version of traffic calming (changes with red arrow)

Table 2. Use Case 1 - traffic calming zone map legend.

Black arrow	Current traffic direction
Red arrow	Changed traffic direction
C	Only destination traffic
X	Closed road
T	Dead-end street
Red T	New dead end street
Red round	Drive restriction street: (Dob utca, Wesselényi utca, Dohány utca, Király utca closed from both sides, only with permission (Camera control))
Blue round	Future plans to drive restriction streets
Green zone	The municipality plans to allow the entire population of the zone to drive through the drive restriction street

3.1.2 Financial analysis

Compared to the costs of traffic calming in Király utca, the benefits should be found to be much higher based on user feedback.

If the street were completely redesigned (creation of green areas and of a community space), the costs would be higher, but the benefits would also increase.

3.1.3 Sustainability impact assessment

As a result of Use Case 1, significantly fewer vehicles drive into the examined section of Király utca compared to the previous period. In the place of closed parking lots, it is possible to create green areas and communal areas, thanks to which, the ecosystem of the street will become more sustainable. It is possible to retain rainwater for the planted vegetation.

Reduced traffic has made the street safer for vulnerable road users. Due to the increase in safety, the investigated street also attracts vulnerable road users from the surrounding streets.

3.1.4 Operational feasibility

Examining the results during the pilot period, it can be concluded that the changes achieved by transforming the area are operational and can be operated properly.

If the street were completely redesigned, the operation would become more complicated, but it would be a known task for the municipalities.

3.1.5 Process evaluation

The traffic calming measures were adopted and implemented in time. However, the transformation of the public space has already run into difficulties. Because of the COVID-19 pandemic, the financial situation of the Municipalities was getting worse, the vacated parking spaces were not converted, plants and street furniture were not installed, and the restaurants were not allowed to expand their existing terraces.

3.1.6 Policies analysis

As parking spaces were not converted into public space, some cars were still occupying the vacated parking spaces despite of the potential fines. Green infrastructure was not improved. Nevertheless, due to the reduced number of cars, delivery cars had less conflicts and it became easier for them to find free parking spots to serve local shops and restaurants. They also occupied significantly less space from the sidewalks.

3.2 Use Case 2: Creation of micromobility points

BKK and Budapest Közút together with District 6 of Budapest planned to implement 86 mobility points in the city centre. There is no regulation for public space use by micromobility vehicles, but during this pilot, the users are supposed to leave their vehicles only at the Mobility Points. More information about this use case is available in the *D4.8 SET-UP report Budapest* document. (SPROUT team, 2020)

The background of Use Case 2 was the increasing number of micromobility services (and the popularity of these services), which resulted increasing number of micromobility vehicles on the streets of Budapest, in many cases parked unorganized.

The relaunch of the Budapest public bike-sharing system (MOL Bubi) is a good example for the increasing success of micromobility services. The system was relaunched in the first half of 2021. (It was temporarily suspended in November 2020.) The relaunch of the public bike-sharing system reshaped the market of the shared micromobility services. The daily trip record of the old system was approximately 5,000 trips/day at the city level, but this number in the new system is almost 9,000 trips/day. The new service started on 20 May 2021 with fewer bikes because the utilisation level of the bikes used to be too low (fewer than 1 trip/bike/day) even before the COVID-19 pandemic. In the new system, the capacity of the docking stations was lower than in the past (BKK, 2021). To utilise the vacant spaces next to the docking stations, Budapest planned to join the Mobility Point network to the public bike-sharing system. To achieve this, we harmonised the design of the two networks.

BKK also started to create the Active and Micromobility Strategy (AMS) of Budapest in 2020, in order to be able to better control the micromobility services and the infrastructure. In this use case the Budapest team tried out new assessment methods, and the concept was completed with this real experience. Currently, the City of Budapest plans to accept it at the end of 2021.

With more access points (mobility points), Budapest aims to increase the usage of shared micromobility vehicles. The target of this use case is to increase the number of shared micromobility users by 10% (I414).

3.2.1 Description of conducted mobility solution tests

In Budapest, there were two pilot actions in 2019 and 2020 in the Cities4People H2020 project, when Mobility Points were set up, but the design guide of the Mobility Points was not defined. During this pilot action, the mobility development department of BKK worked together with BKK design planners to fit the design of the Mobility Points to both the company brand and that of the City of Budapest. (Cities4People team, 2020)

The Budapest Team defined a comprehensive method for the measurement of the utilisation and traffic of (micro)mobility points to be established in the framework of the SPROUT Project. This method could be used after implementing the Mobility Points, so this is a suggestion.

During the selection of the locations of the Mobility Points, supermarkets, banks, pharmacies, educational institutions, post offices, restaurants and other shops were taken into account. It was essential to consider the needs of the local Municipality, too.

By installing Mobility Points into the right placed at junctions, the number of illegal parking options can be potentially reduced, improving the visibility of the junction from subordinate or non-priority roads, which can reduce the number of accidents. BKK and Budapest Közút (the road operator) tried to find the best locations for the Mobility Points with respect to the safety of the pedestrians and cyclists while respecting the National Road Code.

To understand the effects of implementation of the mobility points, the Budapest team started to analyse the impacts based on simulation through the Unified Transport Model of Budapest, which is a strategic transport model with all mobility modes. To make the model more reliable a new assignment procedure (point-to-point) for micromobility users was added to procedure sets. More information about this analysis is available in the impact assessment and in Annex 1.

Three possible assumptions about the potential modal shift were identified. Regarding our analysis, the increase of the shared mobility solutions are the following:

- Optimistic: 17.2 %
- Average: 11.9 %
- Pessimistic: 6.1 %

3.2.2 Data collection

It is indispensable to measure traffic changes to be made at Mobility Points, in order that we could examine the utilisation of the locations and also the possibility of probable expansion. At these points, both privately-used and also shared micromobility devices can be stored, however we can gain information on the exact locations in the case of shared devices, while this information is unknown in the case of devices not being subject to remote surveillance.

Due to the delayed implementation of the (micro)mobility points, we could not collect data on sight. Thus, data collection was done by utilizing two methods at the same time:

In the first method, ten locations specified by us are measured, in this case with the incorporation of 19 (micro)mobility points. When designating these locations, we took into account the proximity of bike lanes, the sections that are key in terms of cycling, main transport hubs, devices serving the measurement of cycling and also the MOL Bubi docking stations. At these locations, measurement would be made twice, at one-hour intervals on a daily basis. When defining the measurement-related time intervals, we took the daily total traffic peak hours as a basis. In the case of the morning peak hours, we specified the ideal time for 9-10 a.m., while in the case of the afternoon peak hours, it was 4-5 p.m.

In the second method, a comprehensive measurement would be made on a weekly basis. Our aim is to gain information on all of the 86 points and their utilisation. The locations could be checked on the same day (Monday or Wednesday) each week, however the time interval would be different. However, in the case of the above-mentioned ten locations (19 points), the locations should be visited at the same time even during these days.

In both cases, the person making the measurement is required to list the devices to be found at each mobility point, registering the different types (e-scooter, bike, Segway, etc.) of devices separately from the differently-used (private, shared) devices.

Because we could not run a real-life test, we cannot evaluate the operational feasibility and financial sustainability of the pilot measurement. As a result, the measurements are based on simulations and assumptions.

- Data collection methods:
  - Traffic counting
  - Public bike-sharing system user data
  - Modelling results
- Data storage methods:
  - Unified Transport Model of Budapest
- Analysis methods:
  - Travel-time savings
  - Mode shift: cross-elasticity calculations
- Impact of COVID pandemic on the results:
  - Delay of implementation of the Mobility Points
  - Usage of alternative methods to analyse the effects of the Mobility Points

The project has proven that point-to-point based assignment can be freely formed, in compliance with the existing model and also with the special demands of the examined layers, whose main benefits are the following:

- it enables to present traffic demand in a decentralised way among an arbitrary number of traffic indicating points
- it will become possible to examine such transport modes, where the average travel length is short, compared to the model resolution (walking, micromobility, cycling)
- the basic model can remain unchanged during the procedure, therefore the distribution or the re-calibration of the area is not required
- layers included in the examination can be quickly and flexibly formed in the model
- elements and parameters of the volume-delay function affecting the selection of route can be changed freely, even in different ways per layer
- the procedure can present such travel demand within the area, which remained hidden when using the conventional methodology.

Thanks to the external Python COM input, the development and transformation of the procedure can be unlimited, in compliance with market demand.

3.2.3 Financial analysis

The cost of the implementation of a single Mobility Point is 1,500 Euro. Therefore, the total cost of the implementation of all the Mobility Points in District 6 is approximately 130,000 Euro.

3.2.4 Sustainability impact assessment

Based on the results of the modelling, there will be 1,600 hours/day travel-time gain in the network according to the optimistic scenario, 1,110 hours/day according to the average scenario and 580 hours/day even according to the pessimistic scenario.

3.2.5 Operational feasibility

According to the surveys and the workshop, the operational costs of the shared mobility providers that used to operate free-floating systems are going to decrease.

3.2.6 Process evaluation

Because of the COVID-19 pandemic, the financial situation of the Municipalities was getting worse in 2020 and 2021. There was a debate between the Municipality of Budapest and the local Municipalities about the financing of the implementation of the Mobility Points. During this pilot process, the Budapest Team should identify the roles of the stakeholders regarding the field of topic. Because every first step is complicated, the process of planning and licensing was longer than we presumed in the beginning of the pilot action.

There were some disagreements during the negotiations between BKK, the Municipality of Budapest and the local Municipalities. Main issues were for example whether the mobility points should be located on current parking spaces or sidewalks, the size of each mobility points or the usage fee paid by the service operators.

3.2.7 Policies analysis

One of the main barriers in Budapest is the multilevel municipality system: the City of Budapest needs to cooperate with the local districts, and each district has its own demand. Besides that, the new-type micromobility vehicles (e-scooters) are not defined in the National Road Code. Because of this lack of legislation, it is difficult to regulate public space use by shared mobility services and their vehicles. Additionally, there is no regulation to collect and monitor shared mobility user data.

3.3 Conclusion

In Use Case 1, car traffic along a main local street (Király utca) was restricted on a short section and only authorised and freight traffic was permitted within the newly implemented pedestrian zone. In the beginning, the implementation of the traffic calming measures was heavily criticised and local politicians and decision-makers were blamed by local residents and the media for longer travel times by motorised vehicles. Nevertheless, after several public hearings and some minor modifications, the number of complaints reduced significantly. Reduced traffic has also made the street safer for vulnerable road users. Due to the increase in safety, the investigated street also attracts vulnerable road users from the surrounding streets.

In Use Case 2, for the implementation of the Mobility Point Network, one of the main barriers in Budapest is the multilevel municipality system: the City of Budapest needs to cooperate with the local districts, and each district has its own demand. Besides that, the new-type micromobility vehicles (e-scooters) are not defined in the National Road Code. Because of this lack of legislation, it is difficult to regulate public space use by shared mobility services and their vehicles. Additionally, there is no regulation to collect and monitor shared mobility user data.

Despite of all the difficulties, with the implementation of the Mobility Point Network, the city managed to increase the number of the users of shared micromobility services and to create order in the public spaces. The Budapest Pilot created the opportunity to utilise the advantages of free-floating shared micromobility services, besides regulating public space use by micromobility vehicles. Furthermore, the implementation of the Mobility Points made junctions (traffic hubs) safer.

The expected expansion of the usage of micromobility vehicles requires the extension of macro-level analysis even for this mobility mode. The elaborated point-to-point based assignment procedure enables the examination of short-term trips without primarily changing the conventional area-based models. Based on the point-to-point assignment of modelling micromobility analysis (annexe 1), the increase in the modal share depends on the scenario examined. The optimistic scenario will reach 17.2%, the negative will increase by 3.9%. In any case, the average estimation is that it will increase by 11.9%. It is 1.9% more than expected before the SPROUT pilot started.Use Case 2 also showed that human resource is required to measure the utilisation of certain Mobility Points - especially in cases of devices not being subject to remote surveillance. However, the measurement of the planned 86 points requires such a level of human resource, for which there is insufficient amount of capacity. Therefore, it will become of paramount importance to specify the key mobility locations, by the help of which we would gain a nearly comprehensive picture of the (micro)mobility points to be found in District 6, owing to their traffic changes and also their effects on traffic.

4 T4.4 Formulation and priotitisation of alternative policy responses

4.1 Introduction

The third stage of the SPROUT project is the setup and implementation of the pilots in each of the pilot cities. The aim of Task 4.4 is to develop, based on the outcomes of the pilots and the operational assessment (Task 4.3), a list of alternative policy responses for each of the 5 pilot cities. The alternative policy responses will then be prioritized for each pilot city with the help of Multi-Actor, Multi-Criteria Analysis (MAMCA) (Macharis, De Witte, & Ampe, 2009).This will allow the identification of synergies and conflicts between different stakeholder groups, to show the (lack of) consensus for the proposed policy alternatives.

Because of the COVID-19 pandemic and the various lockdowns in the Fall of 2020, the implementation of the tasks preceding Task 4.4, and most importantly the implementation of the pilots, was delayed. A traditional MAMCA departs from a problem identified, and formulates alternative solutions to a problem. These alternative solutions are then evaluated by different stakeholder groups to show which alternative has the highest consensus among stakeholders. So as the first step of a MAMCA is a problem identification phase, it was difficult for the pilot cities to come to a problem identification with regards to the pilot due to it not yet being (fully) implemented. This made it difficult to distinguish several potential alternative policy responses. If more than one policy response was proposed, they were not mutually exclusive. This meant that the implementation of one policy alternative did not impede the implementation of the other alternative. For a MAMCA, if there is to be a consensus on one of the alternatives, the proposed alternatives need to be mutually exclusive. If they are not, then the solution would simply be to implement all alternatives. For these reasons, it was decided to implement a modified MAMCA, a Stakeholder-Based Impact Scoring (SIS) instead (te Boveldt, 2019).The methodology and its application will be explained in more details in the section below (Chapter 4.2).

4.2 Methodology

4.2.1 Multi-Actor Multi-Criteria analysis

Multi-Actor, Multi-Criteria Analysis is an evaluation method that includes both quantitative and qualitative criteria with their relative importance, as defined by multiple stakeholders (Macharis et al., 2009). It is used for the participatory evaluation of projects where multiple stakeholders and multiple objectives are to be included. The aim of MAMCA is to facilitate the decision-making process by showing the conflicts and the synergies of different stakeholders.

The method starts with the identification of stakeholders and their objectives, to then come to a prioritization of different alternatives, based on the weights attributed by stakeholders to their criteria. However, Macharis et al. (2012) highlight the importance of not focusing only on the final aggregated, prioritized results of a MAMCA, but on the reasons for why an alternative score negatively or positively. It allows stakeholders to reflect on their objects, and shows the trade-offs all stakeholders have to make. The results of the MAMCA can then start a discussion among stakeholders to find a consensus.

4.2.2 Stakeholder-Based Impact Scoring

Stakeholder-Based Impact Scoring (SIS) is a modified MAMCA that provides a weighted impact evaluation of policy options (te Boveldt, 2019). This impact evaluation considers the objectives of stakeholders that impact, or are impacted by, the problem described, thereby quantifying the benefits and burdens of project alternatives. It was developed for problems that cannot be addressed through the ranking algorithms of other MCA methods. The SIS method contains two fundamental aspects (te Boveldt, 2019):

- *Non-compensability*: the principle of non-compensability entails that positive and negative impacts are accounted for separately, and do not cancel each other out.
- *Non-relativity*: if there are multiple alternatives, these alternatives are not compared to each other, but to a baseline scenario.

SIS steps

The application of SIS involves seven different steps (te Boveldt, 2019):

1. Formulation of the problem and identification of alternative solutions. In order to perform a SIS, there should minimally be one baseline, and one alternative to the baseline.
2. Stakeholder identification. The stakeholders that impact, or are impacted by the project need to be identified.
3. Formulation of stakeholder criteria. These criteria represent the objectives of the stakeholder with regards to the problem and the identified alternative solutions.
4. The effects of the alternative in terms of each criterion when compared to the baseline scenario are assessed through a performance score ranging from +1 (very positive) to -1 (very negative).
5. Attribution of weights to their criteria by the stakeholders, to evaluate the relative importance of each of the criteria.
6. Impact score calculation of each alternative for each criterion, for each stakeholder. This is done by multiplying the weight of a criterion, as attributed in step 5, with the impact, as assessed in step 4. This impact score will be either positive or negative, and will fall between +1 and -1.
7. Calculation of the aggregate positive impacts and of the aggregate negative impacts.

4.3 Application of SIS within SPROUT

The application of SIS within the SPROUT project followed the steps described in the previous section. It was applied to one use case per pilot city. The following section describes steps 1-5 more in detail. These steps make up the preliminary work of SIS, i.e. the gathering of all necessary input for the analysis. Section 5 (Results) describes steps 6 and 7, i.e. the results of the analysis, for each pilot city.

4.3.1 Formulation of problem and identification of alternatives

The first step in the SIS is the identification of the problem and the alternative solutions. To do this, a template was sent out to all pilot cities containing questions with regards to issues they had identified with their pilots. This was filled out and sent back to VUB. For Budapest, extra clarifications were asked, as the identified problem and policy alternatives were not specific enough. The goal was for the proposed policy alternatives to be very specific. An example policy response from the city of Budapest's first input was the creation of city specific planning regulations, containing regulation to plan space for all modes of mobility. Clarifications were then asked about what type of city specific planning regulations were intended. This step was done between October 15 and October 30, 2020.

The sections below give an overview of the identified problems and proposed policy solutions for each city.

Table 3. T4.3: Budapest identified problems and proposed solutions,

Problem encountered	High car traffic volume in the pilot area, there is not enough place for pedestrians, micromobility users.
	Shared micromobility devices are denied at the pilot area, because there is currently no regulation for their storage.
Possible Solutions	Create city specific planning regulations, that contains regulation to plan place for all modes of mobility.
	Create an additional regulation for micromobility in the topic of public place reorganization from the road operator and owner side. The pilot thinks that it can be a capital decree in the future.

4.3.2 Stakeholder identification

In order to come to a weighted evaluation that reflects the preferences of stakeholders, it was necessary to identify the stakeholders to involve in the SIS. The stakeholders to involve are the ones that are impacted, or can impact, the pilot project of the city. To do this, the pilot cities were asked to contact stakeholders that had been previously involved in the scenario building workshops of WP3. The participating stakeholders in WP3, in turn, were the result of the stakeholder identification done in Task 2.3, 'Urban Mobility Transition Drivers'. After asking the cities to contact some more stakeholders than the ones present for the WP3 workshop, the full overview of participating stakeholders per city is described in the following paragraph:

- Public transport operator;
- Mobility operators;
- Infrastructure;
- Walking or cycling associations;
- Users of micromobility services.

4.3.3 Formulation of stakeholder criteria

The third step in SIS is the identification of the criteria for each stakeholder group. The key question for the formulation of criteria is the following: *what distinguishes a good project alternative from a bad one?* Stakeholders therefore reflect on what their objectives are with the implementation of a project. These criteria can be both positive and negative, and examples include traffic safety, cost, or accessibility. Within SPROUT, the alternatives that stakeholders were asked to reflect upon were the pilot situation without policy changes, as well as the pilot situation with the proposed policy alternatives.

In order to collect stakeholder criteria, an email template was set up for all pilot cities. This email, that can be found in Annex 2.2, contains a short description of the pilot without policy changes, and a short description of the pilot including the policy alternatives. The stakeholders were asked to come up with two to six criteria that would make the implementation of the pilot situation with policy changes successful, in their eyes. This step required a lot of exchanges with the city, as it was not always clear from the beginning what was understood by 'criteria'. After two or three rounds however, a consolidated list of criteria for each stakeholder group was obtained.

An overview of the criteria per stakeholder group for Budapest can be found below.

- Public transport operator;
  - Economic sustainability of operations
  - Social sustainability of operations
  - Environmental sustainability of operations
  - Increase in MaaS use
  - Decrease of the environmental impact of transport
  - Decrease in private car use
- Mobility operators;
  - Increased support for shared mobility
  - Economic sustainability of operations
  - Social sustainability of operations
  - Environmental sustainability of operations
  - Decrease of the environmental impact of transport
  - Increased share of eco-friendly transport modes
- Infrastructure;
  - Economic sustainability of operations
  - Environmental sustainability of operations
  - Coherence of the public space configuration
  - Increase in road safety
  - Simplification of maintenance work
- Walking or cycling associations;
  - Coherence of the public space configuration
  - Increase in safe infrastructure for micromobility users
  - Increase in modal shift
  - Decrease of the environmental impact of transport
- Users of micromobility services.

- Reliability of the service
- Decrease in traffic
- Coherence of the public space configuration

4.3.4 Expert evaluation

After the identification of stakeholder criteria, the next step of the SIS is an evaluation of policy intervention on the impact of the policy interventions on these criteria by experts. In this step, the effects of the pilot with policy implementation are compared to the pilot without policy changes for each of the criteria. The alternative is given a performance score on a 7-point scale, ranging from 'Very negative' to 'Very positive'. The key question to answer in this step is the following: in terms of each criterion, *what are the impacts if the alternative pilot with policy changes were implemented?*

The scientific partners in each of the pilot cities were asked to evaluate the alternative in terms of their stakeholders' criteria. Annex 8.3 contains the email with explanation that was sent out to the scientific partners. If the experts had any additional information or justification for their evaluation, they were asked to add this to the evaluation form as well. The expert evaluations were done between February 22 and April 28, 2021. Below, the results of each expert evaluation are shown.

Table 4. Experts evaluation results

Criteria	Scenario 1: current situation	Scenario 2: pilot compared to current situation	Performance score of the pilot compared to current situation	Justification for the chosen evaluation
Economic sustainability of operations	Shared micromobility points without regulation for storing the vehicles	Shared micromobility points with regulation that requires public space designers to plan space to store shared micromobility vehicles within a specified zone, and that will define the number of dedicated spaces for shared micromobility devices	slightly positive	maintenance is more efficient because the devices are in a specific location, but the number of users may decrease
Social sustainability of operations			positive	arranged public space, attracts more users
Environmental sustainability of operations			slightly positive	maintenance is more efficient because the devices are in a specific location (with one ride you can maintenance several devices), several devices can be stored in one parking space
MaaS use			no change	this will not better integrate services
Decrease of the environmental impact of transport			positive	more environmentally friendly devices thanks to more storage options
Decrease in private car use			slightly positive	predictable device availability and device storage location are known
Increased support for shared mobility			very postive	due to the nature of the project, we are best placed to help with this
Increased share of eco-friendly transport modes			positive	increase the storage capacity of environmentally friendly devices, predictable device availability and device storage location are known

Criteria	Scenario 1: current situation	Scenario 2: pilot compared to current situation	Performance score of the pilot compared to current situation	Justification for the chosen evaluation
Coherence of the public space configuration			positive	uniform public appearance
Road safety			positive	we place the micromobility points to increase the visibility of the intersections
Simplification of maintenance work			very postive	devices are in a specific location (with one ride you can maintenance several devices)
Increase in safe infrastructure for micromobility users			slightly positive	storage capacity increases security
Modal shift			no change	possible negative due to extra walking, positive due to reduced car use
Reliability of the service			positive	predictable device availability and device storage location are known
Traffic reduction			slightly positive	the number of users of the micromobility devices is increasing, which is expected to reduce road traffic

4.3.5 Criteria weighting by stakeholders

The next step in a SIS evaluation is the attribution of weights by the stakeholders to their criteria. This shows the relative importance that the stakeholders attach to each criterion. To evaluate this, a survey was set up to be distributed to all stakeholders within each of the pilot cities. The survey was set up by VUB, and an example for the city of Kalisz can be found in Annex 8.4. To facilitate the process for the stakeholders, it was decided to translate the surveys in the local language. This was done by each pilot city.

4.3.6 Results

Figure 4 and Figure 5 show the expected negative and positive impacts of the Budapest pilot as compared to the current situation. While the current situation (shared micromobility points without regulation for storing the vehicles) is taken as a baseline, the pilot involves regulation that requires public space designers to plan space to store shared micromobility vehicles within a specified zone, and that will define the number of dedicated spaces for shared micromobility devices.

As can be seen in Figure 4, 'environmental impact' and 'coherence of public space' are expected to be by far the most important positive impacts, partly due to the fact that they are considered relevant by three of the five stakeholders. In contrast, the pilot is not expected to have any impact with regard to the increase in modal shift and increase in MaaS use. Figure 5 shows the distribution of the impacts over the stakeholders, and that no negative impacts are expected for any stakeholder.

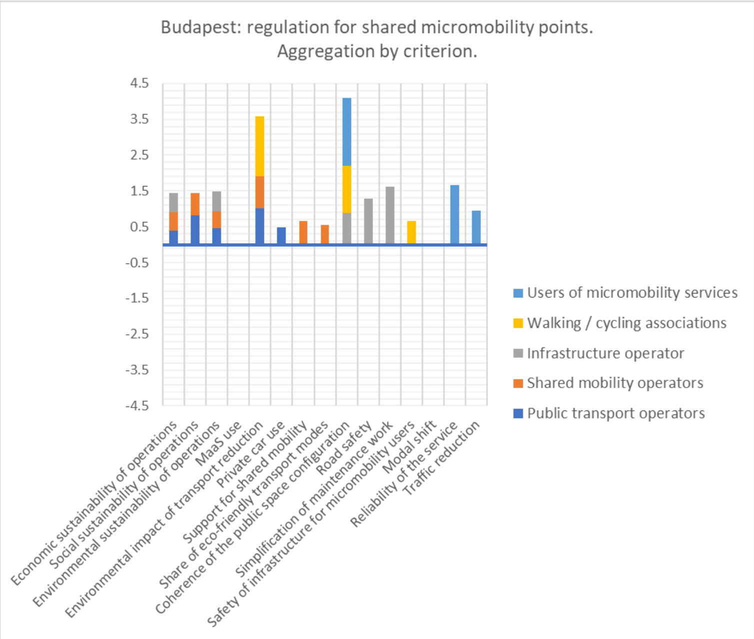

Figure 4. Regulations for shared micromobility points. Aggregation by criterion.

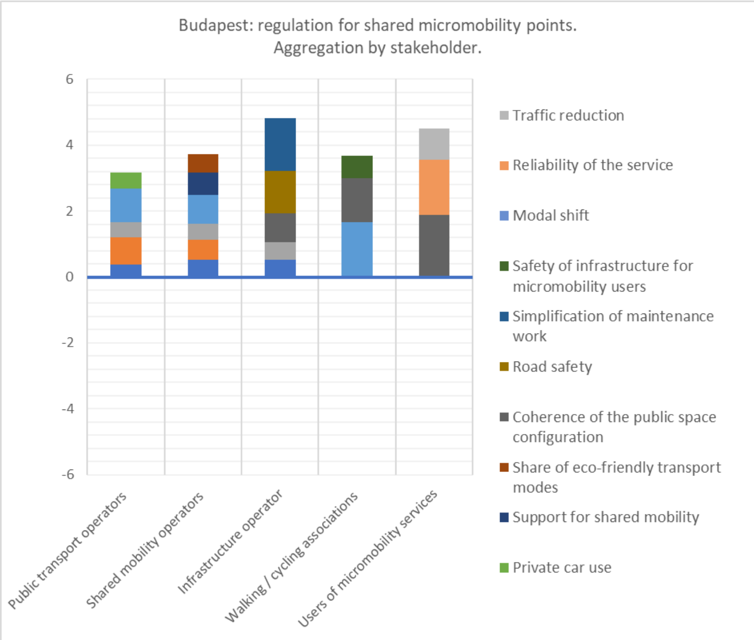

Figure 5. Regulations for shared micromobility points. Aggregation by stakeholder.

4.4 Conclusion

Compared to the pilot as it is, the adaptation of regulations for shared micromobility points has positive effects for all stakeholders. Following the analysis, coherence of the configuration of public space and the reduction of the environmental impact of transport are the most important advantages. The advantages are especially pertinent for the infrastructure operator and the users of micromobility services, yet no stakeholders are expected to be negatively impact by the implementation of the regulations.

5 T4.5 City-specific policies for harnessing the impact of new mobility solutions

5.1 Introduction

The objective of this task is to compile the information to assess the feasibility and user acceptance of introducing the predefined set of policy responses on a limited scale (city-specific). This task uses some information from the previous tasks 4.4, more specifically the set of stakeholders and preferred set of policy responses. About the latter, by the time the T4.4 was implemented the pilots were not able to distinguish several potential alternative policy responses that were mutually exclusive (see section 4), therefore prior this exercise additional policy responses were identified by the methodological partners (VUB, CERTH, ZLC) and shared with the pilots. Then they validated and fine-tuned to better address pilots' characteristics. The result of this task is the combination of champion city-specific policy responses or city-led policy response.

5.2 Methodology

Implementation of effective policy responses that will harness the benefits of the emerging mobility solutions represents a challenging process which can be viewed as a knowledge quest and creation process within an urban stakeholder's network requiring the reduction of uncertainty. Uncertainty is particularly high for those measures that include new science, technology, markets, regulatory frameworks. The types of uncertainties can be categorized as being concerned with technological feasibility, organizational capability and social acceptability.

In order to minimize the uncertainty in implementation of a policy measure and at the same time to maximize its effectiveness, the Task 4.5 will address three main research questions per each pilot:

1. How to assess the policies implementation feasibility?
2. How to assess the policies, user acceptance?
3. How to determine threshold user acceptance and feasibility values for selecting policy responses?

5.2.1 Implementation feasibility

About the first question, the policy implementation feasibility will be addressed by the following steps:

1. Selection the relevant feasibility criteria;
2. Ranking the relevant feasibility criteria by the stakeholders and determining the most critical criteria;
3. Detailed analysis of the most critical feasibility criteria in order to identify potential infeasibilities;
4. Determining a set of actions to avoid the risk of infeasibility during the implementation of a policy measure.

The set of feasibility criteria will include the following dimensions:

1. Technical feasibility;
2. Financial feasibility;
3. Political feasibility;
4. Administrative feasibility

Detailed explanation of the feasibility criteria included within each of these dimensions are explained below.

1. ***Technical feasibility*** dimension includes following feasibility criteria:
   - Effectiveness: the extent to which the alternative policy measure will reach the goals set in the project statement;
   - Feasibility of implementation: Under this category will be assessed whether technology exists or is readily available to implement an alternative policy measure.
2. ***Financial dimension*** includes impact on the local/regional economy, on expected revenues of public sector or on expenses of local/regional government. Within the financial dimension costs and benefits will be considered. Costs represent the most common financial criteria. The following categories of costs will be considered:
   - Direct costs: the costs directly related to the policy alternative;
   - Indirect costs: additional nonfinancial impacts (noise, congestions, accidents, etc.);
   - Fixed costs: initial investments;
   - Operations and maintenance costs;
   - Opportunity costs.

Benefits can be measured in the same ways as costs. The following categories of benefits will be included:

- Direct benefits: financial effects which are directly attributable to the alternative policy measure;
- Indirect benefits: non-financial effects which are indirectly attributable to the alternative policy measure.

3. ***Political feasibility*** includes two feasibility criteria:
   - Acceptability: Whether or to what extent the alternative policy measure will be acceptable to relevant stakeholders (decision makers etc.).
   - Responsiveness: whether the proposed alternative will meet the real/perceived needs of the target groups.
4. Since alternative policy measures will be implemented by public authorities, it is necessary to assess ***administrative operability or administrative ease of implementation***. Therefore, the following criteria under the administrative feasibility will be considered:
   - Authority: does the public body have the authority to implement the proposed policy?
   - Commitment: to what extent the policy measure has the commitment of different levels of decision making?
   - Capacity: does the public authority have the resources to implement the proposed policy measure (skills, financial assets, training, expertise)?

The questionnaire will be used to assess the critical feasibility criteria for each of the set of prioritized policy responses. Participants will rate the policy measures against the different feasibility criteria based on a 5-tier scale (from ‘very low’ to ‘very high’). Those measures with a low feasibility rating (*less than 2.5 on a 1-5 scale*) against the specific feasibility criteria will be the subject of additional analysis in order to reveal eventual risks of implementation as well as mitigation strategies.

5.2.2 User acceptance

User acceptance includes different indications based on attitudes, believes and norms of individuals that are directly or indirectly affected by a proposed policy measure. More precisely, the user acceptance (social feasibility) relates to the question how will potential users act and react if a certain policy response is implemented. Following main indicators of user acceptance will be used for analysis (this list may be extended depending on the specific policy measure):

1. Personal and social aims;
2. Problem perception;
3. Information and knowledge about;
4. Perceived efficiency;
5. Satisfaction;
6. Usefulness;
7. Affordability.

Detailed explanation of the user acceptance criteria is given below.

1. ***Personal and social aims***. In general, a higher valuation of common social or personal aims will be positively related to acceptability. Users of the service who perceive a proposed policy measure as compliant to their own preferences will express a higher acceptability and acceptance rate.

2. ***Problem perception***. The extent to which a problem corresponding to a specific policy measure is a necessary indication in defining of user acceptance. In general, the high problem awareness will lead to an increased willingness to accept proposed policy measures for the perceived problems. More precisely, in order to assess the user acceptance from the perspective of "problem perception", the respondents will be asked to rank the importance of different factors (perceived as a consequence of non-applying a specific policy measure). It can be assumed that the higher a specific factor is ranked; the more users will perceive that factor as a problem in society and therefore the higher weight will be given to a corresponding policy measure.

3. ***Information and knowledge about***. The level of acceptance can depend on how well informed the potential users are about a specific urban mobility problem (corresponding to a specific policy measure) and about the new policy measure that can be introduced to reduce/eliminate the consequences of the problem. The better the people are informed the higher acceptance will be. During the questionnaire design, from the perspective of this dimension, the distinction will be made between whether a person feels well or poorly informed or whether he/she is actually well or badly informed. In other words, the difference between objective knowledge and the subjective assessment of the own knowledge must be made.

4. ***The perceived efficiency*** indicates the possible benefits potential users expect from a concrete policy measure as compared to other measures. More precisely, respondents will need to evaluate how they perceive different policy measures and how they evaluate a specific policy measure as compared to other alternative measures. The recognition of

corresponding problem and the information potential users have will influence the rate of efficiency. If the users note a specific policy measure as more efficient a higher support to that measure can be possible.

5. ***Satisfaction*** will result in a degree how the policy measure solves the users' needs. Satisfaction will be given by evaluation the policy measure as pleasant/unpleasant, irritating/likeable, undesirable/desirable.
6. ***Usefulness*** is related how the policy measure will support the users' objectives and their transport service use behavior. A potential user can find a specific policy measure effective but not for his own travelling needs. Usefulness is stated as the degree to which a person believes that implementing a specific policy measure will enhance his/her performance.
7. ***Affordability*** is related to socio-economic status of users. It may be assumed that the socio-economic status will affect the user acceptance of a specific policy measure. In cases of some policy measures it can be expected that low income groups should be more opposed to its acceptance. The willingness to pay will depend on income, and it can be assumed that higher willingness will imply a higher acceptance of some policy measures.

User acceptance of policy measures will be estimated based on the responses of experts which will rate each policy measure against each indicator of user acceptance by using the a 5-tier scale (from 'very low' to 'very high'). Those measures that have low user acceptance rate (*less than 2.5 on a 1-5 scale*) against the specific indicator will be the subject of additional analysis. Additional analysis will result in a strategy for improving the user acceptance of a specific policy measure against a "critical" user acceptance indicator.

5.3 Application to Budapest pilot: Use case 1

According to the methodology explained in chapter 5.2, the set of alternative policy measures was defined and the survey was designed (added as the Annex 3) to collect the opinions related to the most critical aspects of policy implementation feasibility and user acceptance.

5.3.1 Set of alternative policy responses and stakeholders involved and role

The relevant stakeholders participating in this use case are listed below.

- Public transport operator;
- Mobility operators;
- Infrastructure (Road) operator;
- Walking or cycling associations;
- Experts from Budapest University of Technology;
- Municipality of Budapest
- Municipality of Budapest VII. district
- Users of micromobility services

Table 5. Use case 1: Alternative policy measures (PM): stakeholders involved and role.

Alternative policy response	Stakeholders involved and role
PM1: Construction of protected and well-maintained bicycle lanes and main lines	Infrastructure (Road) operator, Municipality of Budapest VII. District, Public Transport Operator, Walking or cycling associations
PM2: Establishment of low-emission zones (emission-based recovery restrictions	Infrastructure (Road) operator, Municipality of Budapest, Municipality of Budapest VII. District, Public Transport Operator.
PM3: Resolving legal issues related to the regulation of market-based services	Municipality of Budapest, Public Transport Operator, Experts from Budapest University of Technology, Mobility operators
PM4: Tools used to strengthen the link between the public and private sectors	Municipality of Budapest, Public Transport Operator, Experts from Budapest University of Technology, Mobility operator

5.3.2 Set of alternative policy responses and interrelationships

Table 6 shows the most preferred policy measures included in the feasibility assessment and the interrelationship with the mobility solution:

Table 6. Use case 1: T4.5 Alternative policy measures (PM) and interrelationships.

	PM1: Construction of protected and well-maintained bicycle lanes and main lines	PM2: Establishment of low-emission zones (emission-based recovery restrictions	PM3: Resolving legal issues related to the regulation of market-based services	PM4: Tools used to strengthen the link between the public and private sectors
PM1: Construction of protected and well-maintained bicycle lanes and main lines	X	There will be more opportunities in the LEZs to use environmentally friendly mobility modes.	The users of the market-based services will have to use only the dedicated bicycle lanes.	Public sector offers better network for the private operators
PM2: Establishment of low-emission zones (emission-based recovery restrictions	Increase the needs of the well protected micromobility infrastructure network	X	Increase the needs of the sustainable mobility solutions	Public sector offers better opportunities in the for the private operators with sustainable vehicles
PM3: Resolving legal issues related to the regulation of market-based services	More potential users for the bicycle lanes	There would be more mobility opportunity in the LEZ.	X	The stakeholders should cooperate.
PM4: Tools used to strengthen the link between the public and private sectors	More potential users for the bicycle lanes	There would be more mobility opportunity in the LEZ.	The stakeholders should cooperate.	X

5.3.3 Implementation feasibility

The survey' questions (six in total) aim to evaluate the selected alternative measures against the most critical dimensions of feasibility – technical, financial, political and administrative feasibility as it has already explained in the Methodology section. The survey was circulated via Qualtrics platform among the stakeholders relevant for implementation of the use case 1 in Budapest pilot.

In total 11 respondents participated in the Feasibility Survey. The structure of the respondents as well as their share is illustrated on Figure 6.

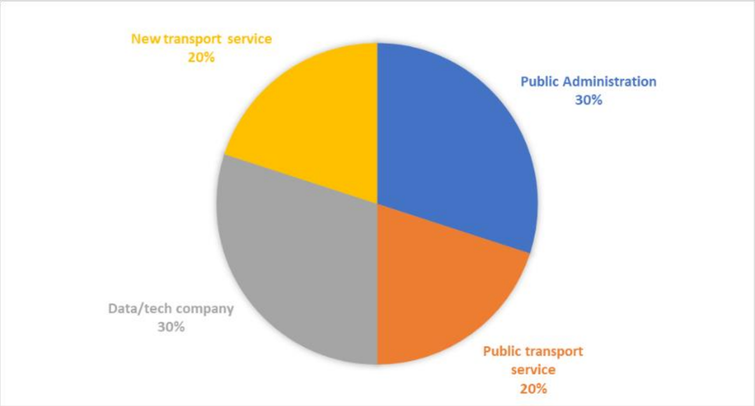

Figure 6. Use case 1 -Feasibility study: The structure and share of respondents.

The responses were analysed and used to identify the relevant questions related to potential policy measures (PMs) infeasibility (identification, analysis, how mitigating the risk). Then, these questions were the object of discussion in the second round of feasibility assessment.

Column three in Table 7 contains the relevant questions for PM implementation, risk identification, analysis and mitigation in Budapest Pilot. Column four includes a summary of the responses collected during the workshop. Annex 3 includes complete responses.

Table 7. T4.5.- Use case1: Implementation feasibility - Second stage: Responses to misalignments.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
PM2: Establishment of low-emission zones (emission-based recovery restrictions	Financial feasibility/fixed costs	What are the fixed costs?	The installation of signs is one of the main costs. It is important to note that the air quality in zones is not the same at all times of the day, so the use of variable message signs is recommended. Traffic data should also be taken into account. The use of "Except for destination signs" is not recommended and enforcement is virtually impossible. Furthermore, it is important to organise a communication campaign to the public and to cover the costs of such a campaign in order to ensure effective operation (introduction of a grace period, gradual introduction of the regulation).
		Will these costs be outbalanced by the benefits	In these zones, people who use micromobility prefer to travel, so it is clearly to their advantage. A problem may be that shared micromobility devices are not yet collected by electric vehicles, so redistribution in low emission zones may be problematic - however, operators support the development of zones. It is recommended that a permit should be available to allow access and possibly parking (night (collection), day (drop-off)).
	Financial feasibility/operations and maintenance costs	What are the real operations and maintenance costs	The main operations and maintenance costs are the cost of deployment and collection of the scooters by the service provider and the "green" solution for its logistics processes and related costs (purchase and maintenance of electric vehicles).
		Which party will be responsible for operations and maintenance costs	This should be included in the regulation in a detailed and clear way, the current idea is that the service providers will bear these costs, the location of the micromobility point will be provided and financed by the municipality, and the service providers will pay a public space fee.
		How this cost burden can be reduced	Closer cooperation between local government and market players.
		Will these costs be outbalanced by the benefits	The costs for stakeholders are expected to be recouped through the creation of low emission zones and a gradual increase in the share of people using micromobility.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
PM3: Resolving legal issues related to the regulation of market-based services	Financial feasibility/fixed costs	What are the fixed costs?	The cost of establishing micromobility points, which can be covered either by market sources or by the municipality's own costs (collection of a public space charge, which is borne by the service providers). However, this burden is expected to be partly passed on to users. A full transfer of costs to users would clearly result in a loss of users. In addition, the costs set by the municipality will have to be paid by the service providers in order to maintain revenue/profit (to maintain the size of the service area and thus the level of utilisation).
		Will these costs be outbalanced by the benefits	Yes, in a long-term it will be more benefits. In the long run, there will certainly be more benefits, given that users will find themselves facing a more predictable service. It will be in the interest of service providers to have their devices available at all locations.
	Technical feasibility	Why is PM1 technically unfeasible?	Service providers work for investors, making it more difficult to contain cost increases.
		How to overcome the gap?	Regulation can be the basis for healthy development.
PM4: Tools used to strengthen the link between the public and private sectors	Financial feasibility/fixed costs	What are the fixed costs?	Building up the system of the cooperation.
		Will these costs be outbalanced by the benefits	Yes, because the stakeholder could find the synergies.

5.3.4 User acceptance

Figure 7 shows the structure and share of respondents of the user acceptance tests for the use case 1 in the city of Budapest. There were 9 participants.

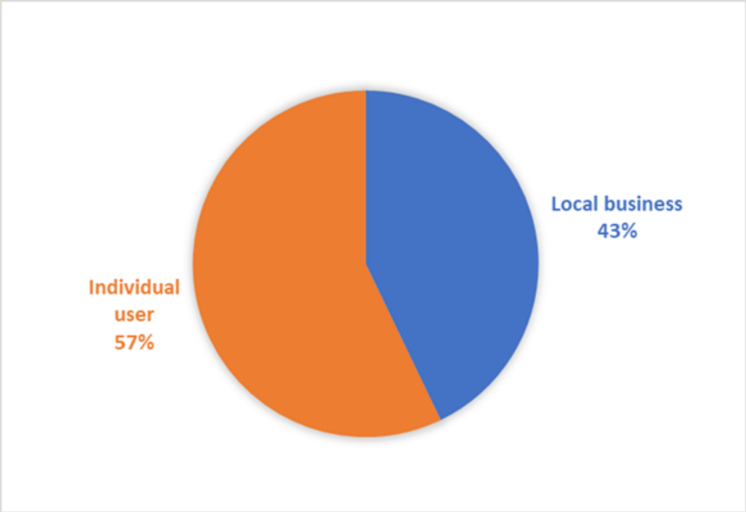

Figure 7. User acceptance study - Budapest Pilot, Use Case 1: The structure and share of respondents

They believe they meet their needs and understand how they can solve the urban mobility challenges. Finally, participants think the proposed policy measures are acceptable and almost affordable.PM1 and PM2 are considered unaffordable and analysed during the second stage of the T4.5 methodology (Table 8).

Table 8. T4.5.- Use case 1 -ser acceptance - Second stage: Responses to misalignments

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Response
PM1: Construction of protected and well-maintained bicycle lanes and main lines	Affordability	What are the real costs of PM1 for the user?	The issue of car tax: while private car transport is much more expensive, cycling is much more cost-effective, not to mention the social and environmental benefits. It is also important to stress that the two should work together. Cycling is not a burden on the road, heavy goods vehicles are the biggest problem (in terms of maintenance).
		How can these costs be overcome (or gradually introduced)?	With a gradual, phased introduction of measures (taxes and subsidies)
PM2: Establishment of low-emission zones (emission-based recovery restrictions)	Affordability	What are the real costs of PM1 for the user?	The issue of car tax: can we expect to have only zero-emission vehicles on the road and transport in 10-15 years?
		How can these costs be overcome (or gradually introduced)?	With a gradual, phased introduction of measures.

5.3.5 City-led policy response

Use case 1 users considered that PM1, "Construction of protected and well-maintained bicycle lanes and main lines" and PM2 "Establishment of low-emission zones (emission-based recovery restrictions)" are not affordable for them. During the workshop, the participants concluded that these measures reduce the collection of taxes from private and fossil fuel-based vehicles and would make them unviable in the long term. To mitigate this impact, they suggest including new collection measures based on taxing the new mobility forms to sustain the maintenance and creation of infrastructures. About the latter, the stakeholders assessed it as not financially feasible. Fixed costs refer to the installation of signs with variable messages depending on the air quality level, the collection of traffic data and the organization of communication campaigns to ensure effective operation. Benefits may balance these costs as people using micromobility prefer these zones. Operational and maintenance costs concern the collection of the scooters and the maintenance operations of the vehicles for the operators. Although the costs may be balanced with a gradual increase in the share of people using these vehicles, the workshop participants suggest close cooperation between the local government and market players where the operators assume the operation costs of providing these areas with shared micromobility vehicles and the municipality with the costs of creating secure spaces that would include a fee for these service providers.

About PM3, "Resolving legal issues related to the regulation of market-based services", workshop participants think that the potential reasons for considering the PM3 financially unfeasible are that a full transfer of costs to users would result in a loss of users. Therefore, the costs set by the municipality should be partially paid by the service provider to be able to maintain the profit and the level of service. They believe the costs will be balanced by the benefits of keeping the micromobility market share (public space occupied, emissions). About the technical unfeasibility, they feel that the pressure from investors makes it more difficult to assume additional costs. To mitigate this conflict, the participants suggest developing regulations.

PM4, "Tools used to strengthen the link between the public and private sectors", requires some investment to build the system of cooperation. However, the benefits will balance the costs as a good relationship between the stakeholders is essential to sustain changes in the long term.

To conclude, all policy measures are considered not financially feasible, but indirect benefits on reducing negative externalities balanced these hurdles. More specifically, PM4 is the basis for building a good relationship among the city members and ensuring a successful transition towards the new environmental, social and consumerism patterns change and challenges. PM3 can support the scalability of the creation of low calming zones but may require additional regulations to balance the new mobility providers operating the area financial sustainability and users affordability.PM2 is the most controversial measure as neither the users nor the stakeholders consider it financially feasible. On the one hand, the low emissions zones may require the definition of a new taxation system for the citizens and the operators. It will require close cooperation, as suggested by PM4. Finally, PM1 as PM2 is assessed as not affordable by the citizens as they believe that building and maintaining this infrastructure will increase the taxes of micro-mobility vehicles while the conventional ones decrease. AS with PM2, the close cooperation in the establishment of a new taxation system facilitated by PM4 may ensure the citizens' acceptance.

5.4 Application to Budapest pilot: Use case 2

According to the methodology explained in chapter 5.2, the set of alternative policy measures was defined and the survey was designed (added as the Annex 3) to collect the opinions related to the most critical aspects of policy implementation feasibility and user acceptance.

5.4.1 Set of alternative policy responses and stakeholders involved and role

The relevant stakeholders participating in this use case are listed below.

- Public transport operator;
- Mobility operators;
- Infrastructure operators;
- Walking or cycling associations;
- Users of micromobility services;
- Experts from Budapest University of Technology

Table 9. Use case 2: Alternative policy measures (PM): stakeholders involved and role.

Alternative policy response	Stakeholders involved and role
PM1: Advantage of active transport over individual motorized transport	Infrastructure (Road) operator, Municipality of Budapest VI. District, Walking or cycling associations, Shared Mobility Operators
PM2: Provision of leisure activities, green surfaces, street furniture	Infrastructure (Road) operator, Municipality of Budapest VI. District, Walking or cycling associations
PM3: Measures taken to give priority to public transport	Infrastructure (Road) operator, Municipality of Budapest VI. District, Walking or cycling associations, Public Transport Operator, Shared Mobility Operator
PM4: Definition of measures and guidelines for transport in favour of certain modes of transport	Infrastructure (Road) operator, Municipality of Budapest VI. District, Walking or cycling associations, Shared Mobility Operator

5.4.2 Set of alternative policy responses and interrelationships

Table 6 shows the most preferred policy measures included in the feasibility assessment and the interrelationship with the mobility solution:

Table 10. Use case 2: T4.5 Alternative policy measures (PM) and interrelationships.

	PM1: Advantage of active transport over individual motorized transport	PM2: Provision of leisure activities, green surfaces, street furniture	PM3: Measures taken to give priority to public transport	PM4: Definition of measures and guidelines for transport in favour of certain modes of transport in cities
PM1: Advantage of active transport over individual motorized transport	X	With the effective space usage there will be more space for liveable public spaces.	Strengthen the relation between the Public Transport and the active mobility modes.	Create more opportunity to use active mobility modes than before.
PM2: Provision of leisure activities, green surfaces, street furniture	The environment will be friendlier for the active mobility mode users.	X	Creating better environment near by the stops of the public transport.	Give more space to active mobility modes.
PM3: Measures taken to give priority to public transport	Strengthen the relation between the Public Transport and the active mobility modes.	Promote the Public Transport to leisure activities.	X	Increase the capacity of the most efficient mobility mode.
PM4: Definition of measures and guidelines for transport in favour of certain modes of transport	More opportunity will be friendlier for the active mobility mode users.	Promote alternative mobility modes to leisure activities instead of individual motorized transport.	Increase the capacity of the most efficient mobility mode.	X

5.4.3 Implementation feasibility

The survey' questions (six in total) aim to evaluate the selected alternative measures against the most critical dimensions of feasibility – technical, financial, political and administrative feasibility as it has already explained in the Methodology section. The survey was circulated via Qualtrics platform among the stakeholders relevant for implementation of the use case 2 in Budapest pilot.

In total 11 respondents participated in the Feasibility Survey. The structure of the respondents as well as their share is illustrated on Figure 8.

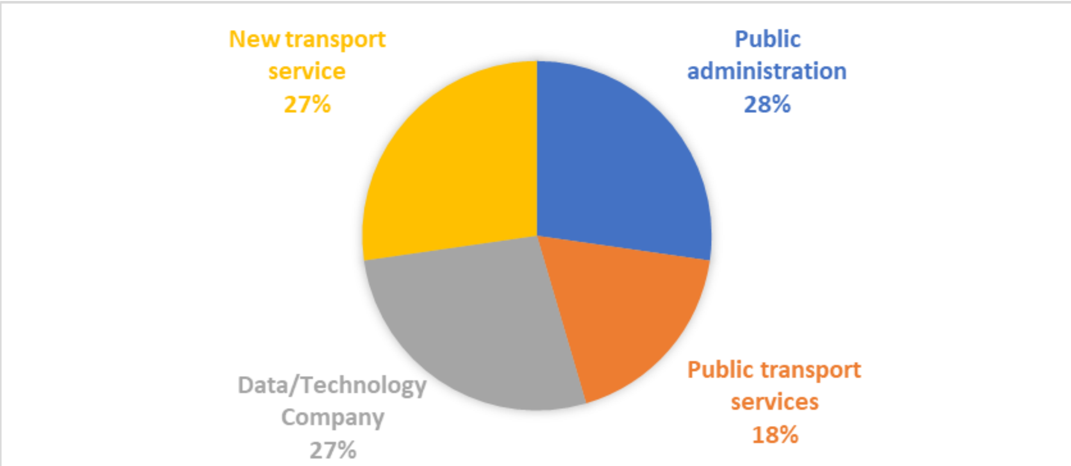

Figure 8. Use case 2 -Feasibility study: The structure and share of respondents.

The responses were analysed and used to identify the relevant questions related to potential policy measures (PMs) infeasibility (identification, analysis, how mitigating the risk). Then, these questions were the object of discussion in the second round of feasibility assessment.

Column three in Table 11 contains the relevant questions for PM implementation, risk identification, analysis and mitigation in Budapest Pilot. Column four includes a summary of the responses collected during the workshop. Annex 3 includes complete responses.

Table 11. T4.5.-Use case 2: Implementation feasibility - Second stage: Responses to misalignments.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
PM1: Advantage of active transport over individual motorized transport	Financial feasibility/indirect costs	What are the indirect costs?	Determining the direct and indirect cost benefits of cycling. The benefits of cycling mainly cover health aspects, which can be quantified in monetary terms (lower rates of sickness, reduced absenteeism, etc.). Preferring active transport can contribute to tackling the climate challenge; identify the associated benefits.
		Will these costs be outbalanced by the benefits	There are a number of environmental, health, economic, etc. benefits of favouring active transport over private motorised transport.
PM2: Provision of leisure activities, green surfaces, street furniture	Financial feasibility/indirect costs	What are the indirect costs?	There is a high demand for public spaces and green areas, and no one wants to spend time in a depressed environment. Most of the criticism of the traffic calming measures that have been implemented has been directed at the lack of greening. We can learn a lot from shopping centres in terms of the means they use to attract people and the money they spend on renovation and appearance. In Vienna, for example, an IKEA was built in the middle of the city centre, it is inaccessible by car, it is 'people-friendly' inside, the roof terrace is free for locals to use, and it has become a very good public space with a good view. In Hungary, the roof terrace of the 'WESTEND' mall has a similar design.
		Will these costs be outbalanced by the benefits	If active and micro-mobility is booming, people will also go to retail places more often, not just shopping centres, as we walk to smaller shops more often than we drive.
	Financial feasibility/operations and maintenance costs	What are the real operations and maintenance costs	Amortization of the road signs and the street furniture’s (bicycle racks).
		Which party will be responsible for operations and maintenance costs	Road operator, local municipalities

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
		How this cost burden can be reduced	Standardization
		Will these costs be outbalanced by the benefits	Yes, but only the indirect benefits will be outbalanced
PM3: Measures taken to give priority to public transport	Financial feasibility/fixed costs	What are the fixed costs?	Implementing dedicated bus lanes, changing then traffic signal programs
		Will these costs be outbalanced by the benefits	Micromobility has a strong seasonality compared to public transport, but micromobility and public transport should not be placed in opposition to each other, but should operate in parallel and should reinforce and complement each other. In other cities abroad (Oslo, for example) people also use bicycles and scooters in winter, so this is partly a question of transport culture, and the aim is to move towards this approach in Hungary too.

5.4.4 User acceptance

Figure 9 shows the structure and share of respondents of the user acceptance tests for the use case 2 in the city of Budapest. There were 9 participants. As we observe, participants are divided among three categories homogenously.

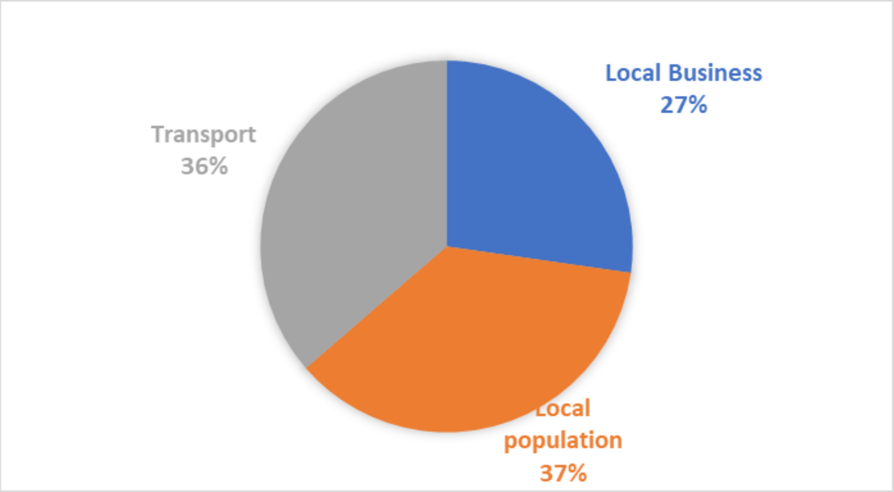

Figure 9. User acceptance study - Budapest Pilot, Use case 2: The structure and share of respondents

According to the results further detailed in the annex 4, the participants of the survey consider the policy measures acceptable for all the criteria asked. They have a good perception of the urban mobility challenges, included last mile efficiency, However, they do not fully understand the challenges of city logistics.

Table 12. T4.5.- Use case 2: User acceptance - Second stage: Responses to misalignments

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Response
n.a.	Challenges of the efficiency of the last mile	How the participants of the survey have a better understanding of the last mile logistic efficiency?	Faster journey times, competitive with the private car (micromobility). This should be promoted at government level (local level is not enough) and communicated to the public. Time is an important and tangible factor, this is a good communication direction especially towards people using private cars. However, cycling is a "learn to ride and get used to it" issue. The role of marketing in shaping attitudes (encouragement). Importance of network (infrastructure), mapped route planning, traffic calming.

5.4.5 City-led policy response

PM4 “Definition of measures and guidelines for transport in favor of certain modes of transport” is the most accepted and feasible policy measure to support the creation of mobility points. Stakeholders and users participating in the survey understand the measure. Moreover, they and consider it affordable, acceptable and feasible.

PM1 “Advantage of active transport over individual motorized transport” was considered as the indirect costs make this measure financially unfeasible. However, the comments during the workshop reinforce the benefits on the environment and population’s health in general, but also on monetary terms as it reduces the healthcare costs. Furthermore, PM1 can be considered a specific form of PM4. Therefore, it will support the use case 2 mobility solution similarly.

PM2 “Provision of leisure activities, green surfaces, street furniture” is the most controversial. It requires more investments in providing and maintaining these new features and reducing the commercial activity to the retail stores. Ownership between the actors (shop owners, municipality, residents) can be a main issue. However, it is also believed that green spaces surrounding commercial areas and with micromobility points may raise the attractiveness of these new layouts to the citizens and increase the change towards these new mobility systems.

PM3 “Measures taken to give priority to public transport” may require high investment/ fixed costs to create dedicated lanes, change traffic signal programs. However, as the micromobility is very seasonal and long-distance may reduce the acceptance, PM3 complement and reinforce the creation of mobility points and may increase the cultural change towards more active, shared and eco-friendly mobility.

To conclude, all the alternative policy measures explored for the installation of micromobility points will help to accept it and scale to other neighborhoods. The combination of these PMs with the creation of micromobility points will ensure and speed up the transition towards Budapest new mobility in the long term.

6 Conclusions

In this project, the Budapest Team tested two use cases: the definition of traffic calming in the centre of Budapest (Use Case 1) and the introduction of 86 Mobility Points in the same downtown district (Use Case 2). Use Case 1 aimed to make the area more liveable by reducing motorised traffic and providing a safer environment for cyclists and pedestrians. The focus of Use Case 2 was the Mobility Point Network for shared and private bikes and e-scooters

Use Case 1 banned entrance to car traffic in a short section in one of the main local streets (Király utca), permitting access only to authorised vehicles and freight transport. In the beginning, the traffic-calming measure was heavily criticised. Residents and the media higly criticies the local politicians and urban plannes for longer travel times by motorised vehicles. Nevertheless, after several public hearings and some minor modifications, the number of complaints reduced significantly. Currently, the local municipality is planning to further increase the traffic-calming measures within the district by creating designated zones where only residents can enter by motorised vehicles.

Reduced traffic has also made the street safer for vulnerable road users. It has increased surrounding citizens attraction to visit the street. In terms of operational feasibility, the changes can be operated properly.

One of the main barriers encountered during the assessment of the Mobility Points in Budapest is the multilevel and hierarchical municipality system. The City of Budapest needs to cooperate with the local districts, and each one has its demand. Besides that, the National Road Code does not recognize the new type of micromobility vehicles (e-scooters). This lack of legislation hinders the regulation of public space used by shared mobility services and vehicles. Additionally, there is no regulation to collect and monitor shared mobility user data.

Mobility Points can help manage the deteriorated public space use caused by the increase in shared micromobility services and provide safer mobility. The Budapest Pilot created the opportunity to consider the advantages of the free-floating shared micromobility services, besides regulating public space use by micromobility vehicles.

The results of the detailed analysis foresee an average increase in modal share of 11.9%. It is 1.9% higher than expected before the implementation.

The stakeholders in Budapest identified the advantages and disadvantages that supportive policy measures can have on the implementation of the Mobility Points. Moreover, they helped understand the effect of introducing supportive policy measures into the use cases above.

In a nutshell, the pilot in Budapest reinforced two key messages: 1) The introduction of traffic-calming zones and the acceptance take time and require political commitment. It showed the real benefits for the whole city, enhanced with green spaces, street furniture and permissions for terraces. 2) Mobility Points plays a crucial for avoiding bad micromobility parking practices and fostering the adoption and acceptance of micromobility vehicles for people either in favour or not.

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Annex 1: The point-to-point assignment of modelling micromobility in the framework of the SPROUT project

The analysis of the Mobility Points Network was performed by transforming the Unified Transport Model of Budapest (EFM) maintained by BKK Zrt. To prepare the model, we first had to define the purpose of the study, identify the network transformations needed to achieve this goal, traffic needs, and the expected modal shift in line with changes in travel costs, and finally quantify the results.

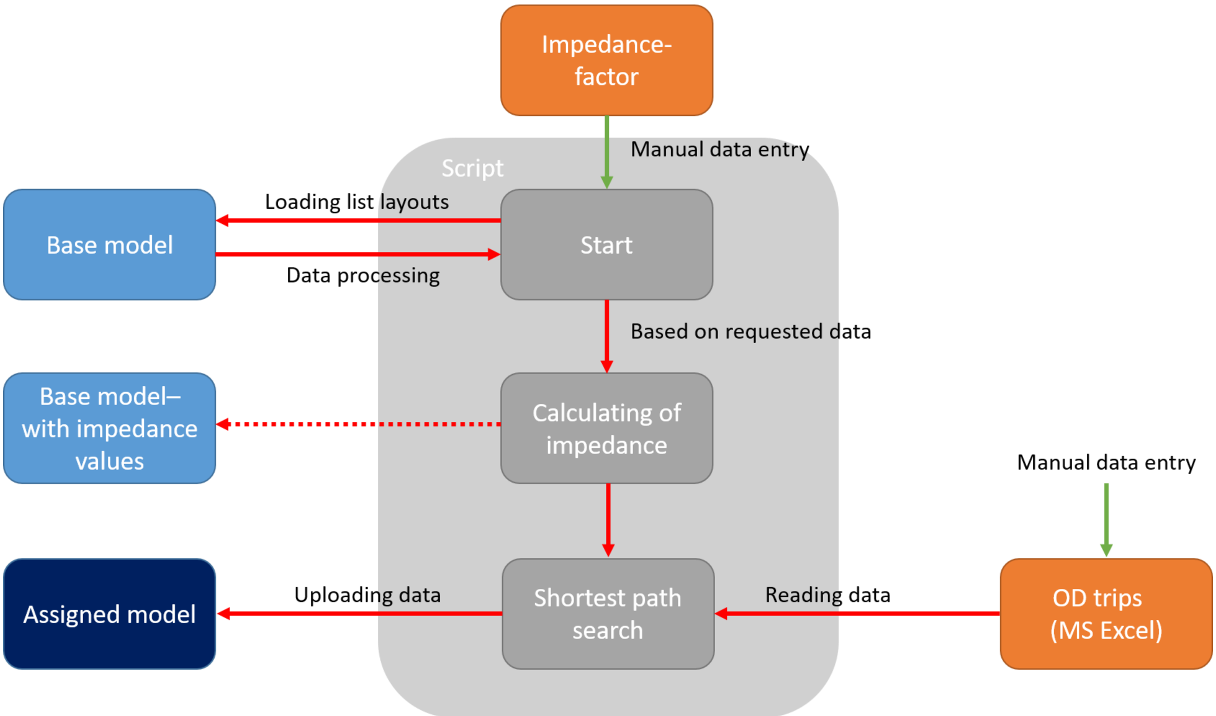

Figure 10 Analysis of the Mobility Points Network by utilizing the Unified Transport Model of Budapest

The purpose of the study is the expected benefits

In this current examination, we have taken into account the base-year traffic demands regarding the SV05 version of the EFM model. Between the Mobility Points (microMobility Points) to be established in the framework of the project, it will be possible to use faster (and with the possibility of selecting different routes) micromobility devices, complementing walking. In this correlation, the main benefit is the saving in travel time, which can be realised primarily at the following transport layers:

- in case of public transport, by partially replacing walking to and from a public transport vehicle ("last mile trips").
- in case of walking, partially or fully replacing trips taken only by walking.

It is important to mention that we have elaborated the basics of the examination, by the new modelling methodology assignment concerning the existing cycling layer of the EFM model, however in case of this layer, we have not seen a chance to realise benefits parallel to the establishment of Micromobility Points.

Preparation of the network

After registering the Micromobility Points, the extension of the network became necessary by partially reading the current OpenStreetMap and also by parameterising the read new network elements (Mozgásvilág, 2021).

The network extended in the first round is described by Figure 11:

Figure 11 Extension of the Micromobility Points network, phase one (source: edited by the company)

Identify the demand

As the examination is primarily aimed at the benefits of micromobility providing an alternative for walking, we needed to specify first and foremost the demand for walking within the examined area.

Walking can be realised along the network in two ways: as an independent walking layer and also as a partial journey of public transport (last mile trips).

New layer for walking

The independent walking demand is calculated and stored by the in-built demand model of the EFM model, however its assignment to the network is not realised in the basic model, thus:

- a walking assignment had to be established in the EFM basic model, which presents the aggregate walking demand per personal transport layer on the network
- in the surrounding environment of the examined area, a so-called sub-network had to be established, by the help of which, we were able to specify and define the entry points

of trips heading into the directly examined area and we could include them as quasi "cordon points" into the examined points

- traffic in areas covering the examined area had to be distributed among the mobility points.

As a result of the procedure, in the six examined areas we have assigned 31,250 walking trips in the relation of a total of 10,712 relations on the network, the average walking distance is 521 m, time spent walking is 4,071 hours.

Walking as a partial journey

In public transport, we have examined walking as the starting and final points of the travel chain. To explore the demand, we have taken the following steps:

- in the EFM's basic model, we have specified such stop areas where the first boarding points of trips or the last arrival points of trips to the related areas are located
- we have dedicated the stop area nodes, as hubs included in the point-to-point based assignment
- we have distributed the selected stop area nodes and the demand of the original area among the mobility points.

As a result of this procedure, on the examined area, we have assigned 91,106 walking trips in the relation of a total of 3,915 relations on the network, the average walking distance is 411 m, time spent walking is 9,357 hours.

Elasticity

We have assigned the above-described demand both as the walking and the micromobility layer to the network. In each relation, the program saves the main parameters of a given route, such as travel time, distance or the combined cost, simultaneously with the presentation of traffic on the network. The resistance matrices created this way show different values in case of the layers for those who walk and for those who use micromobility. We have expanded the time demand of micromobility with the time demand of device use (time taken for the pick-up and return of the device), which we specified uniformly as 45 seconds.

We have specified the ratio of modal shift in relations, where the micromobility assignment has lower costs, enabling "faster" trips.

The DfT TAG (M2.1, 2020) recommends basically two functions to calculate the modal shift elasticity; one of them calculates with the difference between the costs of the two modes (Exponential), while the other calculates with the ratio of the two costs (Power).

The formula of the exponential curve is the following:

$$T_{ij} = g_{ij} * 0T_{ij} * exp\{B * (G_{ij} * 0G_{ij})\} \quad (1)$$

while the formula of the power curve is the following:

$$T_{ij} = g_{ij} * 0T_{ij} * \left(\frac{G_{ij}}{0G_{ij}}\right)^A \quad (2)$$

where

T_{ij} the estimated future travel demand in the relation of i-j

G_{ij} the future generalised cost in the relation of i-j

$0T_{ij}$ the base year's travel demand in the relation of i-j

$0G_{ij}$ the base year's travel cost in the relation of i-j

g_{ij} estimated traffic increase

A the power curve's elasticity parameter

B the exponential curve's elasticity parameter

The shape of the curves is shown in Figure 12 The shape of the elasticity functions recommended by DfTTAG (source: edited by the company)

:

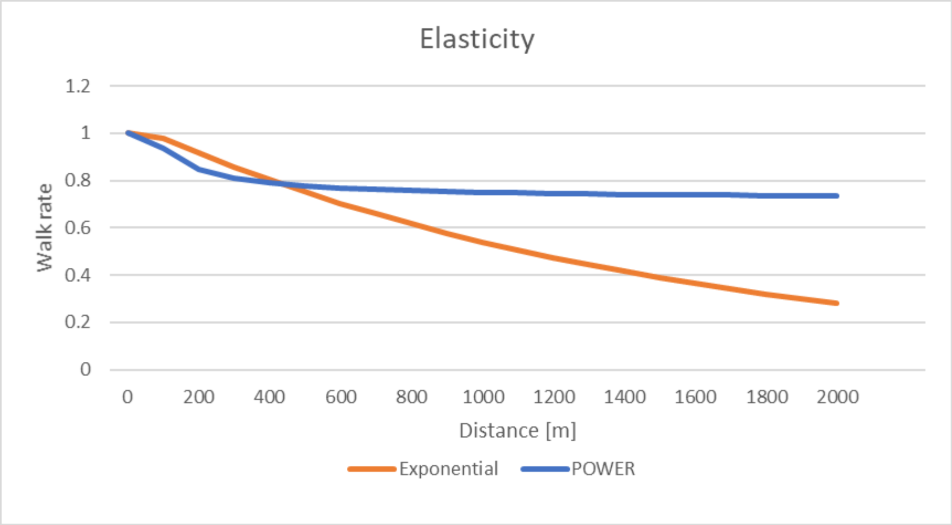

Figure 12 The shape of the elasticity functions recommended by DfTTAG (source: edited by the company)

As the ratio of the travel time of walking and micromobility narrows the speed ratio of the two modes, by increasing the distance, and the difference is increasing on a continuous basis, we have selected the power curve providing the restricted cross-elasticities.

We have re-assigned the demand recalculated with the help of elasticity to the network and aggregated the results.

Presentation of the results

The situation arisen due to the coronavirus pandemic has not enabled us to explore the modal shift willingness on the examined area in the project, therefore we have calculated the expected benefits by analysing scenarios.

We have carried out the examinations as per three cross-elasticities, assuming one optimistic, one pessimistic and one average script, in accordance with the expected popularity of the new device. The function's elasticity factor *(A) 0,3 (optimistic), 0,2 (average) and 0,1 (pessimistic).* The shape of the functions is shown in Figure 13.

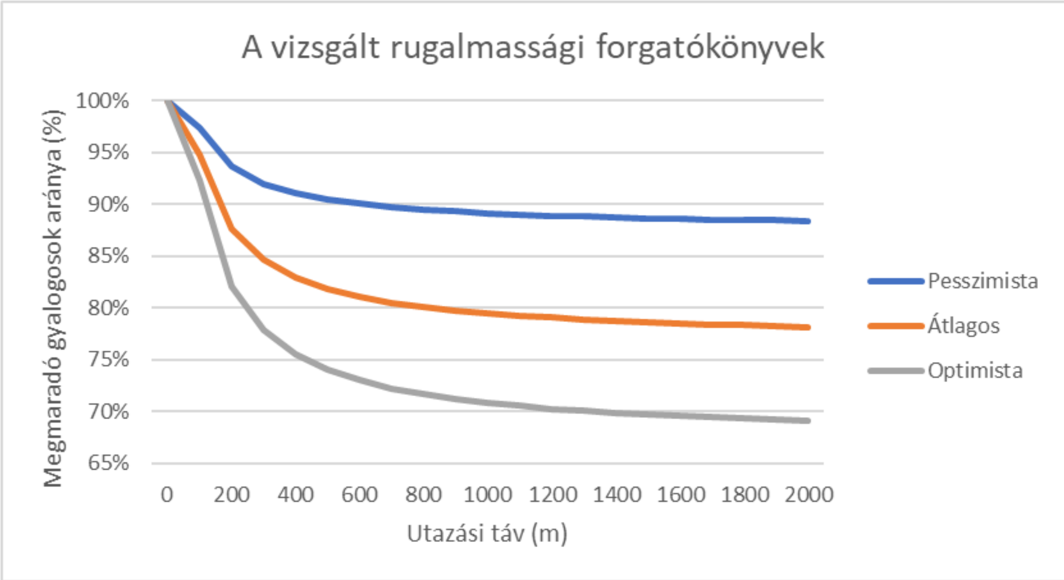

Figure 13 Modal split flexibility of the scripts examined (source: edited by the company)

The numerical results of the examination made in accordance with the optimistic script are specified in Table 13, as follows:

Table 13 Expected benefits of the development in case of the optimistic script

	Walking, baseline	Modal shift (micromobility)	Remaining walking distance	Trips taken partially by public transport, baseline	Modal shift (micromobility)	Remaining walking distance
Demand (trip/day)	31,250.6	5,886.3	25,364.3	91,106.3	15,129.0	75,977.3
Total time (h/day)	4,071.6	371.2	3,146.7	9,357.5	823.1	7,488.9
Average distance (m)	521	946	496	411	816	394
Time gained (h/day)	**-**	**553.6**		**-**	**1,045.4**	

The numerical results of the examination made in accordance with the average script are specified in Table 14, as follows:

Table 14 Expected benefits of the development in case of the average script

	Walking, baseline	Modal shift (micromobility)	Remaining walking distance	Trips taken partially by public transport, baseline	Modal shift (micromobility)	Remaining walking distance
Demand (trip/day)	31,250.6	4,090.3	27,160.3	91,106.3	10,472.6	80,633.7

	Walking, baseline	Modal shift (micromobility)	Remaining walking distance	Trips taken partially by public transport, baseline	Modal shift (micromobility)	Remaining walking distance
Total time (h/day)	4,071.6	258.3	3,426.8	9,357.5	570.4	8,060.5
Average distance (m)	521	947	505	411	817	400
Time gained (h/day)	**-**	**386.4**		**-**	**726.5**	

The numerical results of the examination made in accordance with the pessimistic script are specified in Table 15, as follows:

Table 15 Expected benefits of the development in case of the pessimistic script

	Walking, baseline	Modal shift (micromobility)	Remaining walking distance	Trips taken partially by public transport, baseline	Modal shift (micromobility)	Remaining walking distance
Demand (trip/day)	31,250.6	2,133.3	29,117.3	91,106.3	5,440.4	85,665.9
Total time (h/day)	4,071.6	135.0	3,734.2	9,357.5	296.7	8,681.8
Average distance (m)	521	949	513	411	818	405
Time gained (h/day)	**-**	**202.4**		**-**	**379.0**	

It can be seen that the project could realise a gain of 580 h/day travel time even in case of the pessimistic script, solely by partially replacing the existing walking demand.

Figure 14 shows the presentation of the assignment procedures in the model.

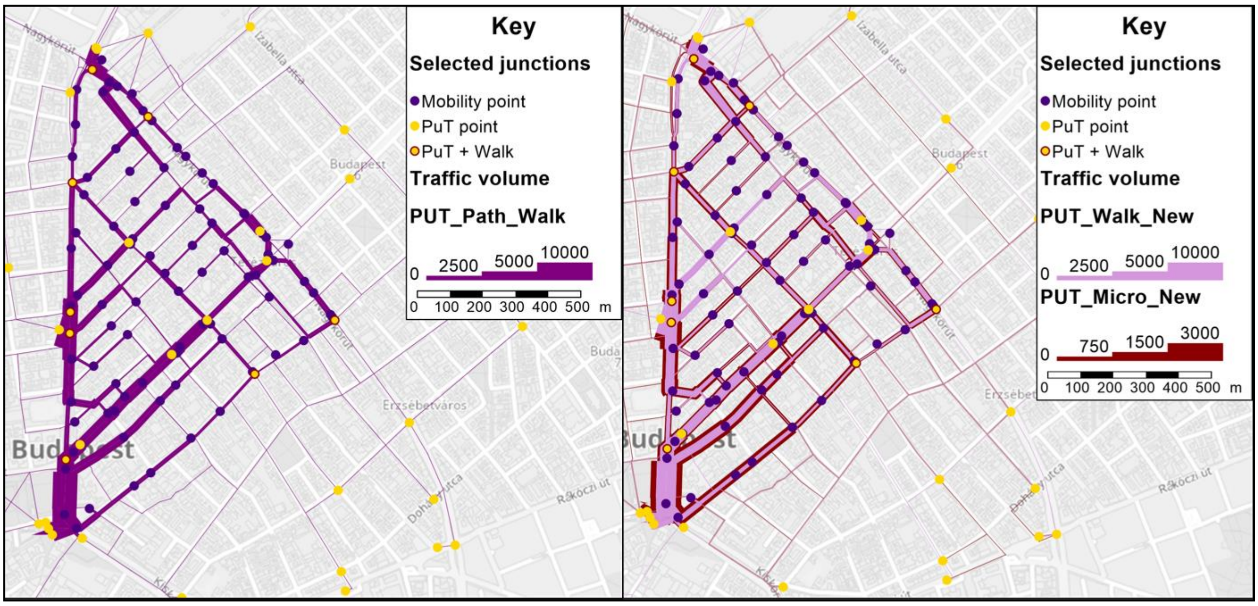

Figure 14 Presentation of results in the model, trips taken partially by public transport (edited by the company)

On the left side of the diagram, the partial walking journeys connected to public transport on the affected area can be seen with point-to-point based assignment to the network; while on the right side of the diagram, after the redistribution of demand, the remaining walking distance (pink) and trips taken by the newly-generated micromobility devices (wine-red) can be seen.

Conclusion of the modelling

The expected expansion of micromobility devices requires the extension of macro-level examinations even for these layers. The elaborated point-to-point based assignment procedure enables the examination of short-term trips without primarily changing the conventional area-based models.

The procedure applied first in the framework of the SPROUT project facilitated the exploration of such benefits in the macro-model, which remained hidden when using the conventional modeling methodology.

The project has proven that the point-to-point based assignment can be freely formed, in compliance with the existing model and also with the special demands of the examined layers, whose main benefits are the following:

- enables to present traffic demand in a decentralised way among an arbitrary number of traffic indicating points
- it will become possible to examine such transport modes, where the average travel length is short, compared to the model resolution (walking, micromobility, cycling)
- the basic model can remain unchanged during the procedure, therefore the distribution or the re-calibration of the area is not required
- layers included in the examination can be quickly and flexibly formed in the model

- elements and parameters of the volume-delay function affecting the selection of route can be changed freely, even per layer in different ways
- the procedure can present such travel demand within the area, which remained hidden while applying conventional methodology.
- thanks to the external Python COM input, the development and transformation of the procedure can be unlimited, in compliance with market demand.

Annex 2: T4.4 Templates

1. Problem identification template- SIS step 1

Goal

- Develop a list of alternative policy responses for each pilot
  - Based on:
    - T3.3- Policy impact assessment of future urban mobility scenarios
    - T4.2- Results from the operational assessment of the pilots
- Prioritisation of alternative policy responses
  - Through multi-actor-multi-criteria analysis (MAMCA)

Input needed

In order to develop and prioritise the alternative policy responses, the answer to the following questions is needed:

1. What is the main problem you encounter in relations with your pilot?
2. What are the possible (policy) solutions to this problem?

An example could be as follows:

1. Main problem encountered: the integration of autonomous pods with surrounding traffic does not happen properly and creates dangerous situations.
2. Possible policy solutions:
   a. Making the area around the pods' path a 30km/h zone;
   b. Developing a smart traffic light system that favours the pods so that car traffic is halted when they need to cross.

In order to ensure the correct development of this Task 4.4, we need the **main issue** you encounter with your pilot, and at least 2 possible solutions to that issue. Of course, it is possible to offer more than 2 solutions as well.

The template below needs to be filled in and sent to **sara.marie.tori@vub.be** by **Oct. 30, 2020**.

Template

Please fill in the template below. If you have more than one regarding the pilot, feel free to add an extra item to the list. However, the first issue should be the **main one**.

Main issue with the pilot

- Description of the problem encountered:
- Description of the possible policy solutions to the problem:
  1. ...
  2. ...

2. Stakeholder criteria request for Budapest- SIS step 3

Dear SPROUT stakeholders,

We are now a year and a half into the project. Up to now, we have inventoried the drivers of the transformations in urban mobility, and developed scenarios for the future of urban mobility in your city. To those of you who participated in the workshops to help build the scenarios, thank you again! You can take a look at the scenarios and their visualisations here (under the 'Resources' tab). As you may also know, pilot projects are now underway to test an innovative urban mobility solution in your city.

As part of the next step in the SPROUT project, we are looking at alternative policy responses for the pilots being implemented, based on issues that the SPROUT team uncovered during the implementation. This will be done through a modified multi-actor multi-criteria analysis (MAMCA), which is an evaluation that takes into consideration different stakeholders and their priorities.

As one of the first steps of the process, we need your input. We want to know what your objectives are with regards to your city's urban mobility environment, in terms of the pilot that is being implemented, in the next 10 years. Below, you will find two short descriptions of the pilot. The first is the pilot as it is today; the second description is a situation where policy changes have been implemented as a result of the pilot. What we would like to know from you is the following: if we were to implement the alternative, what factors are important in your eyes that we need to pay attention to? In other words, **what makes a good alternative better than a bad alternative**? These factors can be positive, but also negative. To give you an idea of what we mean, these are a few example criteria against which alternatives can be evaluated: traffic safety, cost, accessibility, air pollution, noise, impact on other transport modes, etc.

We ask you to send us **between 2 and 6 criteria** that are important to you by **January 4, 2021**.

Collecting your objectives is the first part of the MAMCA. Once we have all of them, we will get back in touch with you with a short survey for the actual evaluation process.

Best regards,

The SPROUT team

Scenarios:

1. Do-nothing alternative (the pilot as it is today): shared micromobility points without regulation for storing the vehicles
2. Shared micromobility points with regulation that requires public space designers to plan space to store shared micromobility vehicles within a specified zone, and that will define the number of dedicated spaces for shared micromobility devices

3. Expert evaluation form- SIS step 4

To be filled in by the scientific partners

Instructions:

In this phase of the Task 4.4 Multi-Actor Multi-Criteria analysis, we have collected local stakeholders' objectives with regards to your pilot. For this next step, we ask you to **evaluate the two scenarios** (the situation with and without the pilot) against these objectives. In order to do this, the table below lists all the stakeholder criteria that need to be evaluated. For each criterion, the following question needs to be answered: how does the second scenario (i.e. the scenario with the pilot implementation) score in terms of this objective? The drop-down menu allows you to choose between:

- Very negative;
- Negative;
- Slightly negative;
- No change;
- Slightly positive;
- Positive;
- Very positive.

For example: if I were to implement parcel lockers at a metro station, I could have the following evaluation:

- Very positive in terms of accessibility to customers (customers can now access their parcels any time they want);
- Negative in terms of financial feasibility (there is a cost associated with the implementation of the lockers).

In order for us to understand the evaluations, please write a (short) justification in the last column. If the evaluation is based on figures that are at your disposal, please also include those (for example, if you have a concrete implementation cost for the lockers in the example above, this needs to be added in the justification column).

Many thanks!

The Sprout Team

4. Stakeholder evaluation form Kalisz- SIS step 5

VRIJE UNIVERSITEIT BRUSSEL

English

Intro and stakeholder group

You are invited to take part in a European funded project called SPROUT, which aims at developing innovative policy responses to urban mobility challenges. We ask you to fill in the following questionnaire as part of the stakeholder evaluation of the pilot of the smart loading bays in Kalisz. It will take no longer than 5 minutes. You can withdraw at any moment. By participating in the survey, you consent to use the data you provide in SPROUT and to make them publicly available in anonymised form. Your privacy will be respected in any case. For more information regarding SPROUT and the data you provide, please contact privacy@zlc.edu.es. Thank you very much for your collaboration.

To which of these stakeholder groups do you belong?

- ◯ Kalisz Municipality
- ◯ Infrastructure
- ◯ Business incubator
- ◯ School
- ◯ Entrepreneurs and companies
- ◯ Logistics service providers
- ◯ Shops and restaurants

Kalisz Municipality

Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).

	0	1	2	3	4	5	6	7	8	9	10
Increased road safety	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Ease of use	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Improvement in air quality	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Traffic reduction	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Adequacy of used technologies for research purposes	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Infrastructure

Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).

	0	1	2	3	4	5	6	7	8	9	10
Accessibility to users	○	○	○	○	○	○	○	○	○	○	○
Allocation optimization of available parking spaces	○	○	○	○	○	○	○	○	○	○	○
Ease of use	○	○	○	○	○	○	○	○	○	○	○
	○	○	○	○	○	○	○	○	○	○	○

Business Incubator

Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).

	0	1	2	3	4	5	6	7	8	9	10
Costs	○	○	○	○	○	○	○	○	○	○	○
Accessibility	○	○	○	○	○	○	○	○	○	○	○
	○	○	○	○	○	○	○	○	○	○	○

School

Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).

	0	1	2	3	4	5	6	7	8	9	10
Adaptability to demand	○	○	○	○	○	○	○	○	○	○	○
Compatibility to city development plans	○	○	○	○	○	○	○	○	○	○	○
IT integration	○	○	○	○	○	○	○	○	○	○	○
	○	○	○	○	○	○	○	○	○	○	○

Entrepreneurs and companies

Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).

	0	1	2	3	4	5	6	7	8	9	10
Ease of parking regulation enforcement	○	○	○	○	○	○	○	○	○	○	○
Improved accessibility to Logistics Service Providers	○	○	○	○	○	○	○	○	○	○	○

Logistics Service Providers

Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).

	0	1	2	3	4	5	6	7	8	9	10
Ease of use	○	○	○	○	○	○	○	○	○	○	○
Allocation optimization of available parking spaces	○	○	○	○	○	○	○	○	○	○	○
Increased road safety	○	○	○	○	○	○	○	○	○	○	○

Shops and restaurants

Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).

	0	1	2	3	4	5	6	7	8	9	10
Ease of use	○	○	○	○	○	○	○	○	○	○	○
Adaptability to varying needs	○	○	○	○	○	○	○	○	○	○	○

Stakeholder ranking

Below you can see the different stakeholder groups that are impacted by or impact the Kalisz pilot. Please rank the stakeholder groups from most impacted (1) to least impacted (7).

Kalisz Municipality

Infrastructure

Business incubator

School

Entrepreneurs and companies

Logistics Services Providers

Shops and restaurants

Pilot improvement

How could the pilot be improved, in your opinion?

[ ]

Do you see other alternative policy responses that could benefit the pilot implementation?

- ○ Yes
- ○ No

What other alternative policy responses do you think could benefit the pilot implementation?

[ ]

Conclusion

Thank you for your answers!

If you have any questions, don't hesitate to get in touch with us!
sara.marie.tori@vub.be
geert.te.boveldt@vub.be

If you are interested in staying up to date with the SPROUT project, visit sprout-civitas.eu.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grand agreement No 814910.

Annex 3: T4.5 Implementation feasibility

Use case 1: Planned traffic regulation changes

Implementation feasibility: First stage

Technical feasibility dimension aims at assessing the pool of resources that each of the alternative policy responses requires.

According to the opinion of the involved stakeholders, the policy measure PM3 represents a critical alternative from the aspect of technical feasibility since its average rating value (5-tier scale) falls slightly below the 2.5 threshold (Figure 15).

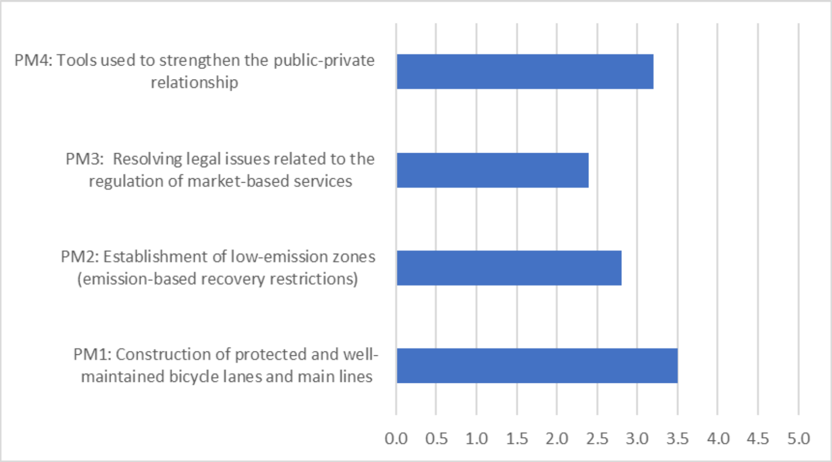

Figure 15 Use case1: Assessment of policy measures against the technical feasibility dimension

In order to assess potential risks as well as the risk mitigation strategies for the implementation of PM3 from the technical feasibility aspect a round table will be organized.

Financial feasibility includes evaluation of following cost categories: direct costs, indirect costs, fixed costs as well as operations and maintenance costs; as well as the selected benefit categories: direct and indirect benefits.

According to respondent opinions (Figure 16to Figure 25) the following conclusions are derived:

1. From the aspect of fixed costs PM2, PM3 and PM4 require additional analysis. PM2 requires an additional analysis for the operations and maintenance
2. From the aspect of the rest of the cost categories (direct and indirect costs), all the PMs are considered as feasible.
3. From the aspect of indirect benefits, all policy measure will produce positive outcomes.

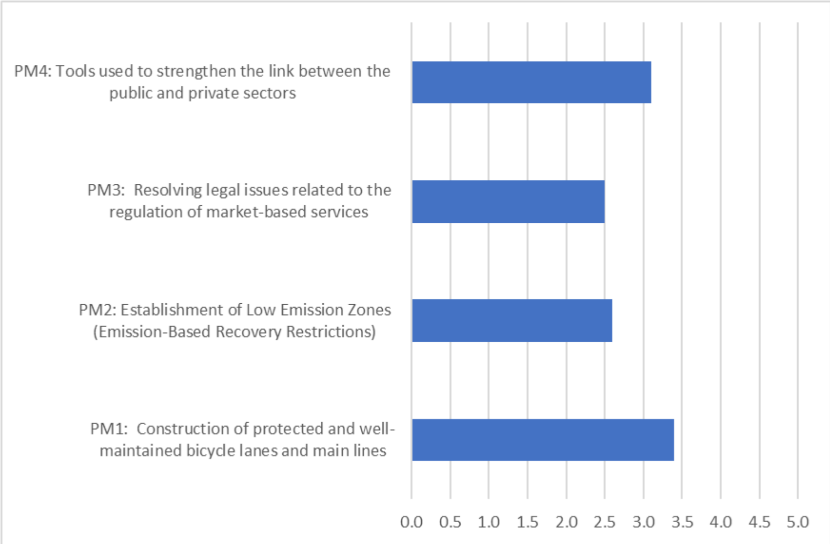

Figure 16 Use case1: Assessment of policy measures against the financial feasibility dimension: Direct costs

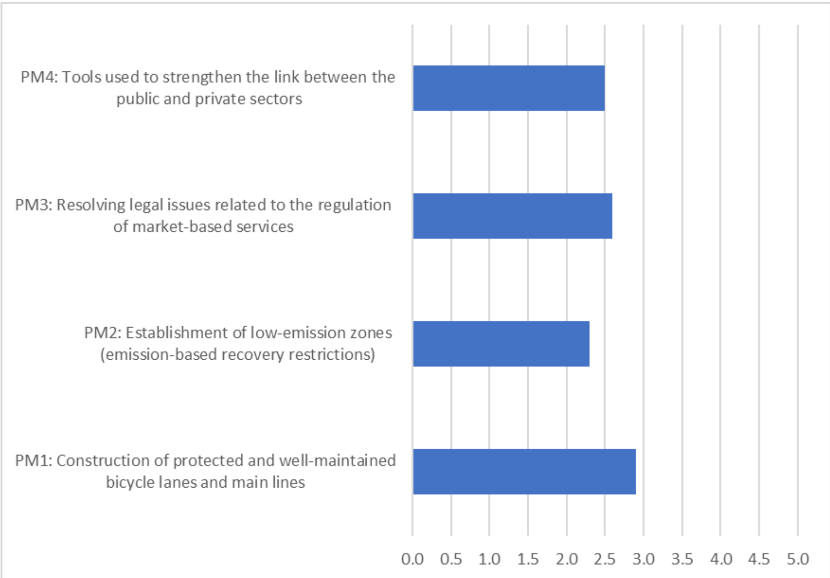

Figure 17 Use case1: Assessment of policy measures against the financial feasibility dimension: Indirect costs

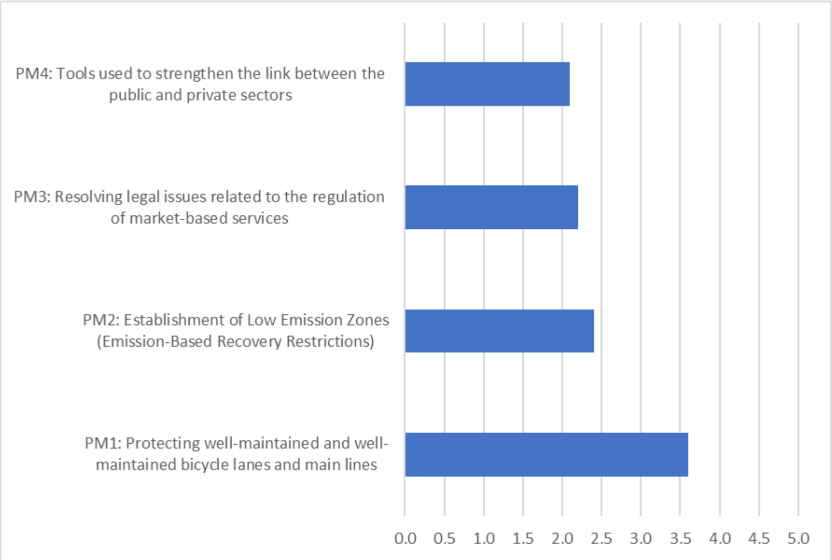

Figure 18 Use case1: Assessment of policy measures against the financial feasibility dimension: Fixed costs

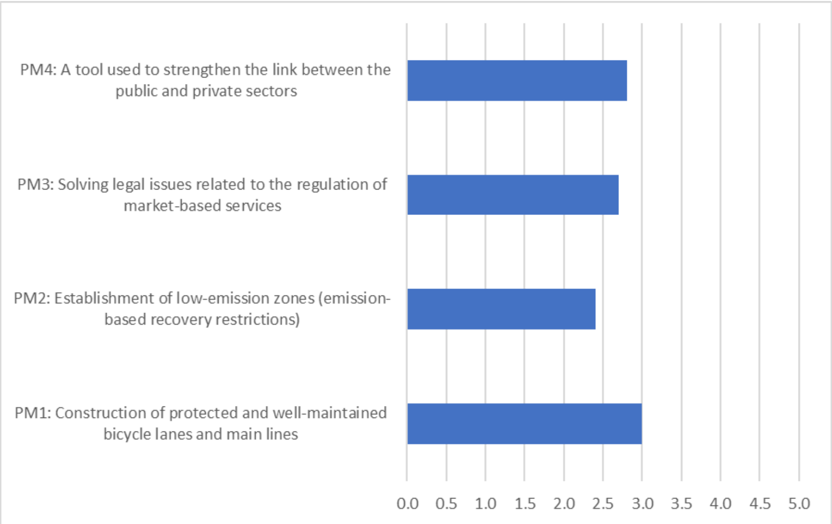

Figure 19 Use case1: Assessment of policy measures against the financial feasibility dimension: Operations and maintenance costs

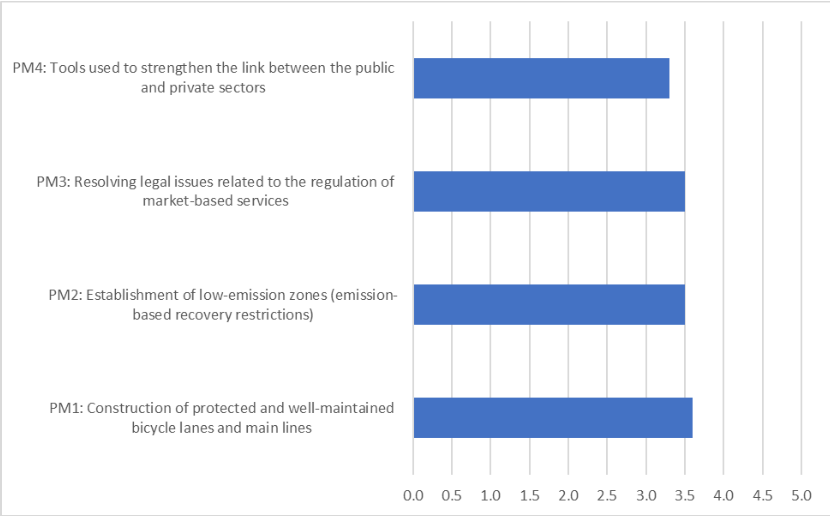

Figure 20 Use case1: Assessment of policy measures against the financial feasibility dimension: Direct benefits

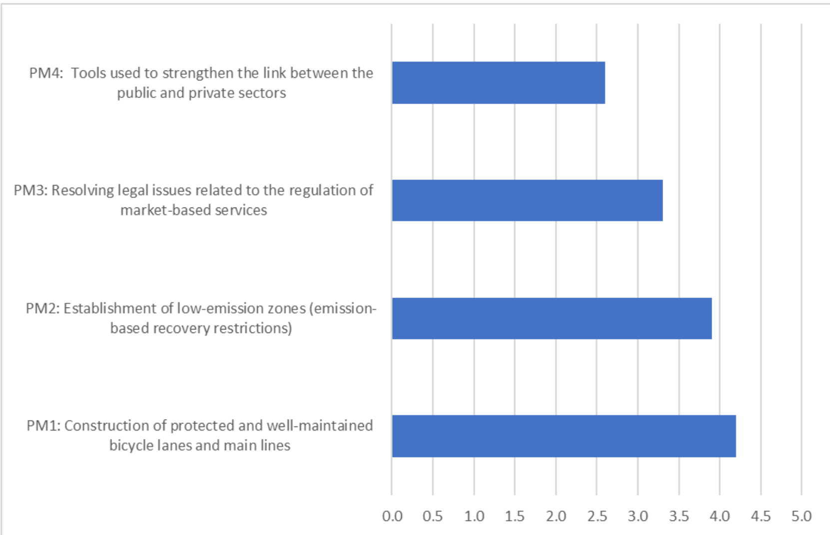

Figure 21 Use case1: Assessment of policy measures against the financial feasibility dimension: Indirect benefits

Political feasibility includes evaluation of acceptability of alternative policy measures from the aspect of relevant stakeholders. According to the graphs below, all the stakeholders score the PMs quite positively.

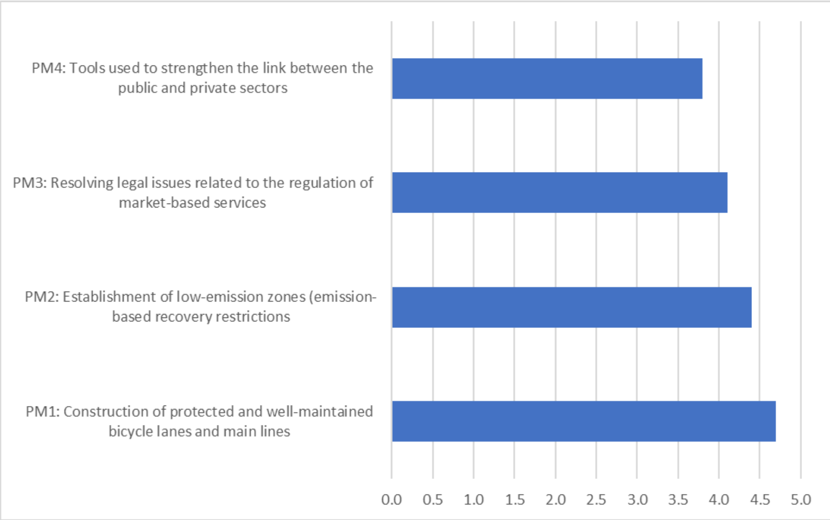

Figure 22 Use case1: Acceptability of alternative policy measures from the aspect of Public Administration.

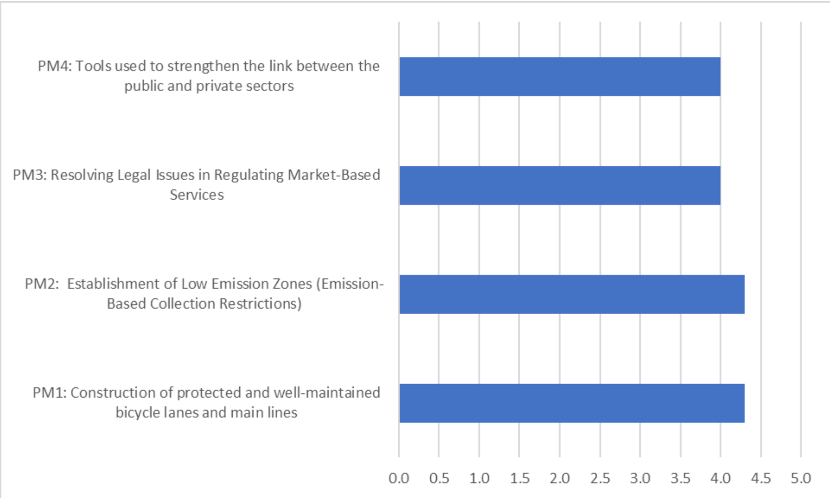

Figure 23 Use case1: Acceptability of alternative policy measures from the aspect of Public transport operator.

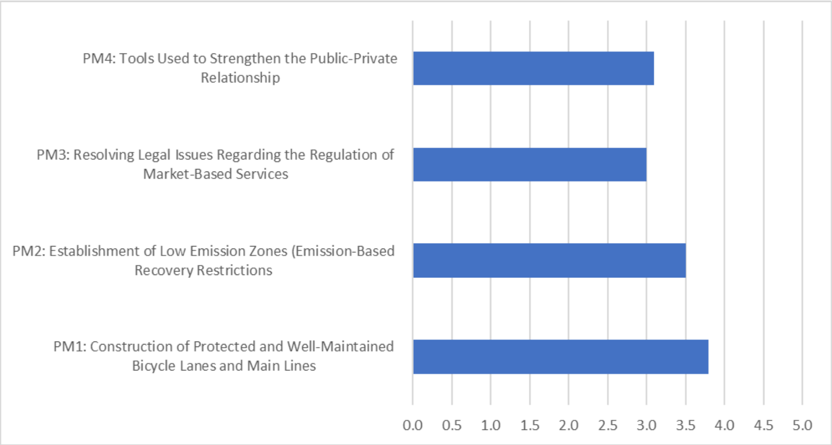

Figure 24 Use case1: Acceptability of alternative policy measures from the aspect of Data/ Tech Company

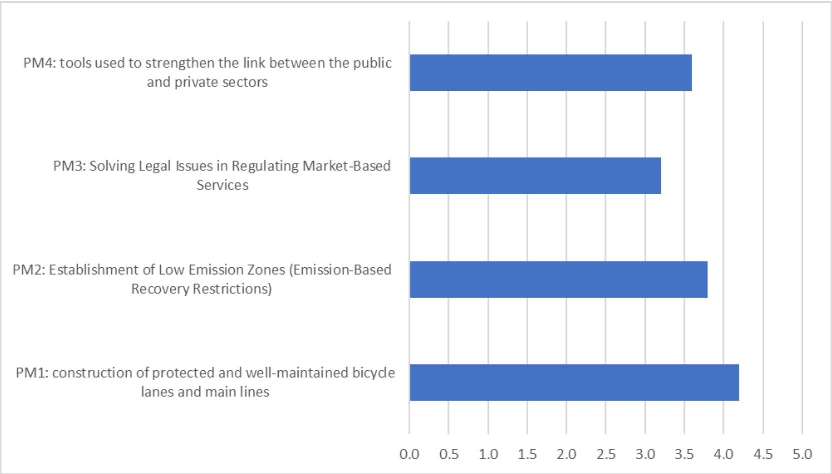

Figure 25 Use case1: Acceptability of alternative policy measures from the aspect of New mobility service operator.

Administrative operability and capability are the main criteria for assessment of policy measures against the political feasibility. According to the stakeholder responses, the following conclusion is derived:

- From the aspect of administrative capability PM2 and PM3 require additional consideration.

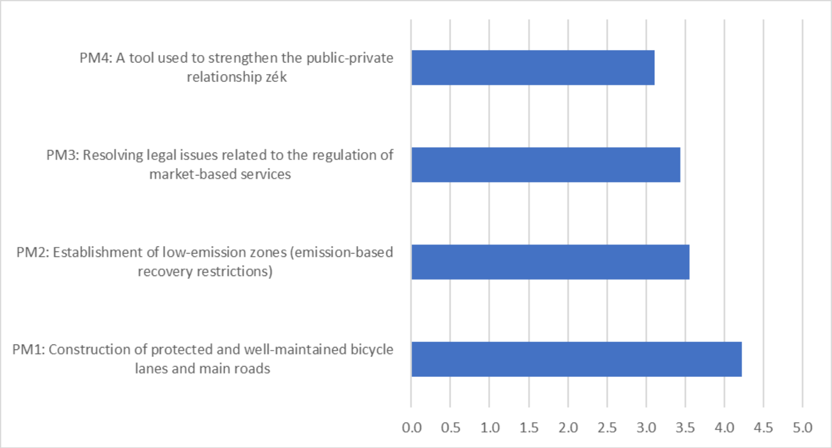

Figure 26 Use case1: Assessment of policy measures against the political feasibility dimension: Administrative operability

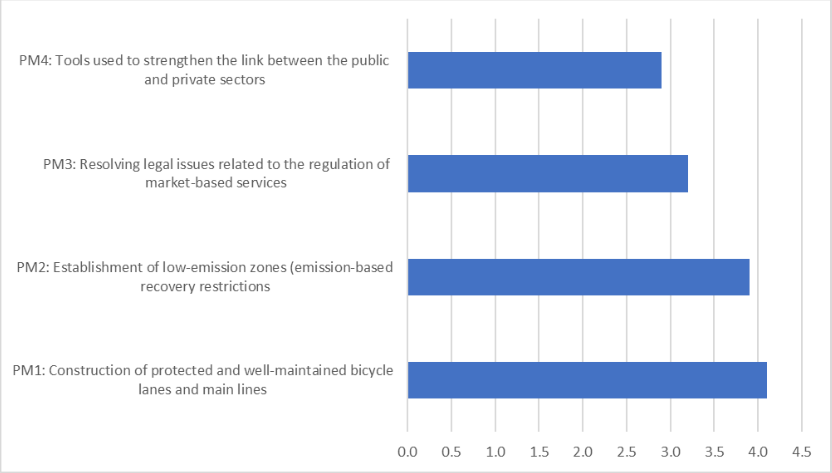

Figure 27 Use case1: Assessment of policy measures against the political feasibility dimension: Administrative capability

Use case 2: Creation of micromobility points

Implementation feasibility: First stage

Technical feasibility dimension aims at assessing the pool of resources that each of the alternative policy responses requires.

According to the opinion of the involved stakeholders, all the policy measures are feasible.

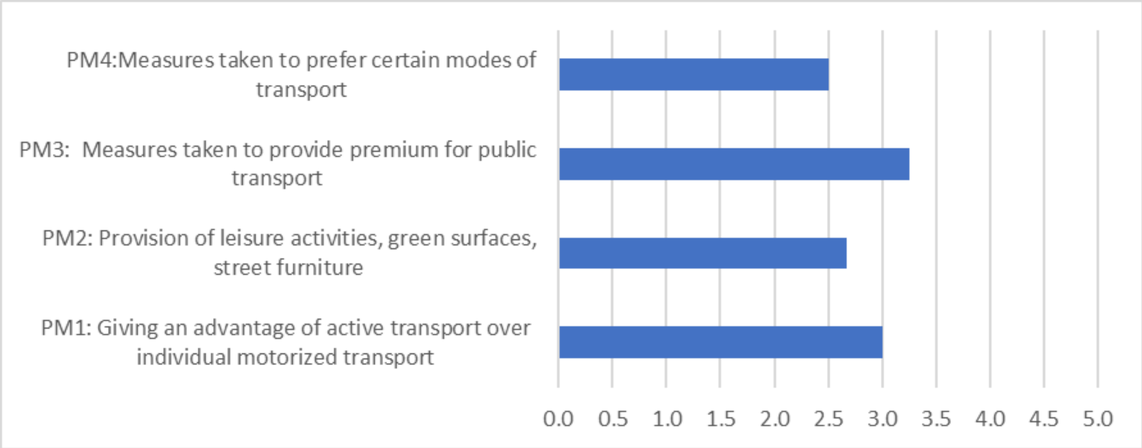

Figure 28 Use case 2: Assessment of policy measures against the technical feasibility dimension

Financial feasibility includes evaluation of following cost categories: direct costs, indirect costs, fixed costs as well as operations and maintenance costs; as well as the selected benefit categories: direct and indirect benefits.

According to respondent opinions (Figure 29-Figure 34), PM1 and PM2 are unfeasible for indirect costs. PM2 is not feasible for the operations and maintenance costs either. Finally, PM3 is considered as not feasible for the fixed costs category.

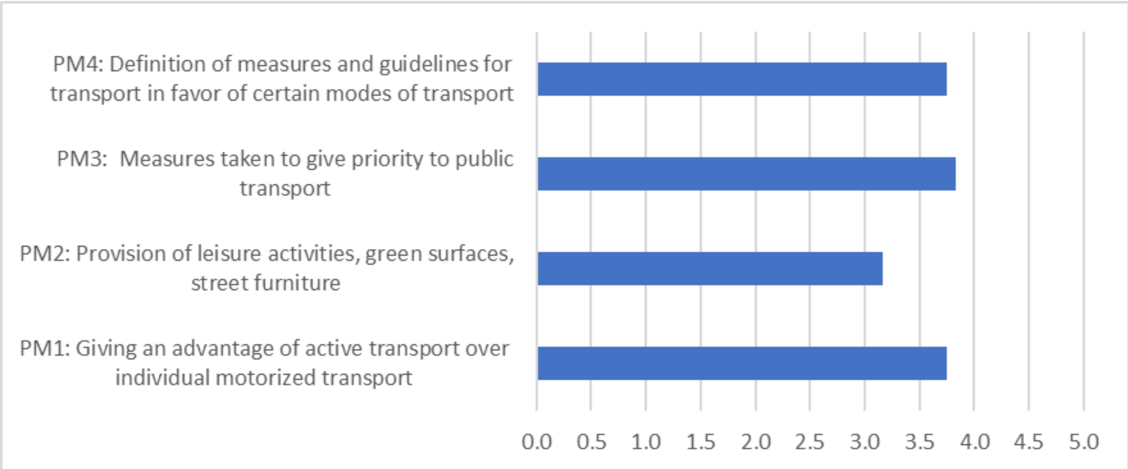

Figure 29 Use case 2: Assessment of policy measures against the financial feasibility dimension: Direct costs

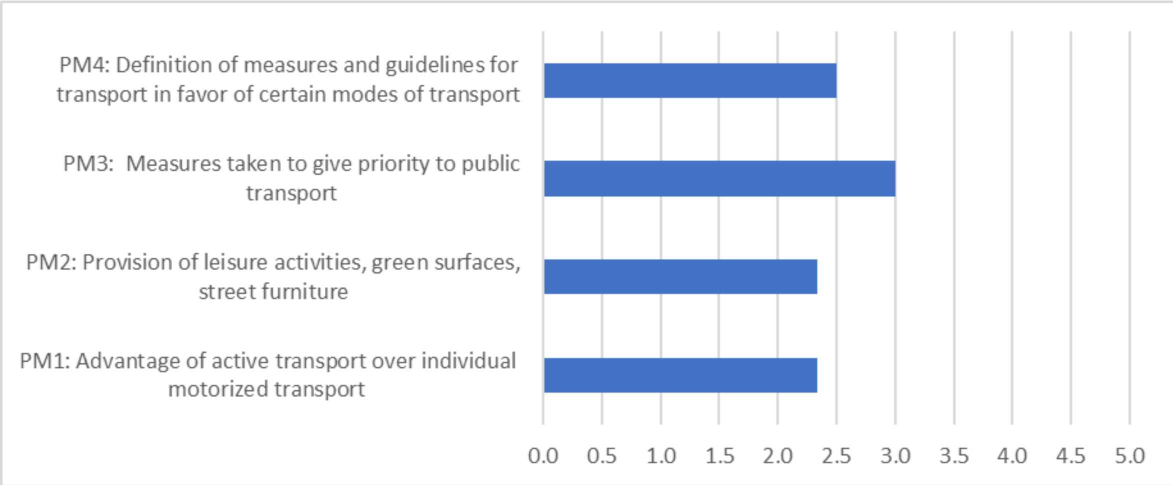

Figure 30 Use case 2: Assessment of policy measures against the financial feasibility dimension: Indirect costs

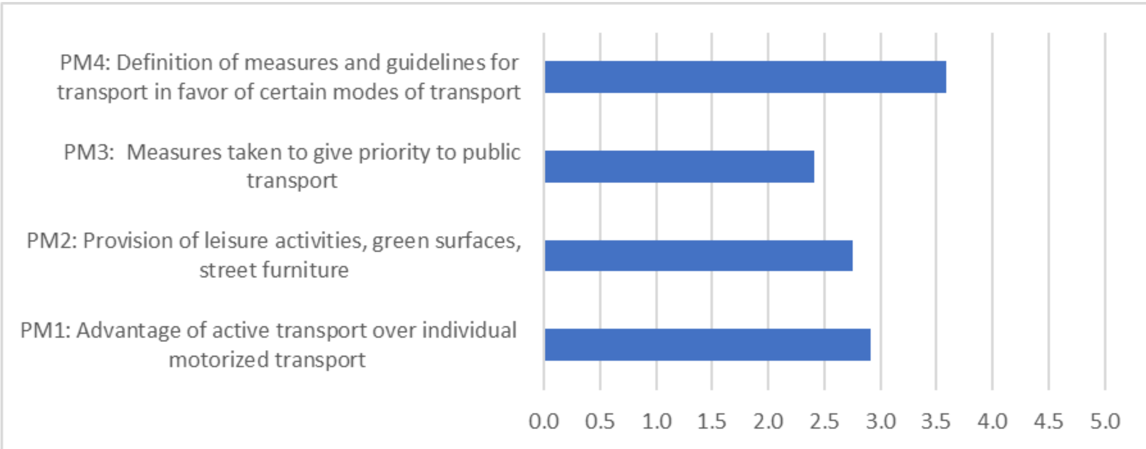

Figure 31 Use case 2: Assessment of policy measures against the financial feasibility dimension: Fixed costs

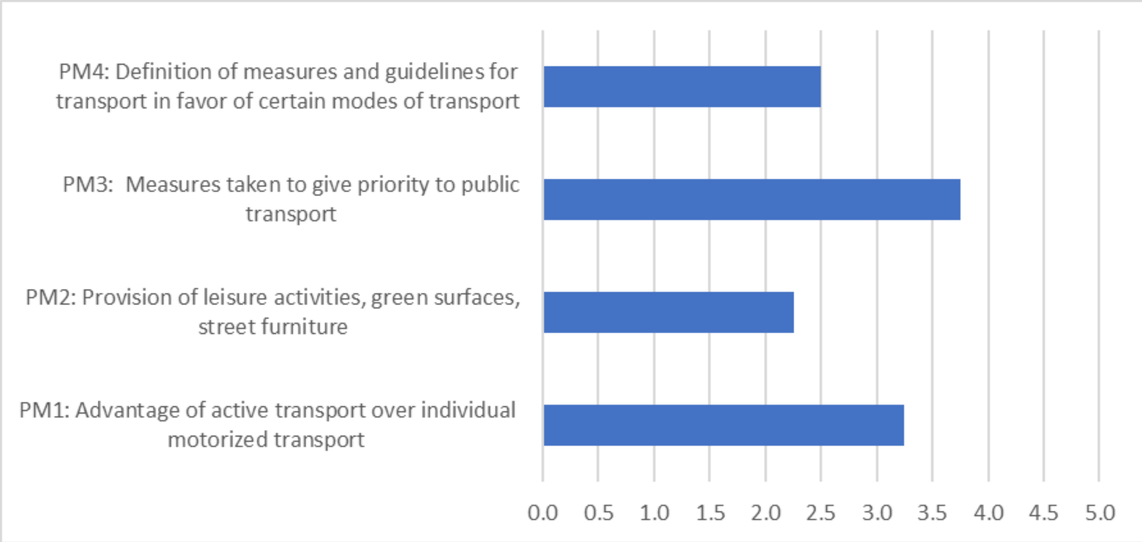

Figure 32 Use case 2: Assessment of policy measures against the financial feasibility dimension: Operations and maintenance costs

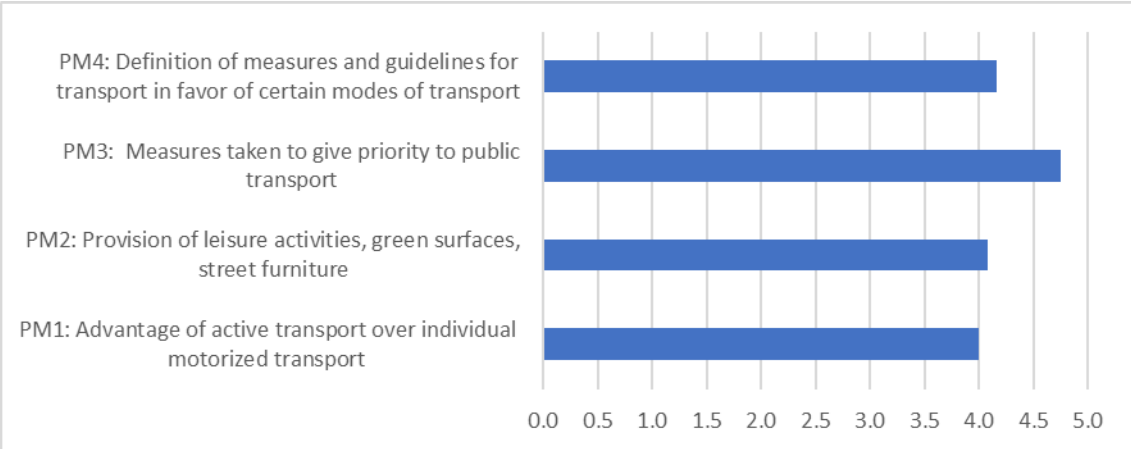

Figure 33 Use case 2: Assessment of policy measures against the financial feasibility dimension: Direct benefits

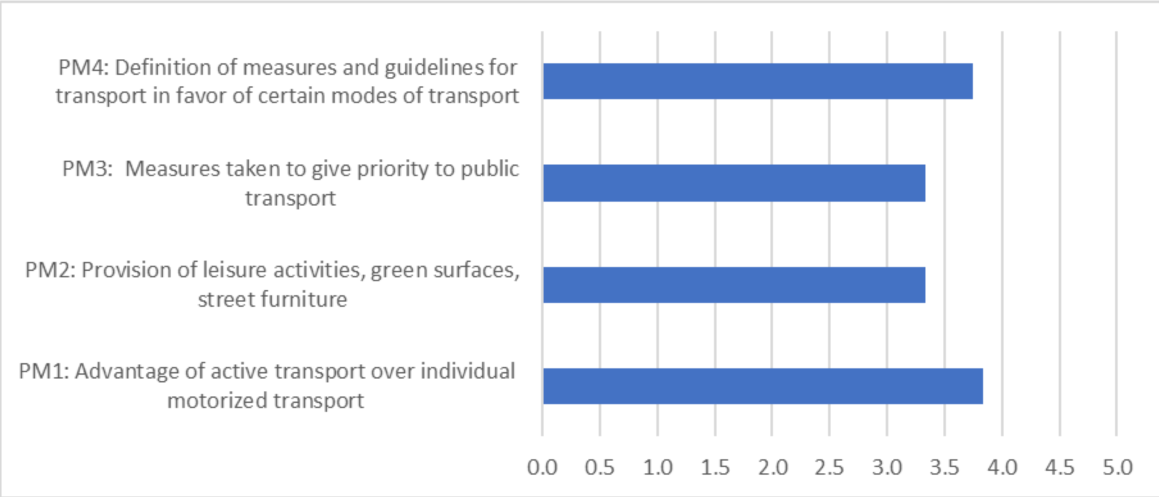

Figure 34 Use case 2: Assessment of policy measures against the financial feasibility dimension: Indirect benefits

Political feasibility includes evaluation of acceptability of alternative policy measures from the aspect of relevant stakeholders. From the results, we observe all the stakeholders participating in the survey considered the PM feasible for the political dimension.

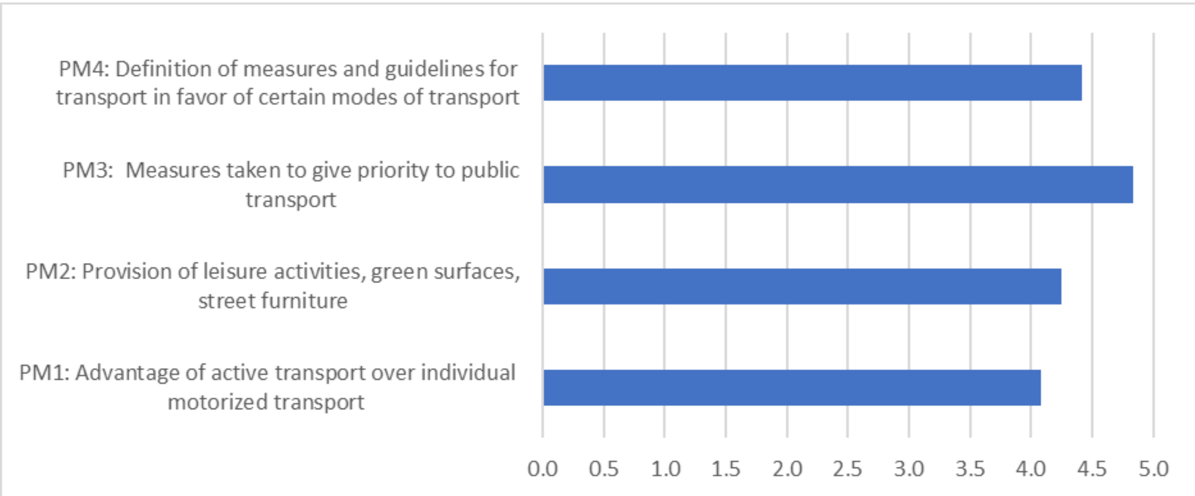

Figure 35 Use case 2: Acceptability of alternative policy measures from the aspect of Public Administration.

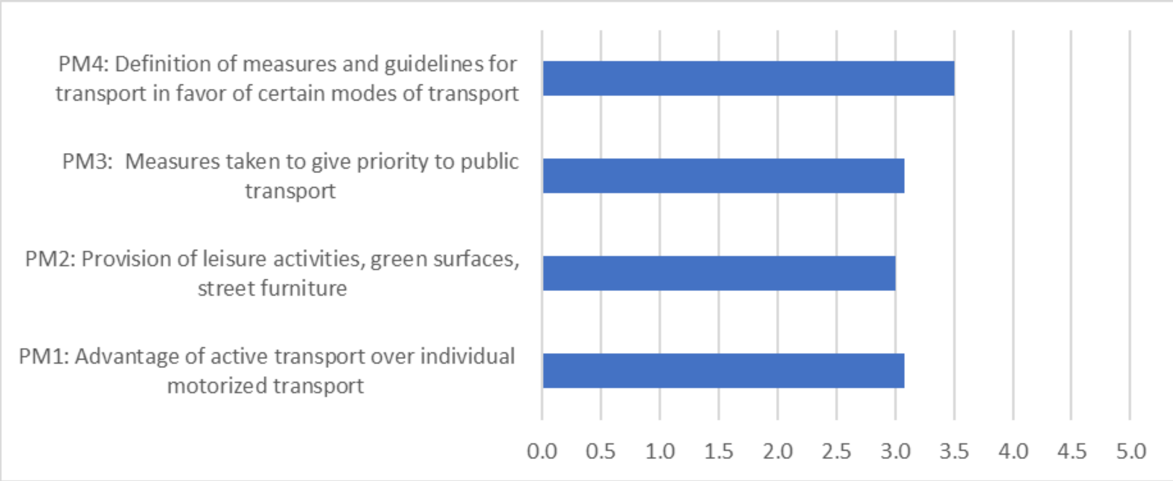

Figure 36 Use case 2: Acceptability of alternative policy measures from the aspect of Public transport operator.

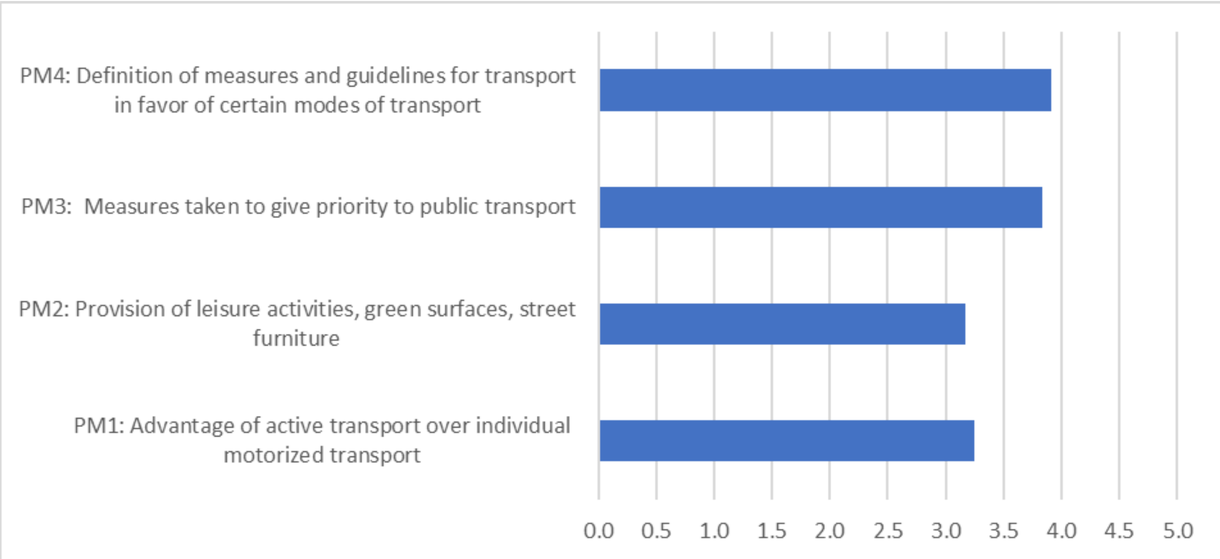

Figure 37 . Use case 2: Acceptability of alternative policy measures from the aspect of Data/ Tech companies.

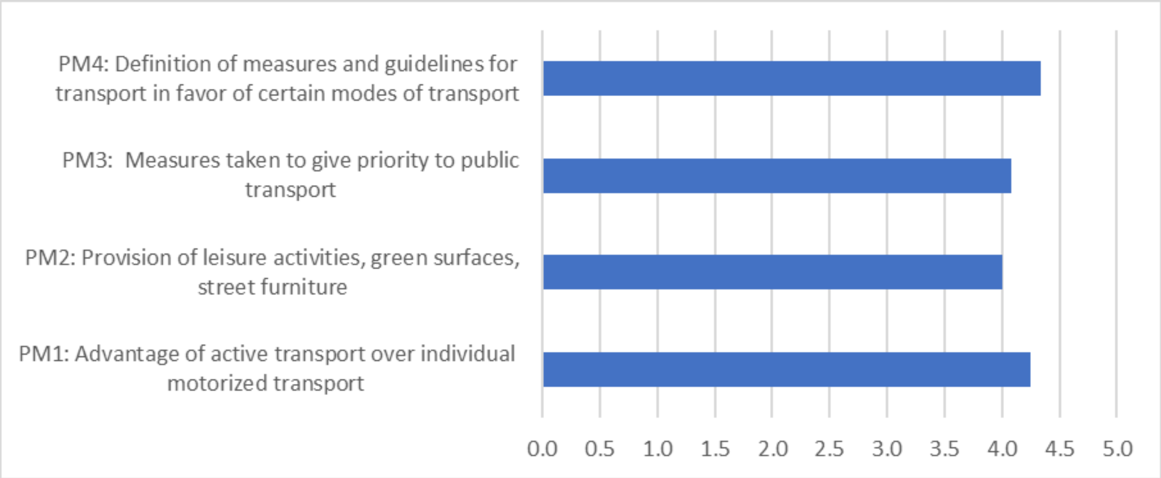

Figure 38 Use case 2: Acceptability of alternative policy measures from the aspect of New mobility service operator.

Administrative operability and capability are the main criteria for assessment of policy measures against the political feasibility. According to the stakeholder responses (Figure 39-Figure 40), the PMs are feasible for administrative operability and capability criteria.

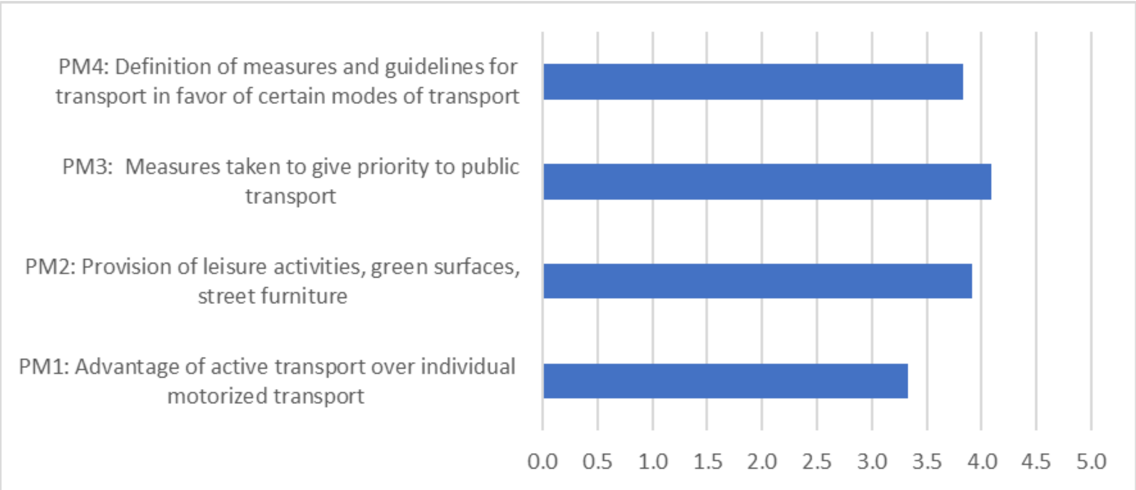

Figure 39 Use case 2: Assessment of policy measures against the political feasibility dimension: Administrative operability

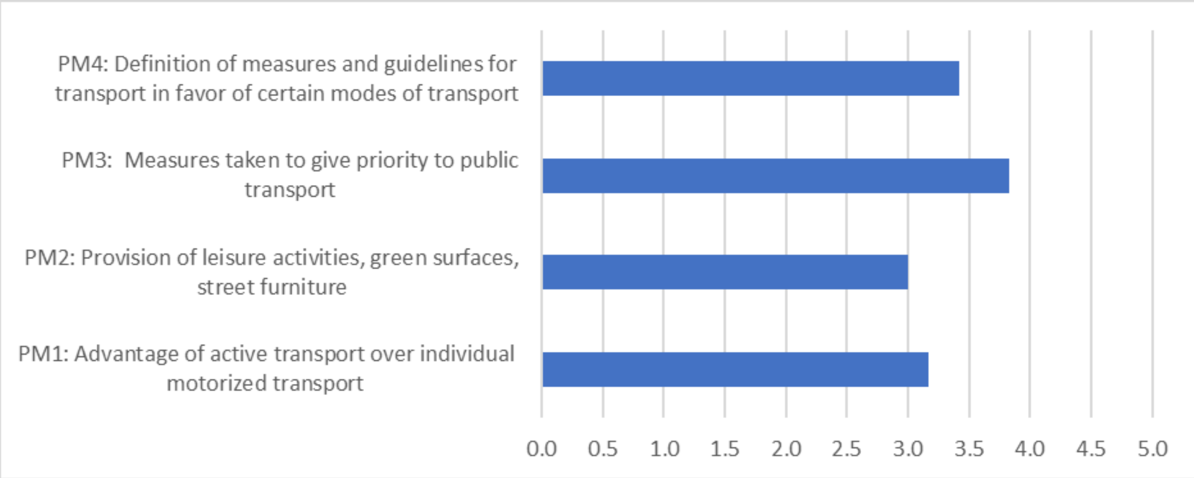

Figure 40 Use case 2: Assessment of policy measures against the political feasibility dimension: Administrative capability

Annex 4: T4.5 User acceptance

Use case 1: Planned traffic regulation changes

User acceptance: First stage

Criteria "Personal and social aims" is assessed by the extent a specific PM fulfills the needs of the respondents. According to the survey results (Figure 41) all PMs are fully reflecting the social and personal aims of the users.

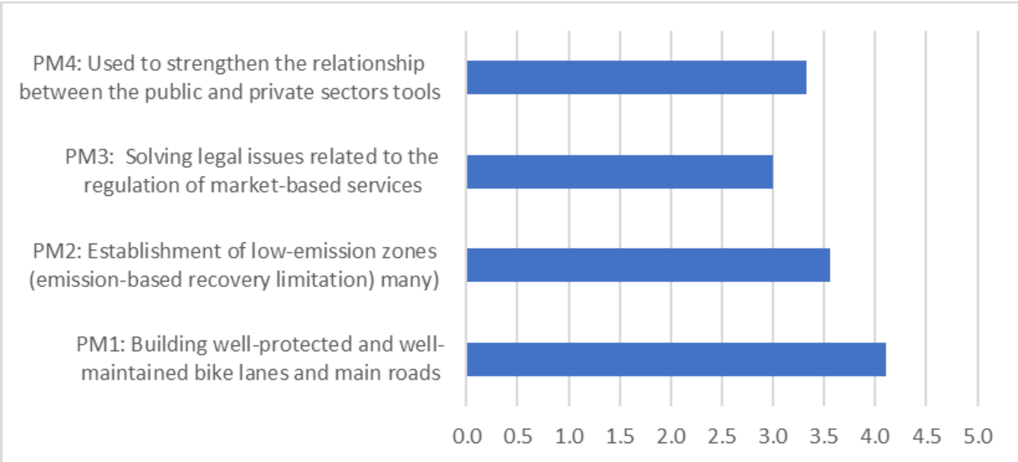

Figure 41 Use case 1: Assessment of policy measures against the user' personal and social aims

High problem perception reflects an increased willingness to accept a specific policy measure. According to the survey results (Figure 42-Figure 46) UC1 respondents have a good user' perception of the urban mobility challenges.

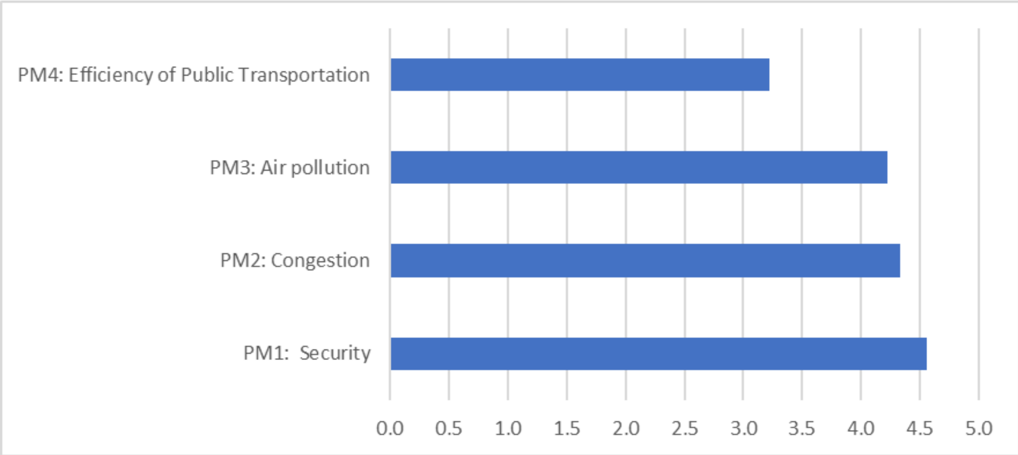

Figure 42 Use case 1: Assessment of policy measures against the user's problem perception

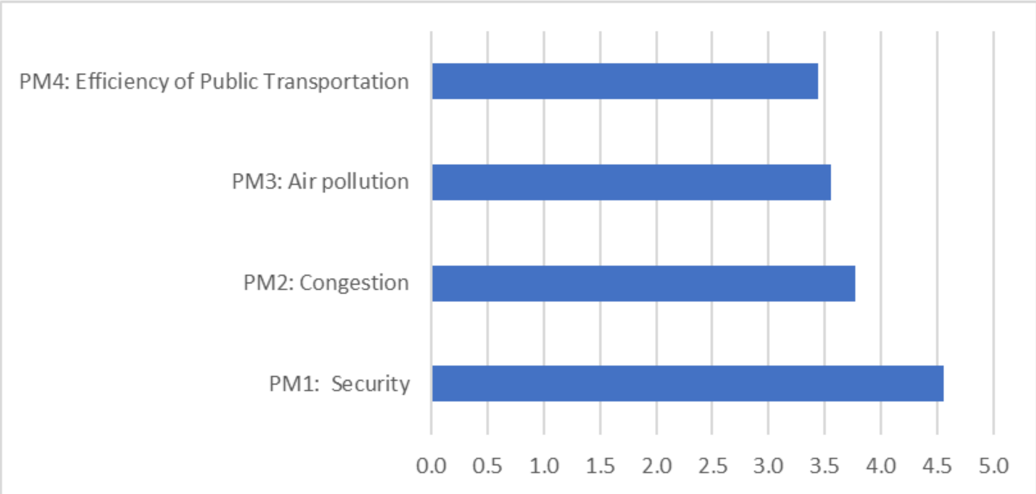

Figure 43 Use case 1: Assessment of policy measures against the user' problem awareness

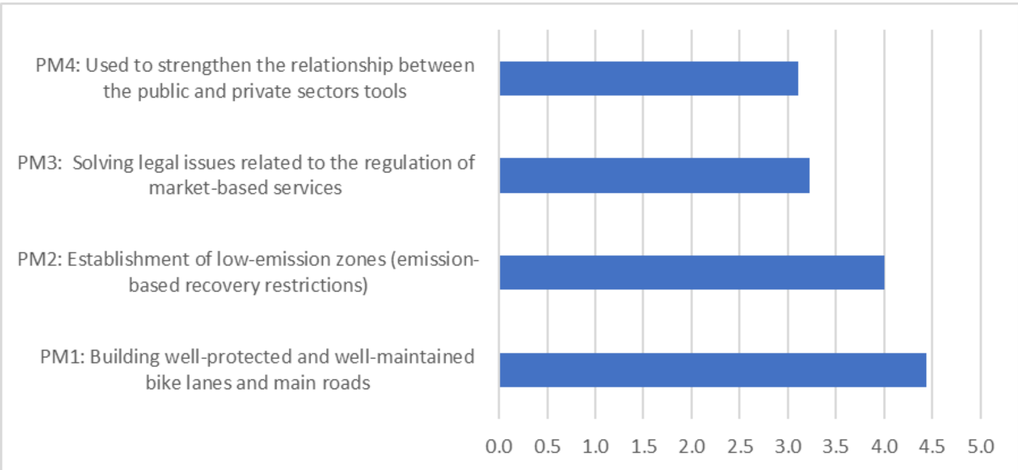

Figure 44 Use case 1: Assessment of policy measures against the user' awareness about policy measure

User' satisfaction with proposed solution, policy measure in this case, reflect the degree by which the policy measure solves the users' needs. According to the survey results the users are satisfied with proposed policy measures.

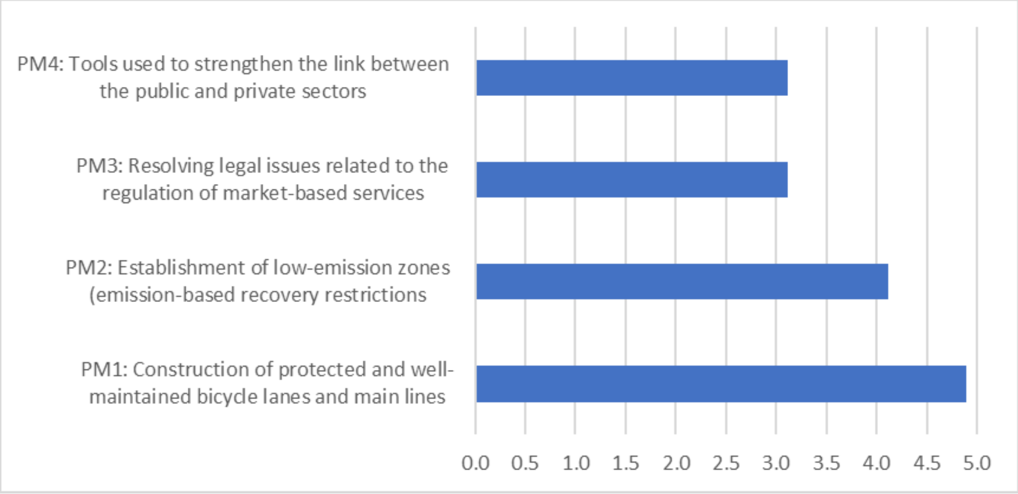

Figure 45 Use case 1: Assessment of policy measures against the user' satisfaction with a policy measure.

Affordability of the policy measures from user perspective is also one of the determinants of the success of a specific policy measure. Based on its socio-economic status the users express their preference towards a specific policy measure. The survey results show that PM1 and PM2 are considered unaffordable.

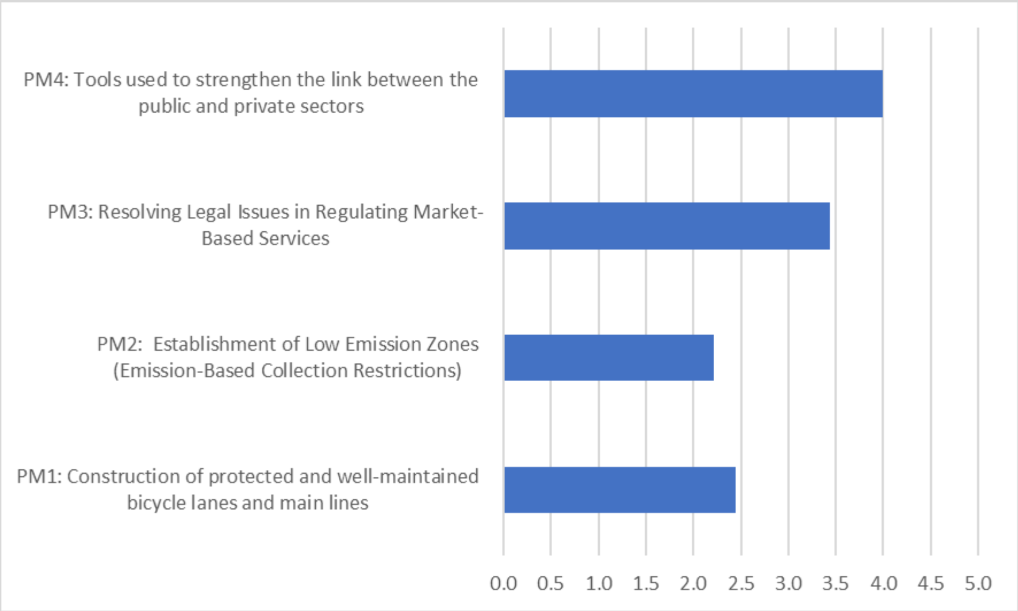

Figure 46 Use case 1: Assessment of policy measures against the users' affordability of policy measures.

Use case 2: Creation of micromobility points

User acceptance: First stage

Criteria "Personal and social aims" is assessed by the extent a specific PM fulfills the needs of the respondents. According to the survey results, all PMs are fully reflecting the social and personal aims of the users.

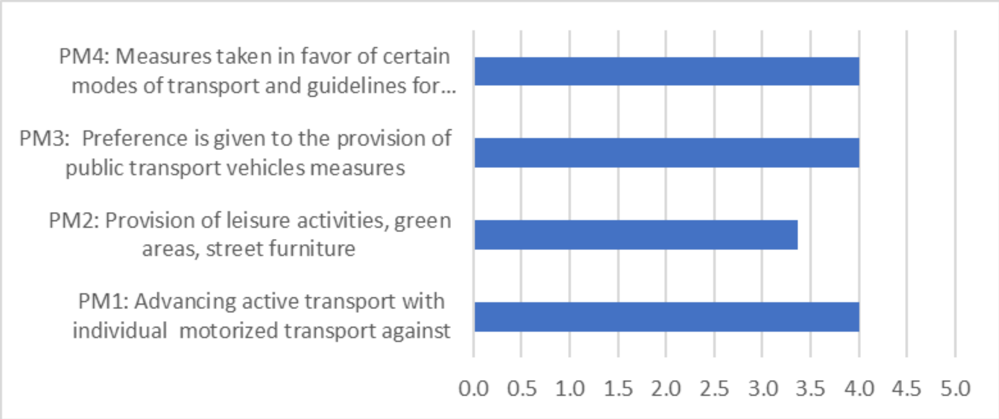

Figure 47 Use case 2: Assessment of policy measures against the user' personal and social aims

High problem perception reflects an increased willingness to accept a specific policy measure. According to the survey results (Figure 48-Figure 52) UC2 respondents have a good user' perception of the urban mobility problems. However, they are not aware of the challenges of the last mile logistics.

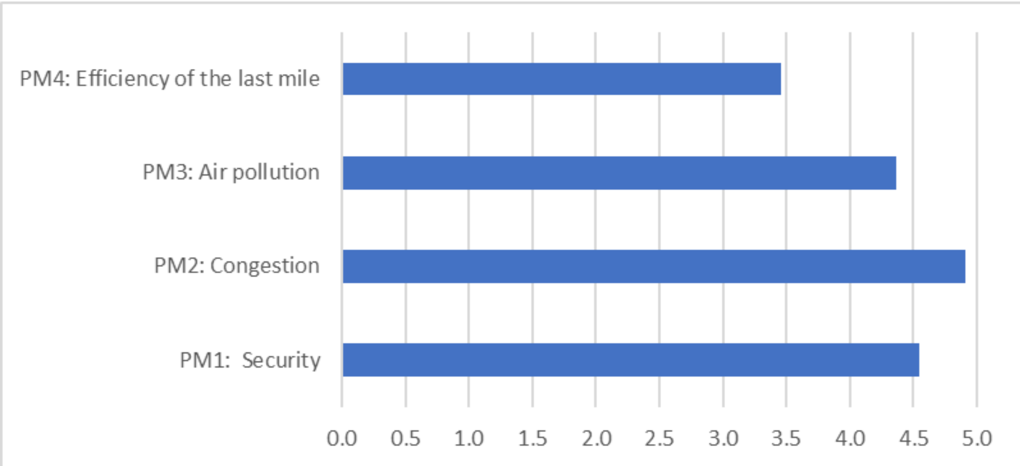

Figure 48 Use case 2: Assessment of policy measures against the user's problem perception

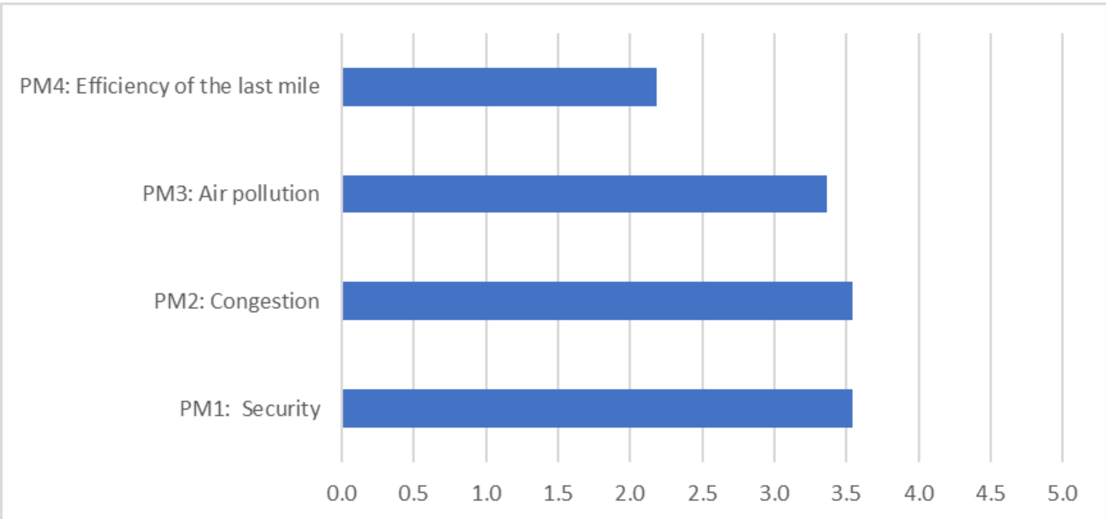

Figure 49 Use case 2: Assessment of policy measures against the user' problem awareness

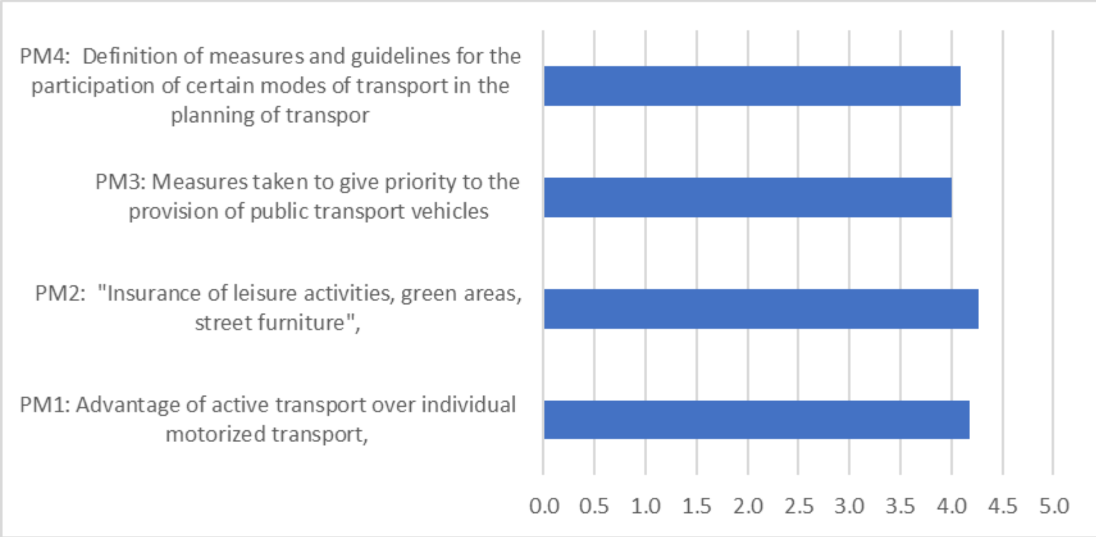

Figure 50 Use case 2: Assessment of policy measures against the user' awareness about policy measure

User' satisfaction with proposed solution, policy measure in this case, reflect the degree by which the policy measure solves the users' needs. According to the survey results the users are satisfied with proposed policy measures.

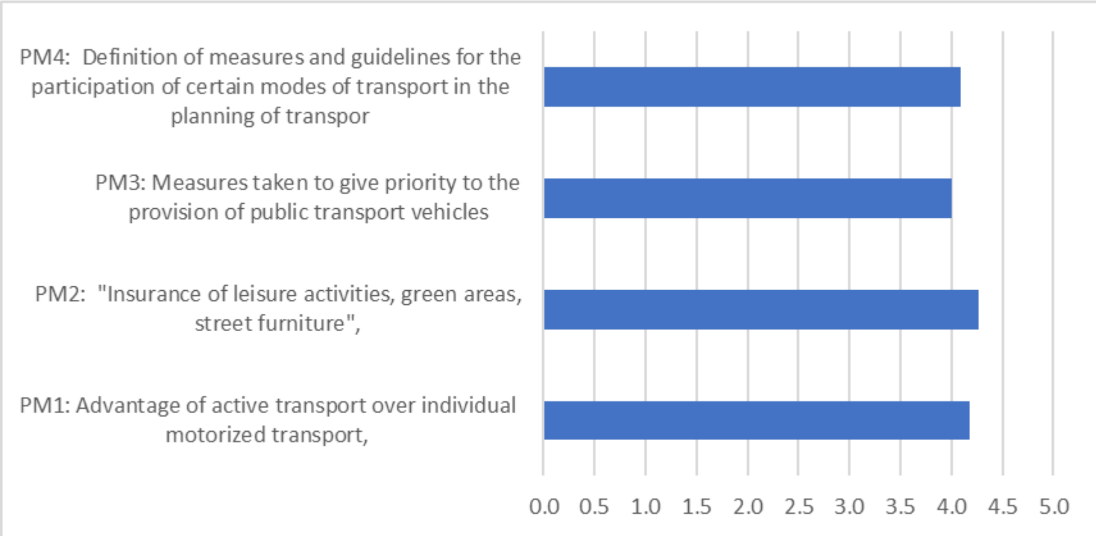

Figure 51 Use case 2: Assessment of policy measures against the user' satisfaction with a policy measure.

Affordability of the policy measures from user perspective is also one of the determinants of the success of a specific policy measure. Based on its socio-economic status the users express their preference towards a specific policy measure. The survey results show that all PMs are considered affordable.

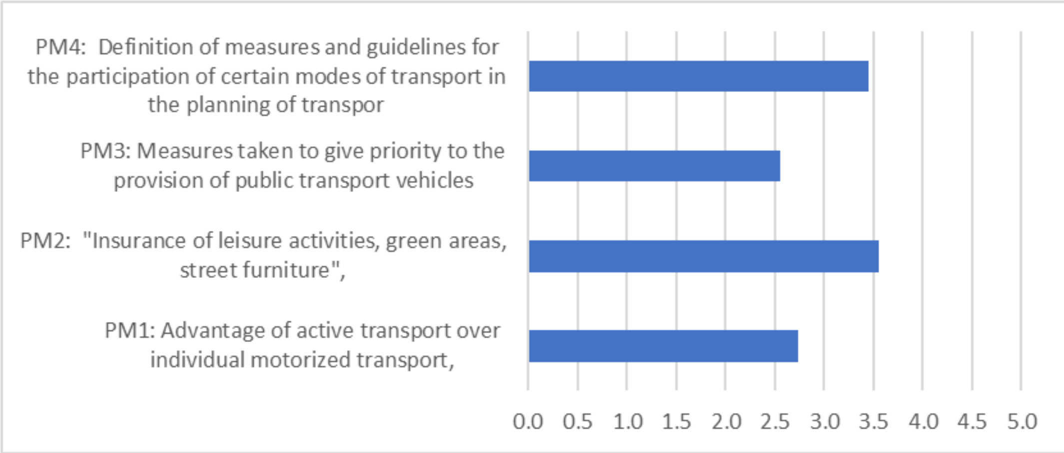

Figure 52 Use case 2: Assessment of policy measures against the users' affordability of policy measures