D4.11: Impact assessment and city-specific policy response

Tel-Aviv pilot



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

This document reflects only the author's views and the Agency is not responsible for any use that may be made of the information it contains.

Deliverable

Work package	WP4
Work package title	Pilots' setup, running & testing
Date	03/03/2022
Authors	Ebtihal Sheety, Technion Batel Eshkol, TLV
Status	Final
Version	4
Dissemination level	Public (PU)

Contributing Authors

Name	Organisation
Ebtihal Sheety	Technion
Batel Eshkol	TLV
Yana Barsky	Technion
Ilya Finkelberg	Technion
Ayelet Galtzur	Technion
Haggai Yaron	TLV
Beatriz Royo	ZLC
Sara Tori	VUB
Elpida Xenou	CERTH

Table of Contents

Executive summary 6

1 Introduction 8

1.1 Aim of the deliverable 8

1.2 How this deliverable relates to other deliverables 8

1.3 Task participants and sharing of contribution 8

1.4 Structure of deliverable 9

2 Pilot activity description 10

3 T4.3 Sustainability assessment of the pilots impacts 12

3.1 Use Case 1: Data-driven analysis and visualization of current travel behavior mobility patterns using Bluetooth detectors data – Assessment 12

3.1.1 Introduction 12

3.1.2 Testing and data collection activities 13

3.1.3 Impact Assessment 18

3.1.4 Outcomes 24

3.1.5 Conclusions 25

3.2 Use Case 2: “Re-allocating the public sphere - balance between capacity and liveability – Assessment 26

3.2.1 Introduction 26

3.2.2 Testing and data collection activities 28

3.2.3 Impact Assessment 35

3.2.4 Outcomes 40

3.2.5 Conclusions 40

3.3 Use Case 3: Identifying and prioritizing vulnerable road users at signalized intersections – Assessment 41

3.3.1 Introduction 41

3.3.2 Testing and data collection activities 42

3.3.3 Impact Assessment 44

3.3.4 Outcomes 49

3.3.5 Policy-related and regulatory barriers 49

4 T4.4 Formulation and priotitisation of alternative policy responses 50

4.1 Introduction 50

4.2 Methodology 50

4.2.1 Multi-Actor Multi-Criteria analysis 50

4.2.2 Stakeholder-Based Impact Scoring 51

4.3 Application of SIS within SPROUT 51

4.3.1 Formulation of problem and identification of alternatives 52

4.3.2 Stakeholder identification 52

4.3.3 Formulation of stakeholder criteria 52

Copyright © 20222 by SPROUT.

4.3.4 Expert evaluation 53
4.4 Criteria weighting by stakeholders 57
4.5 Results 57
4.6 Conclusion 58
5 T4.5 City-specific policies for harnessing the impact of new mobility solutions 59
5.1 Introduction 59
5.2 Methodology 59
5.2.1 Implementation feasibility 59
5.2.2 User acceptance 61
5.3 Application to Tel-Aviv pilot: use case 1 62
5.3.1 Set of alternative policy responses and stakeholders involved and role 62
5.3.2 Set of alternative policy responses and interrelationships 63
5.3.3 Implementation feasibility 67
5.3.4 User acceptance 72
5.3.5 City-led policy response 72
5.4 Application to Tel-Aviv pilot: use case 2 73
5.4.1 Set of alternative policy responses and stakeholders involved and role 73
5.4.2 Set of alternative policy responses and interrelationships 74
5.4.3 Implementation feasibility 78
5.4.4 User acceptance 83
5.4.5 City-led policy response 85
5.5 Application to Tel-Aviv pilot: use case 3 85
5.5.1 Set of alternative policy responses and stakeholders involved and role 85
5.5.2 Set of alternative policy responses and interrelationships 86
5.5.3 Implementation feasibility 89
5.5.4 User acceptance 94
5.5.5 City-led policy response 96
6 Summary and outlook 97
References 99
Annexe 1: T4.4 Templates 100
Annexe 2: T4.5 Implementation feasibility 108
Use case 1: Data-driven analysis and visualization of current travel behavior mobility patterns using Bluetooth detectors data - Mobility solution description 108
Use case 2: Re-allocating the public sphere - balance between liveability and capacity - Mobility solution description 116
Use case 3: Identifying and prioritizing vulnerable road users at signalized intersections - Mobility solution description 123
Annexe 4: T4.5 User acceptance 130

Copyright © 20222 by SPROUT.

Use case 1: Data-driven analysis and visualization of current travel behavior mobility patterns using Bluetooth detectors data - Mobility solution description 130
The user acceptance questionnaire was distributed to relevant stakeholders. However, due to the specification of the use case and the type of the policy responses, stakeholders who are not familiar with both the technical and organizational context were not able to complete the questionnaire. 130
Use case 2: Re-allocating the public sphere - balance between liveability and capacity - Mobility solution description 130
Use case 3: Identifying and prioritizing vulnerable road users at signalized intersections - Mobility solution description 134

Copyright © 20222 by SPROUT.

Executive summary

The city of Tel Aviv demonstrated three mobility solutions, supporting the ongoing massive changes in the transport system in the city due to the construction of new Light Rail System. the pilot's objectives aligned with the transition towards prioritizing non-motorized traffic modes, road users' hierarchy favouring pedestrians, and a more liveable and inclusive city

The first mobility solution aims to study road users' mobility patterns based on Bluetooth data trajectories clustering and integrate the outcomes into an interactive decision support dashboard to facilitate the data visualization and understanding of the spatial clustering results. The insights derived support decisions associated with traffic rearrangements due to the LRT construction works, roads closure, and capacity reduction. Cost-benefit analysis demonstrated the potential to outbalance the expenses by reducing delays, congestion, and negative externalities of urban mobility.

The second use case is a structured methodology adapted to tackle the challenges and conflicts associated with redistributing roadway rights. The methodology aims to elevate public engagement processes to accommodate stakeholders' needs better and design a more liveable and safer public sphere. The demonstration reflected the complexity of the conflicts between stakeholders, interrelations between measures, and challenges associated with the re-design of the public sphere. Despite the compounded process, the outcome provided a dynamic tool to incorporate stakeholders' engagement processes into decision-making and support the shift into a more liveable public sphere.

Finally, the third use case is aligned with two important policy measures that Tel Aviv municipality considers of high importance, social inclusion of vulnerable inhabitants and locating pedestrians at the top of road users’ hierarchy. Traffic signal logic was developed to reduce vulnerable road users' dangerous crossing at signalized intersections by effectively providing additional green duration if vulnerable road user is identified starting crossing late. Deep-learning methods were used to develop a vulnerable road users recognition tool, that served as vulnerable road users’ detector. Regulatory barriers and supportive policy were the main challenges for implementing use case 3. These challenges prevented real-world implementation, and the demonstration was carried out in a simulation environment. Outcomes showed a noticeable improvement in safety measures for the vulnerable road users, and neglectable impact on conflicting traffic.

Recommendations and policy measures to support large-scale implementation and overcome the encountered technical and regulatory barriers were further investigated. Policy measures to support up scaling these solutions are being discussed by the relevant stakeholders in Tel Aviv municipality.

Municipality officials recommendations include: for use case 1 – recommendation to integrate the travellers' trajectory patterns dashboard into Tel-Aviv municipality's traffic division decision-making processes regarding traffic re-arrangement during LRT and Metro lines construction period; for use case 2 – integrating outcomes into future masterplans, such as the National Metro Master plan currently being formulated, which includes principles for the re-allocation of public space and the 5500 Tel-Aviv Master Plan update, as well as improving various

Copyright © 20222 by SPROUT.

stakeholders' involvement in local decision-making processes; for use case 3 – integrating VRU prioritization at intersections into road regulations, as part of the Equal Rights Law for people with disabilities.

Copyright © 20222 by SPROUT.

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 Tel-Aviv was able to find only one problem for one of the use cases implemented. 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, Tel-Aviv identified a list of alternative policy responses to enhance the mobility solution adoption, scalability and transferability of the three use cases. Finally, the pilot assessed the alternative policy responses implementation and user acceptance and defined the policy measures that harness the implementation of Tel-Aviv 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 D4.10 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, D4.5 D4.7 and D4.9) 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

The Technion led the pilot activities in Tel Aviv, in cooperating with The Mass Transit Department in Tel Aviv Municipality, who is responsible for the planning coordination of the Light Rail Transit lines and the Metro lines within the Tel-Aviv-Yafo jurisdiction area. The department is also responsible for coordinating the transportation plans and the public space design plans in collaboration with other municipal departments and stakeholders.

As the pilot leader, the Technion was responsible for the detailed specifications of each use case, activities planning, execution, and assessment of the three use cases.

Use Case 1: The Technion team conducted the data analysis, characterized, and developed the decision supporting interactive tool, and geo-spatial data visualization. Traffic experts from the Technion and Tel Aviv municipality accompanied the analysis throughout the process, provided their feedback, and incorporated their local knowledge. Traffic experts and decision-makers from the municipality and the Technion assessed the outcomes.

Copyright © 20222 by SPROUT.

Use Case 2: Both partners revised the use case specifications requiring multiple iterations and adaptations. The data collection methodology for each phase, the content of focus groups, expert interviews, the online survey, the interpretation of the results, and the assessment process were also conducted jointly. Tel Aviv Municipality administered the data collection, while the Technion conducted data analysis.

Use Case 3 The Technion designed and executed the vulnerable road users detecting model, the pedestrians' green extension algorithm and applied the experiment in a simulation environment. The real-world data from an intersection in Tel Aviv for the assessment was collected using Tel Aviv's Traffic Management Center cameras.

Stakeholders from other departments in Tel Aviv Municipality, other local authorities, transportation authorities, and the private sector participated in the workshops and interviews, which were conducted to discuss outcomes and policy measures.

The Tel-Aviv SPROUT steering committee comes together every quarter to discuss the SPROUT project updates. It is headed by the Head of Construction and Infrastructure Administration at Tel-Aviv Municipality and includes various professionals, mainly from the Traffic Division.

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

Copyright © 20222 by SPROUT.

2 Pilot activity description

Three use cases were demonstrated in Tel Aviv, adopting a comprehensive approach to tackle the challenges associated with the city's massive changes due to the construction of the Light Rail Transit (LRT) system.

Use case 1 – Strategic level: *"Data-driven analysis and visualization of current travel behavior mobility patterns using Bluetooth detectors data",* **Use case 2 – Tactic Level:** *"Re-allocating the public sphere - balance between capacity and liveability", and* **Use case 3 – Operational Level:** *"Identifying and prioritizing vulnerable road users at signalized intersections".*

The planned description of each use case was included in D4.10. Further specifications were discussed, involving additional stakeholders and experts. The details of the use cases were fine-tuned and adjusted to fit each use case final configuration, as explained throughout the deliverable. Other adjustments had been made to accommodate restrictions caused by COVID-19, delays, and unexpected technical or administrative challenges. All use cases were fully implemented, assessed, and provided a profound understanding of the mobility solutions, advantages, challenges, and measures to overcome these challenges.

Use case 2 and 3 had been adjusted to overcome unseen challenges. The planed methodologies for data collection in use case 2 were observations and field experiment, aiming to capture revealed preferences of road users and demonstrate the road section attributes on real-world, when questioning their preferences. The data collection methodology was adjusted to the restriction of COVID-19 and an online stated preference survey was conducted.

The initial agreement was to conduct a real-world experiment in use-case 3 at an intersection in Tel Aviv. The demonstration involves applying new detection methods interfacing with real-time traffic control, which obligates the approval of the Israeli Ministry of Transport. The expected change of the lengthy and test-intensive process for approval was delayed, and the approval could not be achieved within the framework of the project as expected; this averted carrying out a field experiment. As a substitute, the experiment was carried out in a microsimulation environment, using real-world data from Alenby St. /King George St. intersection in Tel Aviv.

The final configuration of the use case underwent changes and adjustments compared to the initial proposal. This had led to changes in the KPI's measured, shifting from aiming to reduce the total crossing time of VRU by 12% to eliminating unsafe crossing of Vulnerable Road Users, while minimising unnecessary delays for the conflicting traffic by applying the Vulnerable Road Users detection model and extension of pedestrians' green only if needed. The KPI's are:

- Reduce the frequency of potentially unsafe crossing of Vulnerable Road Users to less than 8%.
- Eliminate the additional vehicle delay for the conflicting traffic movements to no more than 5% (comparing delays between two scenarios: (1) fixed green duration (2) after applying the algorithm and extend pedestrians green if needed (see section 3.3).

It is relevant to highlight that the project timeline was affected by COVID-19 restrictions. Several lockdowns influenced the data collection producers for all uses cases. For a few consecutive months, BT data representing normal traffic was needed for use case 1 data analysis. Due to the lockdowns and holidays, historical data from November and December 2019 was used.

The timeline and context of use case 2 were affected by the restrictions associated with COVID-19. Focus groups with older people could not be conducted online and were postpended until restrictions were eased and older road users felt safe to participate in face-to-face meetings.

Use case 3 was also affected by COVID-19 restrictions. Real-world data from the intersection was mandatory. Traffic volumes reduced dramatically during lockdown periods. Therefore, the data collection process to calibrate the simulation model (accurate traffic volumes) and identify vulnerable road users was conducted after the lockdown was eased and traffic was back to normal levels.

Copyright © 20222 by SPROUT.

3 T4.3 Sustainability assessment of the pilots impacts

3.1 Use Case 1: Data-driven analysis and visualization of current travel behavior mobility patterns using Bluetooth detectors data – Assessment

3.1.1 Introduction

The city of Tel Aviv (TLV) undergoes tremendous transport changes during the construction of its new LRT system, affecting existing traffic network dynamics in general and road users' travel patterns in particular. Integrating data-driven methods for studying road users' mobility patterns is a promising way to provide both qualitative and quantitative support to decision-makers in urban mobility planning settings throughout the ongoing infrastructure changes and transport policy measures applications. Transportation and traffic planners relay to a great extent on traditional data collection methodologies, i.e., household travel surveys and traffic counting.

Tel Aviv utilizes a network of 110 Bluetooth (BT) detectors installed at key intersections at fixed locations in Tel Aviv Metropolitan, for traffic state monitoring and control. For the vast majority of consecutive BT equipped locations, BT Links are defined (a total of 307 Links). Real-time travel times reported from each BT Link are continuously processed by an algorithm implemented in AVIVIM – the Traffic Management System (TMS) of the municipality of Tel Aviv-, providing traffic performance measures to traffic managers in the municipality for network monitoring. It should be noted that a built-in filtering process ensures that only vehicle's travel times are calculated.

Each BT detector generates a record of detected unique user ID's (MAC[1] addresses) and detection timestamps. Raw BT records database allows reconstruction of individual road users continuous trips by matching the unique user ID in space and time as each user ID. Raw BT records are ordered by detection timestamp. The spatial coverage of Tel Aviv network by BT units and the BT's unique user ID recording ability enables the evaluation of the feasibility of using BT's re-identification ability to recognize road travellers' trajectory patterns and explore the possibility of trajectory pattern analysis of focused subgroups, e.g., commuters.

This use case demonstrates studying road users' mobility patterns based on BT data trajectories clustering for a planned scenario of infrastructure changes due to the construction of the LRT system. The clustering results were incorporated into a data-driven decision-making support system. The decision support system interface was used to estimate the potential impacts of road closures during the LRT system's construction on traffic. Decision-makers and traffic management experts accompanied the process in all phases, sharing their network

[1] MAC: a unique identifier assigned to a network interface controller for use as a network address in communications within a network segment

Copyright © 20222 by SPROUT.

experts' knowledge, and evaluating the decision support. The framework of the use case is descried in Figure 1. Further specifications are discussed in D4.10.

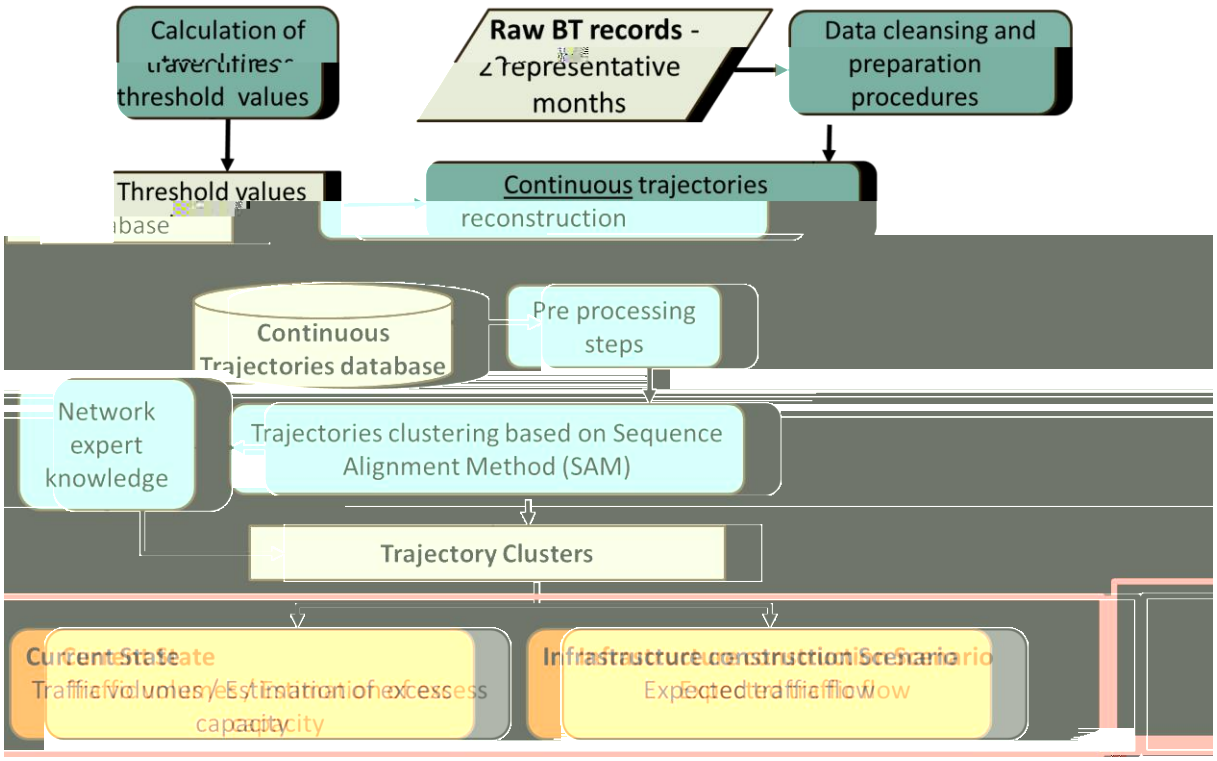


Figure 1. use case 1 framework

3.1.2 Testing and data collection activities

Description

The demonstration focuses on trajectory clusters associated with specific trip attraction zone in Tel Aviv Central Business District. The LRT system construction will impact Arlozorov artery, one of the leading roads to the trip attraction zone. The artery, one of the major and busiest roadways in TLV, is expected to undergo significant revolutionization to integrate an LRT station and lanes, causing lanes closure and reduced capacity during the construction period.

The trip attraction zone, characterized by high demand during morning peak hours, is depicted in Figure 2 contains the Sourasky Medical Center complex serving Tel Aviv and its metropolitan area, a complex of several courthouses, office buildings, and commercial activities. Five BT units cover the zone (marked in a circle in Figure 2, with

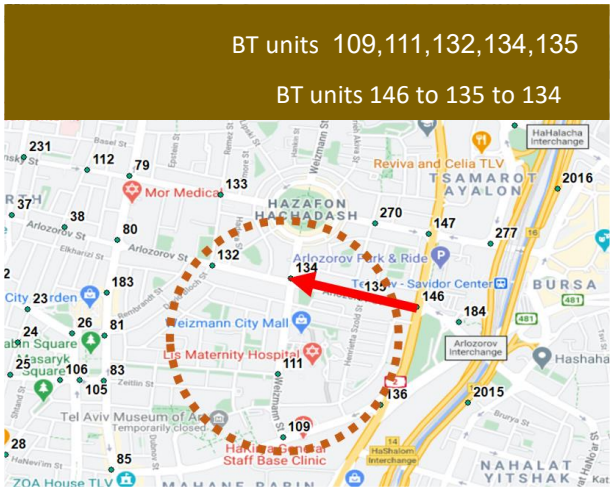


Figure 2. Trip attraction zone and road closure scenario

Copyright © 20222 by SPROUT.

several others in the roads leading to it. The infrastructure changes on Arlozorov artery segment are expected to reduce the capacity into the trip attraction zone marked with a red arrow in Figure 2.

A total of 55,126,493 Raw BT records from 110 available BT units on weekdays during a representative two-month period were collected (November-December 2019). This raw BT records database served as an input to the continuous trips reconstruction process resulting in a total of 10,505,715 continuous trips. To account for trips associated with the trip attraction zone during morning peak hours, only trips ending at or passing through the trip attraction zone, i.e., a trip contains at least one out of the five BT units that belong to the trip attraction zone and trips that started in morning peak hours (between 7 and 10 AM) were extracted. Further processing of the resulting continuous trips dataset conducted to eliminate special trip types not contributing to informative travel patterns formulation (e.g., round trips, that are most likely generated by taxis and delivery services). In the context of the current scenario, commuters were defined as IDs that were detected at the trip attraction zone on at least 40% of weekdays during the selected two-month period. Considering the BT detection rate, that was found to be around 25% in preliminary testing, the threshold of 40% of weekdays is a trade-off between a missed detection and the regularity of traveling.

To ensure the records' validity, e.g., eliminating duplicate detections and invalid recorded timestamps, preliminary data validation steps were conducted. Differentiating whether two consecutive BT detections of a vehicle are linked to the same continuous trip, time lags between consecutive detections were compared to defined threshold parameters. The travel times threshold values calculation is performed for each possible pair of BT's equipped locations (total of 11900 pairs) in a network. It reflects an acceptable deviation from prevailing travel times on the shortest path between the two locations in each hour of the day. Travel time threshold values calculation and their applications in differentiating whether two consecutive records are linked to the same continuous trip requires different procedures for BT pairs that belong to defined BT Link and those that do not. For the defined BT Links, the threshold values were calculated based on an analysis of the historical travel times database of defined BT Links (November-December 2019). The length of each defined BT Link already comprises the shortest path between origin and destination BT units of the Link. The shortest path between BT units that do not belong to defined BT Links involved several challenges. Several map sources were tested to ensure valid traffic network specifications and account for all network-specific characteristics (i.e., turning restrictions and bus lanes). Intervention was required to extrapolate the specific geo-locations of BT units to some radius around the units, accounting for detection from different possible directions of vehicles movements.

The output of the proposed process, applied on the whole raw BT records set, provided a database of continuous trajectories for each user ID, which allows capturing users mobility patterns with trajectory clustering techniques. Among the various methods for trajectory clustering, the Sequence Alignment Method (SAM) (Crawford, Watling, & Connors, 2018) was used as it enables to fully utilize point-to-point sensor data nature, to capture high-resolution route choice and similarities between trajectories (in terms of the ordered sequence of sensors passed), and to account for missing observations within sequences. The Sequence Alignment Method was applied on extracted trips. Finalizing the set of resulting clusters required visual exploration and involved network expert knowledge. As a basis for visualization of data

Copyright © 20222 by SPROUT.

analysis results to support decision-making processes, the resulting clusters were adjusted and attributed with features in accordance with pilots' objectives and requirements.

To support deriving insights from the outcomes, an interactive dashboard (Figure 3) was built in QlikView[2] software, a business intelligent (BI) tool which enables visualization of spatial clustering results in accordance with filters lists having the following clusters attributes:

- **IsThroughConstruction:** binary filter that allows visualization of clusters that contain only trips that pass through Arlozorov artery segment with planned infrastructure changes.
- **EndingAtTripAttractionZone:** binary filter that allows visualization of clusters that contain only trips that end at chosen trip attraction zone.
- **ClusterDirection:** filter that allows visualization of clusters heading to specific direction, North, South, East or West.
- **Cluster Origin:** zone from which the trips begin from. Total of 12 zones available
- **Cluster Destination:** zone at which trips end at. A total of 12 zones available.

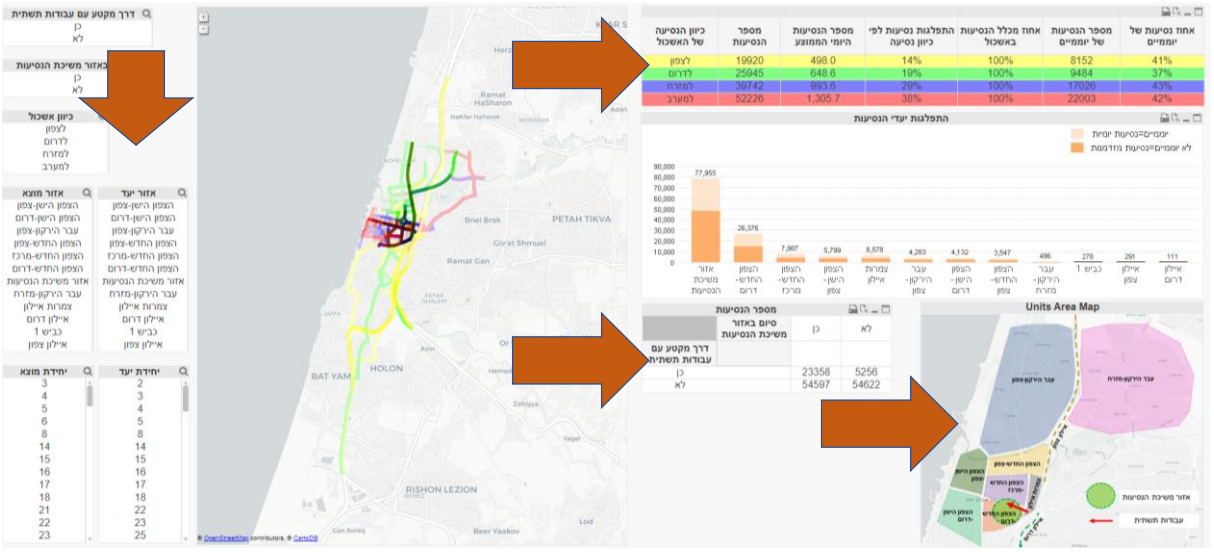


Figure 3. Decision-support interactive tool

The zones were created based on analysis of Tel Aviv geographical layers of quarters and neighborhoods in conjunction with traffic network knowledge and city's land use. In addition to zones, a more detailed filter that allows choosing trips with specific origin and destination BT units ID's is included. The spatial representation enables to review overall trips distribution, zoom into specific routes, and derive trips density on each segment of the route. For each combination of chosen attributes by the user, in addition to visualization of the results, summary statistics of trips satisfying the chosen attributes are displayed and contain:

- Relevant numeric information such as totals and averages of all trips and trips that belong only to commuters, i.e., commuting trips.

[2] https://www.qlik.com/es-es

Copyright © 20222 by SPROUT.

- Trips destination zones distribution, segmented by commuting and non-commuting trips
- Contingency table displaying the number of trips that fall into each of the following categories:

  1) **pass through** Arlozorov artery segment and **end at** chosen trip attraction zone.
  2) **pass through** Arlozorov artery segment and **do not end at** chosen trip attraction zone.
  3) **do not pass** through Arlozorov artery segment and **end at** chosen trip attraction zone.
  4) **do not pass** through Arlozorov artery segment and **do not end** at chosen trip attraction zone.

One of the main objectives of the proposed analysis in this use case is to utilize the outcomes extracted to develop a traffic management strategy tackling the impact of road constructions on traffic flows, aiming to reduce congestion. Identifying potential bottlenecks helps formulation the strategy.

To assess the impact of the expected road closure the “impact area” around the closure need to be determined, in coordination with the city traffic management authority. Using the data from BT detectors, clusters of traffic routes that might get affected are identified. Then the existing capacity of the links belonging to these routes inside the impact zone is estimated.

Signalized intersections are the bottlenecks of the urban road network links and therefore they determine the link capacity. The BT links start and end at signalized intersections, and a link capacity is determined by the green light percentage allocated to the specific Signal Group at the destination intersection the BT link belongs to.

Once the green light percentage and the number of lanes serving the BT link are known – capacity can be estimated as:

$$C = g \times S$$

Where:

C – capacity of the Bluetooth link [veh/hr[3]]
g – green light percentage within the cycle for the relevant signal group at the destination intersection of the link
S – saturation flow [veh/hr] with a typical value of 1800 veh/hr/lane

Once the capacity values for the links in the impact zone are calculated, a ratio between volume (the demand) and capacity can be estimated (V/C). By the aggregation of BT trip data, a total number of detected vehicles for a given time period can be calculated for each link. While Bluetooth-

Copyright © 20222 by SPROUT.

Where:

V_i – volume for link I [veh/hr]
n_i – total number of BT trips on link i [veh/hr]
p – penetration rate

Copyright © 20222 by SPROUT.

- Specify the decision support tool characteristics.
- Development of decision support tool including visualization to illustrate the mobility patterns.
- Assessment.
- Conducting domain experts and policy makers experiment that will examine (1) clarity of the visualized outcomes, (2) ability to extract significant patterns (3) reliability of the obtained insights.

3.1.3 Impact Assessment

All phases of this use case were accompanied by traffic management experts and decision-makers who provided feedback and contributed from their acquaintance with the local network, knowledge, and expertise. The outcomes of the trajectory clustering analysis revealed important information regarding travel patterns associated with trips passing through the Trip Attraction Zone. 82% of all trips passing the Arlozorov artery segment with planned infrastructure changes are actually ending at trip attraction zone. Meaning that this artery segment serves mostly users with trips attraction zone as a destination. In addition, most of those trips are likely originating from cities on the eastern part of Tel Aviv metropolitan area, i.e., coming from outside of Tel Aviv city from east, and entering Arlozorov artery segment through Namir/Arlozorov intersection as shown in Figure 4. The eastern part is not covered with BT Units, thus in order to validate this statement, a comparison of trips count with estimated number of vehicles derived from actual green durations at the intersection approaches was performed. Namir/Arlozorov is traffic actuated signalized intersection, i.e., green durations for each move are determined by actual demand in each cycle. Those actual green durations are continuously recorded for each move in historical database. Throughputs for each move were estimated with Highway Capacity Manual (HCM): for 1-lane left turn and for each lane in through move, the estimated throughput is Total Green/Headway, where Total Green is the sum of all green durations during morning peak hours and Headway is 2 sec. For free right turn, the throughput was estimated by adjusting base saturation flow rate (1,500 veh/hr) with factors representing the level of conflict with pedestrians. The results show very similar distribution of throughputs across the three moves, thus supporting the validity of BT based analysis.

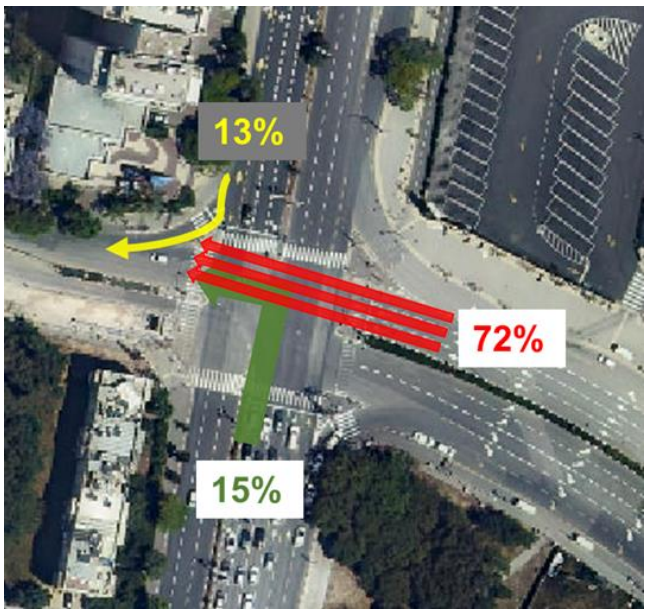


Figure 4. Namir/Arlozorov intersection – incoming traffic

Copyright © 20222 by SPROUT.

Another observation derived from the results is that 30% of all trips ending at trip attraction zone are passing the Arlozorov artery segment. Meaning that about one third of all the volume of trips having the trip attraction zone as a destination is passing through the segment with planned infrastructure changes. These results should be considered in overall estimation of expected capacity reduction impact on travel patterns distribution, planning new traffic arrangements as a basis for re-allocation of travel demand and considering alternative mobility solution for users on specific routes. To assess the capabilities of the decision support tool to provide insights a structured scenario was used (Figure 5).

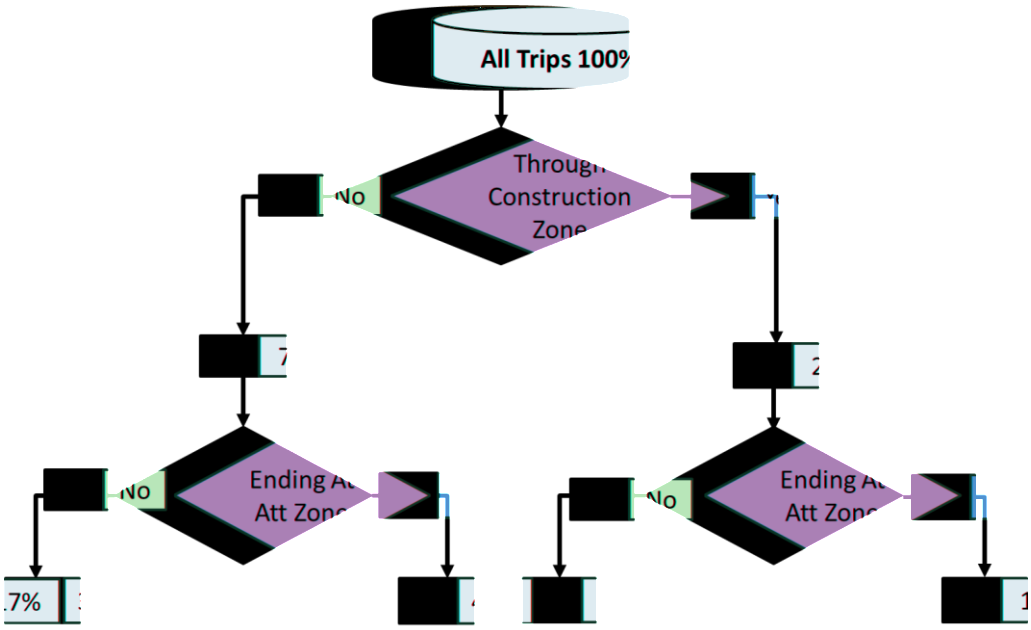


Figure 5. insights derived from the decision support tool

Using data obtained from BT detectors to understand actual travel patterns derived from the analysis of individual movements brings valuable insights and enriches the decision-making process by providing information that is not currently available to traffic planners and authorities.

A scenario of Arlozorov St.'s closure on both sides was used (Figure 6) to demonstrate the calculation of excess capacity in alternative routes. And the "impact area" around the construction zone was determined, in coordination with the traffic management authority. Data received from the BT records analysis was complemented by the Traffic Management System (AVIVIM system) data. AVIVIM system data included (1) BT Links mapping – start/end point of the links, (2) number of lanes and the assigned Signal Groups

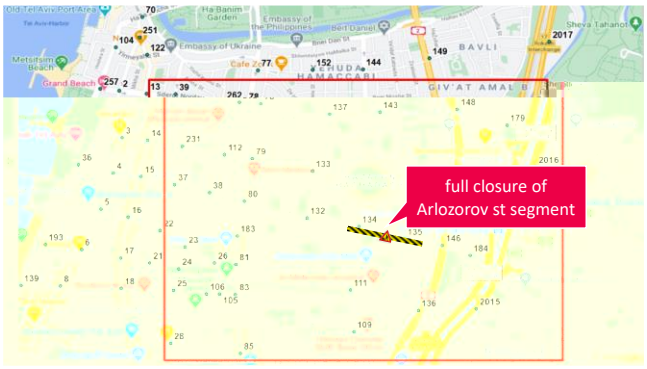


Figure 6. Planned road closure scenario full closure of Arlozorov St

Copyright © 20222 by SPROUT.

controlling the outflow from the links, and (3) historic data of the actual Green light durations for the relevant Signal Groups.

Following the methodology described in section 3.1.2 was applied. The capacity and volumes of each link were calculated based on the data **before** road closure. Volume/capacity (V/C) ratios were calculated for each link and presented in the decision-support tool, according to the following legend:

(1) **Green** – link with sufficient capacity (V/C <= 75%),
(2) **Yellow** – link with higher delays - 75% <V/C <85%,
(3) **Red** – saturated link, long delays are expected (V/C >=85%),
(4) **Grey** – links with no data available due to unit malfunction.

As shown in Figure 7 before the road closure the inner road network had sufficient capacity, while delays are experienced at several outer links – in the entrances to the inner part of Tel Aviv.

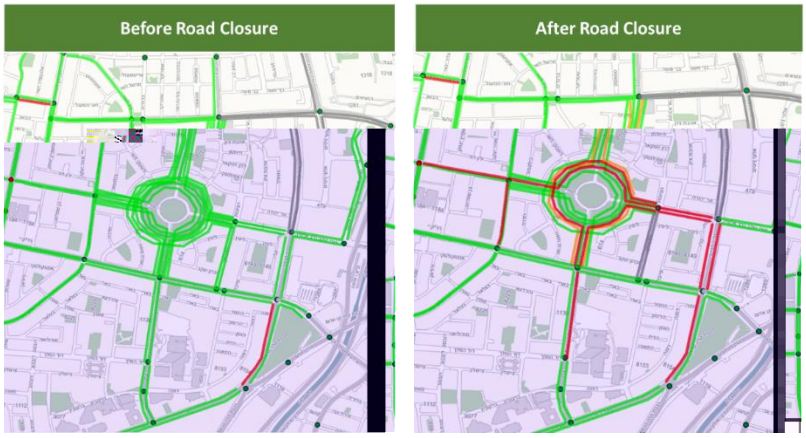


Figure 7. Volume/Capacity ratios visualization before and after road closure – screen shot from the decision-support tool

Next, by using the developed BT trips clustering and analysis tools, the routes clusters that cross the planned roadworks were identified and most likely detour routes were chosen.

Volumes were calculated to adjust for additional rerouted traffic, based on the detour routes that were determined. An updated V/C ratios map after the road closure was generated, (Figure 7). This demonstration showed that during the closure period, the traffic flow is expected to deteriorate in some areas due to the insufficient capacity. Specifically, the northern alternative route – Zhabotinsky Street and Ha-Medina square area will become congested. The southern route, Shaul HaMelech Street, however, has enough capacity to accommodate the rerouted traffic.

Despite being an estimate of the future traffic state, this information is vital to the traffic management authority and should be used during the initial development of the response strategy. The data can be utilized in traffic signal programs redesign process whether to

Copyright © 20222 by SPROUT.

scenario 2. The assessment of the financial aspects of the methodology conducted based on **Cost-Benefit Analysis (CBA).** The methodology proposed by SPROUT Evaluation Framework (SPROUT EF) was adapted to the type of available data. Benefits are measured in terms of savings as a result of delay reduction at intersections after implementing a traffic management strategy. Daily Kilometres per Passenger were not calculated as described in SPROUT EF.

Following the local Israeli guidelines to examine the economic viability of transportation projects and traffic experts knowledge regarding the traffic characteristics, the following factors were used to calculate the monthly savings due to delay reduction (Applying traffic management strategy VS. Do nothing).

- Vehicles categories – Private vehicles.
- Average car occupancy – 1.3
- Hourly rate commute trips - ~ 8 Euro
- Hourly rate professional-work trips ~ 25 Euro
- Percentage of professional drivers – 10%
- Estimation of an average delay in the link [car minutes] - 2 minutes

The total delay was calculated based on the effectiveness of the traffic management strategy that will be implemented after the construction works start. Estimation of the delays was calculated for different degrees of traffic strategy effectiveness (50%, 60%, 80%, 100%) of the (when 0% represents do nothing scenario). Contributing factors to improve the effectiveness of the traffic strategy are data availability, data accuracy, and predictions accuracy.

The Monthly savings in Euro taking into account 21 workdays and morning peak hours is presented in Table 1.

The Costs included are labour salary for senior and junior staff, hardware, software, and devices maintenance costs. The BT detectors costs were not included in the calculation since they were acquired long before the project and served other purposes in Tel Aviv municipality's Traffic Management Center.

Copyright © 20222 by SPROUT.

Table 1. Monthly savings in Euro

Link ID	V/C Before (scenario 1)	V/C After (scenario 2)	Capacity	Total hourly delay [vehicle hours] depending on the effectiveness of the traffic management strategy (scenario 3)			
111331132	0.3036	1.4865	491	24.32	19.46	14.59	12.16
112701133	0.0590	1.3469	805	36.16	28.92	21.69	18.08
111461136	0.9108	1.3121	1296	56.68	45.35	34.01	28.34
111111134	0.3348	1.2177	589	23.91	19.13	14.35	11.96
111461147	0.2006	1.0030	277	9.27	7.41	5.56	4.63
112701134	0.1636	1.0002	491	16.37	13.09	9.82	8.18
111341270	0.1778	1.0000	1035	34.50	27.60	20.70	17.25
111471270	0.3309	1.0000	648	21.60	17.28	12.96	10.80
111331079	0.1025	0.9770	664	21.62	17.30	12.97	10.81
112701147	0.3401	0.9524	1102	34.99	27.99	20.99	17.49
111471146	0.5414	0.9152	614	0.00	0.00	0.00	0.00
111341143	0.2414	0.8131	465	0.00	0.00	0.00	0.00
111431134	0.4732	0.7876	491	0.00	0.00	0.00	0.00
Total delay [vehicle hours]							
Hourly savings in shekels calculated according to the local guidelines				₪12,235	₪9,788	₪7,341	₪6,118
Monthly savings in shekels (21 workdays, morning peak hours)				₪642,354	₪513,883	₪385,412	₪321,177
Monthly savings in Euro (21 workdays, morning peak hours)							

Cost-Benefit ratio was calculated assuming traffic management strategy effectiveness of 60% and 80%. Results are presented in Table 2. The Cost-Benefit Ration improves significantly when the traffic management strategy effectiveness is 80% compared to 60%. As mentioned before, the more the data is complete and accurate, so is the prediction, the effectiveness of the traffic management strategy improves.

Copyright © 20222 by SPROUT.

Table 2. Cost Benefit Analysis Summery

	Traffic Management Strategy Effectiveness (60%)	Traffic Management Strategy Effectiveness (80%)
Total Costs	**32,500 Euro**	**32,500 Euro**
• Labour salary senior staff	15,500 Euro	15,500 Euro
• Labour salary junior staff	8,000 Euro	8,000 Euro
• Hardware and software	3,000 Euro	3,000 Euro
• Devices maintenance	6,000 Euro	6,000 Euro
Total Benefits	**86,805 Euro**	**138,887 Euro**
• Monthly savings due to reduced delays	86,805 Euro	138,887 Euro
Benefit Cost Ratio	**2.67**	**4.27**

Table 3 summarize the mentioned above KPI's that were calculated for this use case.

Table 3. Use Case 1 - KPI's Values

Indicator	Description	Value	Comments
Functional suitability	Completeness	80%	Qualitative evaluation by decision-makers and traffic management experts.
	Correctness	65%	
	Appropriateness	70%	
Usability	Operability and Interface	70%	
Portability	How easily the methodology can be applied in different location	75%	
Traffic congestion	Cost-Benefits Ratio	2.67	Monthly cost of delays during construction works. (Do nothing scenario). (Potential saving when applying traffic strategy to reduce congestion)

3.1.4 Outcomes

The trajectory clustering outcomes provided valuable input to support traffic re-arrangement due to construction and road closure. Challenges encountered during the implementation included incomplete network coverage by BT detectors and missed detections. Also, the inability to obtain data from other sources, including GIS data needed to calculate shortest

Copyright © 20222 by SPROUT.

paths and threshold values. However, integrating data from other data sources such as traffic signals programs, complemented the data, provided additional insights, and validated some of the outcomes.

A broad overview of the network, and calculating excess capacity in all segments, provide vital input to formulate traffic strategy during construction works. Outcomes of this use case demonstrated that a data-based traffic management strategy significantly assists in dealing with congestion and reducing the negative externalities of urban mobility. The cost-benefit analysis indicated toward financial feasibility of data-driven mobility solutions.

3.1.5 Conclusions

The decision support tool demonstrated the capability to simplify complex data and present it to policymakers in an accessible approach that fits their needs. Although having some drawbacks, inter alia due to incomplete network coverage and geo-spatial data visualisation challenges, the data provided valuable insights and was positively evaluated as an input to develop traffic management strategies and temporal traffic re-arrangements to tackle capacity reduction due to road construction. Traditional data collection methods are costly and lengthy and have not been feasible to conduct in order to support decisions regarding temporary traffic arrangements. Thus, even partial data from BT detectors provide meaningful value for planning temporary arrangements due to construction works.

Policy support is essential to support a data-driven decision-making approach alongside an organizational strategy to handle data collection needs, ensure data quality, optimize procedures, and capacity to analyse and present the data.

On a broader vision, business models for data collection and cooperation with providers from the private sector should be studied. Also, policy to support regularity of data collection such as devices maintenance and continual data quality monitoring.

Copyright © 20222 by SPROUT.

3.2 Use Case 2: “Re-allocating the public sphere - balance between capacity and liveability – Assessment

3.2.1 Introduction

Tel Aviv municipality utilizes the construction of the new LRT system to revolutionize the city streets, change the public sphere design and the priorities among road users. Changes in public sphere distribution frequently stimulate public debates. Different stakeholders hold various perceptions of how the public sphere should be allocated. The municipality regularly carries public-engagement events, aiming to incorporate inhabitants' perceptions into the decision-making process; however, no structured methodology is used to resolve conflicts between various needs or stakeholders.

This use case addresses the trade-offs between capacity, safety, and liveability. Aligning with the municipality policy to put pedestrians and cyclists at the top of the road users' pyramid. The use case focuses on the design of sidewalks, cycle lanes, and the interaction between the two groups of road users. Nevertheless, the methodology demonstrated can be used to tackle any conflicts related to the distribution of roadway rights among road users and other transport modes.

Re-allocation of public sphere entails several complex considerations. Moving existing infrastructure might be a barrier preventing desired changes, mainly due to high cost deterring the financial viability. Safety consideration raises debate between experts in different disciplines. Safety experts tend to be stringent and inflexible, while some urban planners believe traditional safety perceptions should be re-considered. The House of quality (HoQ) methodology (Hauser & & Clausing, 1988) encompasses the engagement of multiple stakeholders, alongside incorporating the existing barriers, regulations, standards, and experts’ knowledge.

HoQ (Figure 8) is a structured decision-making technique used for planning and design based on the understanding that products (i.e., street section) should be designed to reflect customers’ desires (i.e., road users), and engineering characteristics (i.e., design attributes) should describe the product in measurable terms and directly affect customer perceptions. In this demonstration, the needs of two groups of road users, pedestrians, and cyclists, are investigated. The design attributes of the road section suggest how road users’ needs are met. The outcomes reflect the synergies and conflicts between pedestrians and cyclists.

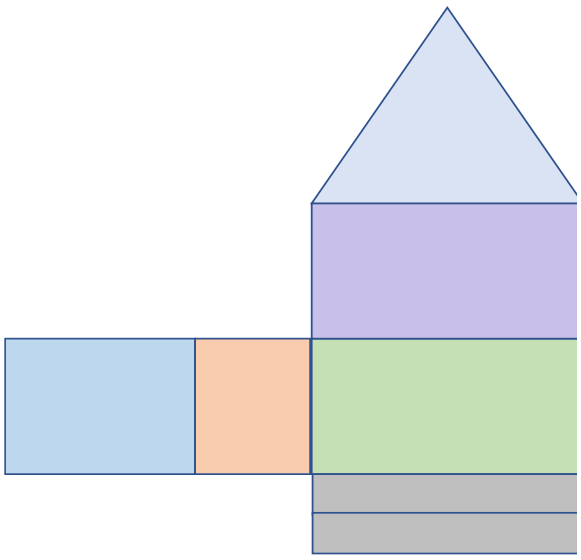


Figure 8. House of Quality

Copyright © 20222 by SPROUT.

Figure 9 describes the four phases of demonstration.

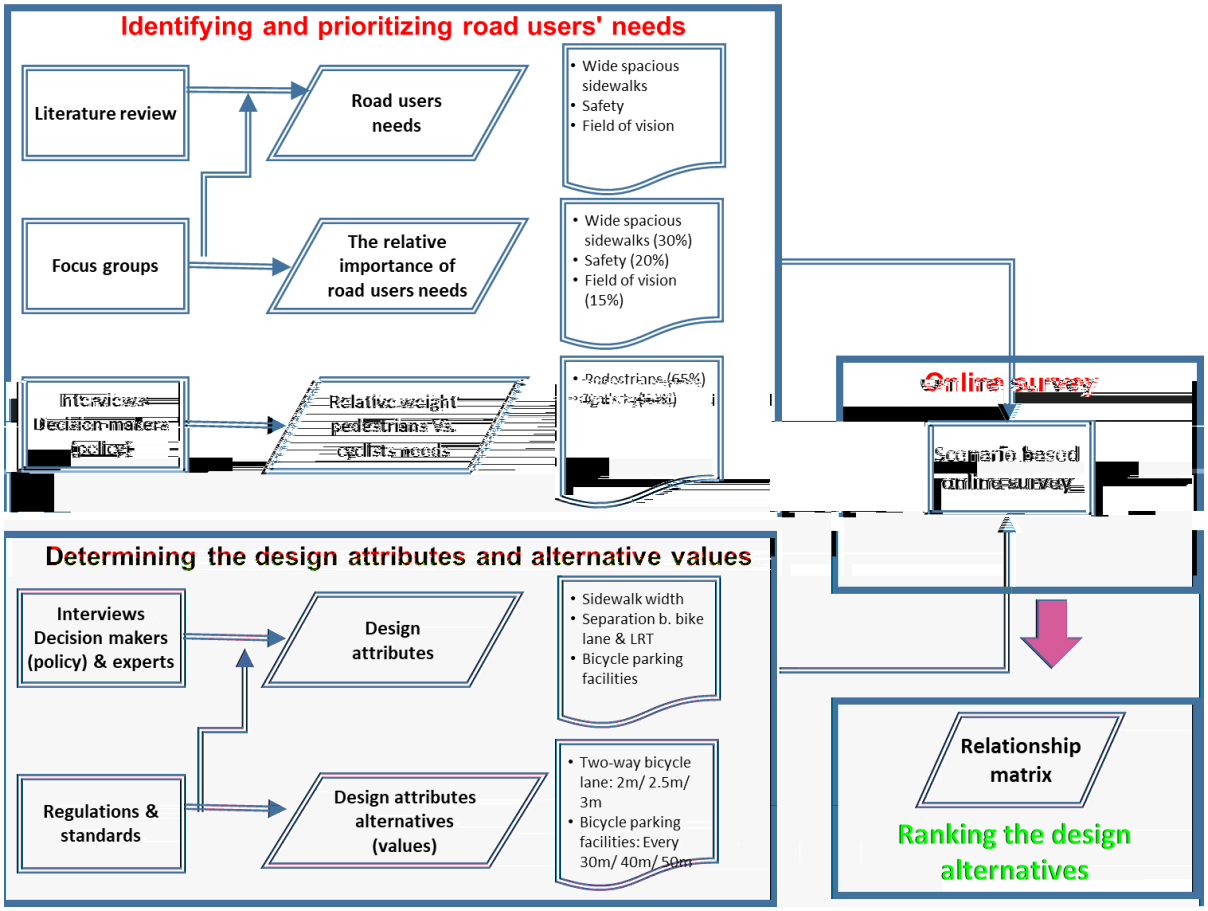


Figure 9. Re-allocating the public sphere - phases

The road section demonstrated in this use case is Arlozorov St. (Figure 10) in which the average right of way is 29 meters. The street is characterized by mixed uses, commercial activities, residency, and leisure. The future road section will include two LRT tracks in the middle, two car lanes, and two bike lanes (Figure 12). Detailed planning of the road section is not finalized yet.

Further specifications of the methodology are included in D4.10.

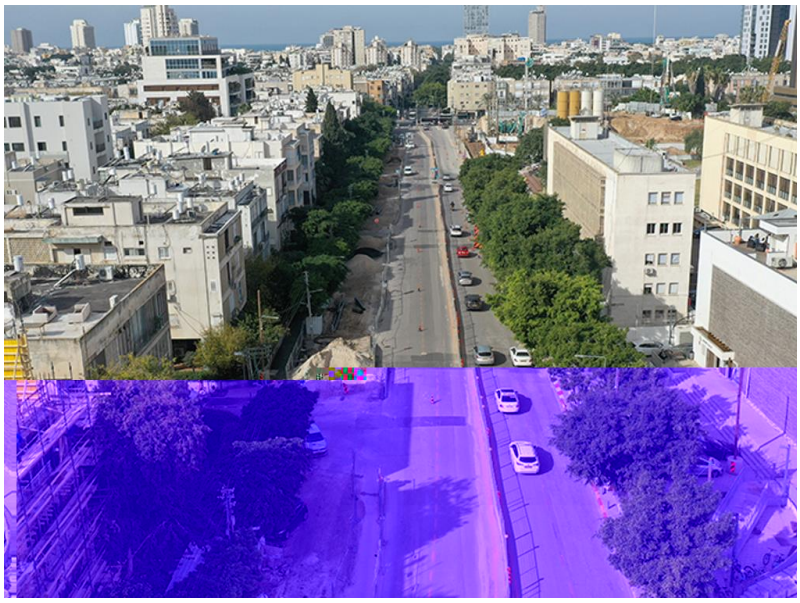


Figure 10. Arlozorov St
(Photo credit: NTA Metropolitan Mass Transit System Ltd.)

Copyright © 20222 by SPROUT.

3.2.2 Testing and data collection activities

Description

A literature review (Table 4) was conducted to review relevant research addressing public sphere design, road users' needs, and the design attributes relevant to urban street sections. The review included local standards and guidelines.

Table 4. Literature review, street section design – needs and attributes

	Cyclists – Youth	Cyclists – moms to infants	Pedestrians – elderly	Pedestrians – youth	Pedestrians – moms to infants
	• good experience • LRT cons[illegible]				
Overall experience	everywhere • Pedestrians walk on cycle lanes and cars parking on them	• [illegible]vival • discomfort • lots of obstacles • discontinuity	• chaos • lack of safety • lack of enforcement	• crowdedness • good-feeling • interesting, • Curiosity	• frustration • noise • lack of safety
Walking/ cycling habits	• prefer wide and spacious boulevards and lanes over small streets with no lanes, • riding on the road is dangerous, lack of lighting after dark	• riding on the road with the cars when there is no cycle lane is very dangerous with children as riding with children is slower • Riding with children creates more conflicts with other road users (pedestrians, around bus stops) • shade is an important consideration to determine where to ride • drainage problems in winter	• prefer to walk in quiet streets, in the evening when it is less crowded • prefer sunlight	• prefer to walk in familiar and crowded streets (more interesting, feel safe) • walk mainly for fun • prefer shaded boulevards • prefer walking in winter over summer	• prefer not to walk in the da • not in the hea • prefer walking winter over summer becau of lack of shad
Influencing factors ranking	(1) Lack of lanes (2) Type of lanes (3) Discontinuity of lanes (4) Crowdedness	(1) safety (2) comfort (weather, topography, crowdedness) (3) conflicts with other road users	(1) safety (2) greenery (3) obstacles (4) shade (5) Lighting	(1) shade (2) Lighting (3) Weather (4) Safety	(1) comfort – sha spacious sidewalks (2) safety – confl with cyclists, obstacles on sidewalks (3) noise
Needs ranking	(1) separated and safe lanes (2) continuity (3) weather/shade (4) safe turns	(1) safety (2) comfort and continuity (3) separation from other road users (4) bicycle parking	(1) safety and security (2) shade (3) lighting (4) sitting benches	(1) spacious sidewalks (2) interest (3) shade, (4) sitting benches (5) lighting	(1) Safety (2) Shade (3) pleasantness (spacious sidewalks, quiet streets) (4) sitting benches
Street sections	• The sections with trees are the most preferable both in terms of safety and pleasantness. • Preferences to the two-way lanes on one side of the street over one-way lanes on both sides of the street	• bollards equal safety • trees equal pleasantness	Participants in this group found the streetsections presentation challenging to understand	Diverse groups. No agreements	

Copyright © 20222 by SPROUT.

1. Identifying Road Users Needs

Initial list of needs identified in the literature review served as basis for the discussions conducted during focus groups.

I. Focus Groups

Five focus groups were conducted each including 4-6 participants. (1) Cyclists – youth (ages 15-24), (2) Cyclists – moms to infants, (3) Pedestrians – elderly (ages 75-86), (4) Pedestrians – youth, (5) Pedestrians – moms to infants. Four of the focus groups meetings were conducted online (using Zoom platform), and one was conducted face-to-face (the elderly group).

The focus groups structure was as follows: (1) moderators' explanation about SPROUT project and the aim of the meeting, (2) participants describe their overall experience in the public space, (3) investigate questions to explore walking/cycling habits. (4) identify factors that influence their walking/cycling experience and rank them, (5) Identify needs, rank them, and try to agree on the ranking, (6) presents various street sections and ranks them according to the level of safety, pleasantness, and personal preference. Moderator directed the discussion to characteristics related to street section. However, all focus groups included discussions regarding network attributes such as discontinuity of cycle lanes, and enforcement.

Each of the focus groups had a different dynamic. Some included very active discussions, and one (pedestrian moms) endured the downsides of online communication and was challenging to moderate. **Table 5** presents the summary of each the focus groups outcomes.

It is a common practice when using the HoQ methodology that "Needs" are grouped into bundles of attributes that represent an overall customer concern (Tan, Xie, & & Chia, 1998). To facilitate the next phases, two concerns raised by participants in all focus groups **safety and Pleasantness** were taken into account to further explore.

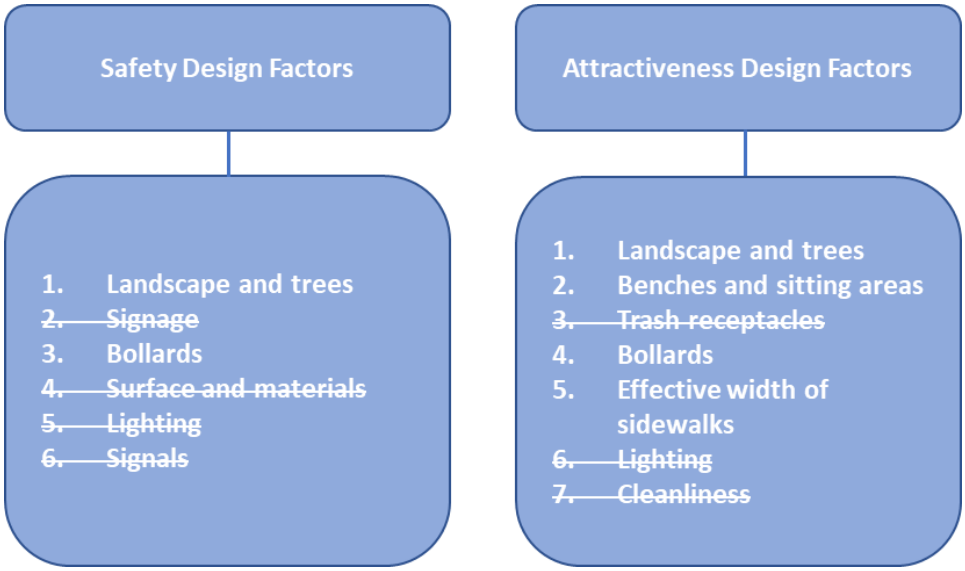


Figure 11: Safety And Attractiveness Design Factors (based on: (Aghaabbasi, Moeinaddini, Shah, Asadi-Shekari, & & Kermani, 2018)

Copyright © 20222 by SPROUT.

Based on the literature review outcomes, the dimensions of safety and pleasantness followed (Aghaabbasi, Moeinaddini, Shah, Asadi-Shekari, & & Kermani, 2018) approach. They identified safety and attractiveness design factors among four factors to evaluate walkability audit tools. The factors and their dimensions were identified through various literature reviews, including sidewalk design guidelines and research papers. Adapted to the context of this demonstration, only relevant dimensions (**Figure 11**) were further investigated. For a more approachable term, the survey addressed pleasantness instead of attractiveness.

Table 5. Focus groups' outcomes summery

	Cyclists – Youth	Cyclists – moms to infants	Pedestrians – elderly	Pedestrians – youth	Pedestrians – moms to infants
Overall experience	• good experience • LRT construction everywhere • Pedestrians walk on cycle lanes and cars parking on them	• survival • discomfort • lots of obstacles • discontinuity	• chaos • lack of safety • lack of enforcement	• crowdedness • good-feeling • interesting, • Curiosity	• frustration • noise • lack of safety
Walking/ cycling habits	• prefer wide and spacious boulevards and lanes over small streets with no lanes, • riding on the road is dangerous, lack of lighting after dark	• riding on the road with the cars when there is no cycle lane is very dangerous with children as riding with children is slower • Riding with children creates more conflicts with other road users (pedestrians, around bus stops) • shade is an important consideration to determine where to ride • drainage problems in winter	• prefer to walk in quiet streets, in the evening when it is less crowded • prefer sunlight	• prefer to walk in familiar and crowded streets (more interesting, feel safe) • walk mainly for fun • prefer shaded boulevards • prefer walking in winter over summer	• prefer not to walk in the dark • not in the heat • prefer walking in winter over summer because of lack of shade
Influencing factors ranking	(1) Lack of lanes (2) Type of lanes (3) Discontinuity of lanes (4) Crowdedness	(1) safety (2) comfort (weather, topography, crowdedness) (3) conflicts with other road users	(1) safety (2) greenery (3) obstacles (4) shade (5) Lighting	(1) shade (2) Lighting (3) Weather (4) Safety	(1) comfort – shade, spacious sidewalks (2) safety – conflicts with cyclists, obstacles on sidewalks (3) noise
Needs ranking	(1) separated and safe lanes (2) continuity (3) weather/shade (4) safe turns	(1) safety (2) comfort and continuity (3) separation from other road users (4) bicycle parking	(1) safety and security (2) shade (3) lighting (4) sitting benches	(1) spacious sidewalks (2) interest (3) shade, (4) sitting benches (5) lighting	(1) Safety (2) Shade (3) pleasantness (spacious sidewalks, quiet streets) (4) sitting benches
Street sections	• The sections with trees are the most preferable both in terms of safety and pleasantness. • Preferences to the two-way lanes on one side of the street over one-way lanes on both sides of the street	• boulevards equal safety • trees equal pleasantness	Participants in this group found the streetsections presentation challenging to understand	Diverse groups. No agreements	

Copyright © 20222 by SPROUT.

II. Experts Interviews

Interviews with experts aimed to help identify and select the design attributes. The interviews were conducted as semi-open interviews. Each interview included the introduction of the research aim, the context in which the HOQ methodology is used, and the lessons learned in the previous phase, including the two needs that will be further explored **safety and pleasantness**. Then, the initial design attributes identified through the literature review were discussed in relation to the Israeli urban context and to accommodate both pedestrian and cyclists needs. The interviewee was then asked to express his/her opinion on the major conflicts/ challenges he/she identifies in relation to his experience in the field and which design attributes he considers as paramount to include.

The main issues discussed with the experts included **(1) Trees and shade** relevancy for both pedestrians and cyclists, (2) Perception towards **separation** means between cyclists and pedestrians to minimize conflicts, (3) consideration towards **Sidewalks and cycle lanes width,** (4) Identifying and addressing points of conflict between road users, (6) **Facilities** for pedestrians and cyclists (shade, parking, benches).

Four specialists from different domains and expertise level were interviewed. Three of the interviews were conducted online (using Zoom platform), and one was conducted face-to-face.

Person 1 – Senior Planner at the Mass Transit Transport Unit, Tel-Aviv Municipality

- The **width of sidewalks and bicycle lanes** should be considered in relation to their intensity of usage and not in relation to the street section. The problem is that this is not always measurable.
- The two main types of **separations** to be considered are those between pedestrians and cyclists and between cyclists and electric scooters/bikes. These two types of confrontations generate most of the conflicts in the public realm.
- **Two-way or one-way cycle lanes** – although it is recommended to design one-way lanes in the Israeli guidelines. There is not one clear preference, it mostly depends on the street configuration and character.
- **Shade** is highly important for both pedestrians and cyclists in the Israeli context, preferably trees.

Person 2 – Project Manager at the Transport and Parking Division, Tel-Aviv Municipality

- **Enforcement** is a major issue in the Israeli context in order to minimize conflicts between road users and to eliminate obstacles on lanes and sidewalks
- **Lack of facilities for cyclists** – bicycle parking, water, air-filling stations, shade along the routes, and bicycle parking shades.
- Acknowledging specific **points of conflicts** between road users and acting to minimize them. Such as bicycle lanes, pedestrians, and bus stops.

Person 3 – CEO Israel Bike Association

- Bicycle lanes **continuity** – an urgent need to create more separated lanes and connecting them to minimize conflicts with other road users

Copyright © 20222 by SPROUT.

- **Trees** – should be an integral requirement for bicycle lanes.
- A different concept of **safety** for men and women. Women require higher levels of safety than men.

Person 4 – Planning Division Manager at the Transport and Parking Division, Tel-Aviv Municipality

- **Trees** – on the one hand, there is a large need in shading sidewalks and bike lanes. On the other hand, the deciduous trees produce hazards such as falling fruits that obtrude the paths and sidewalks and might create safety hazards.
- **Economic issues** influence the design quality, such as the location of drain receptors or other infrastructure requiring different lanes or bypasses.

The interviews identified bus stops as major points of conflict due to the interactions among cyclists, buses, and passengers accessing bus stops. The current Israeli guidelines for streets design recommend designing bicycle lanes that pass behind bus stops. The experience on the ground from Tel-Aviv and other cities proves that this is not always the safer solution. Therefore, this point of conflict was added to the design attributes for further investigation.

After an iterative process, the experts agreed upon the design attributes. Considering that street section width is fixed, the division of the right of the way among the attributes reflected the trade-off between capacity, liveability, and safety. i.e., seating facilities (0.5 m width) will be at the expense of the sidewalk width, which will decrease by 0.5 m (liveability vs. capacity). The design attributes and the alternative values are presented in Table 6.

Table 6. Design attributes and their values

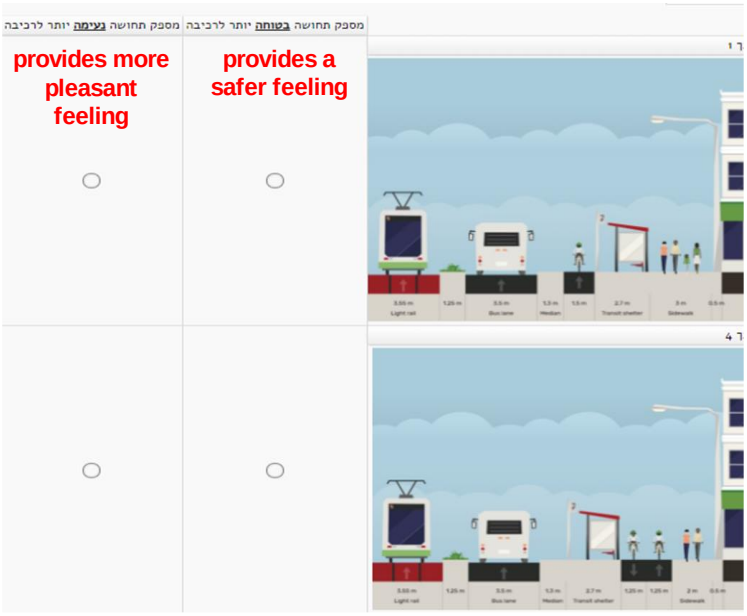
	Sidewalk width	Bicycle path location relative to station	Bicycle path width, one/two directions	Separation between bicycle path and sidewalk	Pedestrian seating facilities	Bicycle parking facilities
Baseline value		behind	2.5 Two way	No separation	No	No
Value 2	1.5-2.0 m	In front	1.5 One way	Physical buffer (0.3 m)	Yes (0.5 m)	Yes (0.5 m)
Value 3	2.2-3.0 m			Trees (1 m width)		

Streetmix[4] software was used to present the street section. Example of the street section presentation is in Figure 12.

[4] https://streetmix.net/

Copyright © 20222 by SPROUT.

Copyright © 2022



sense of pleasantness (

Figure 13). To allow participants to concentrate on the details of the relevant attributes of the street section, only half of the street section was presented. Each participant was presented with a block of eight scenarios.

The design attributes and alternative value resulted in 17 potential configurations of street sections. Several experiment designs (Holmes, Adamowicz, & Carlsson, 2017) were examined. The Orthogonal Full Factorial Design was disqualified due to the large number of respondents needed. Efficient Design was also excluded since the methodology requires sufficient prior information, that was not available. The most appropriate design method was





Figure 14. screen shots from the introduction video

Copyright © 20222 by SPROUT.

Fractional Factorial Design[5]. Constraints related to the optional configurations of the street sections allowed only partial implementation of the Fractional Factorial Design. Total of 4 blocks including 8 scenarios each included in the survey. To enhance the respondents understanding of the street sections presented, a short introduction video was included, showing real-world setting of every design attribute, and explaining every component of the street design (screen shots from the video in Figure 14)

Policy framework

This use case is aligned with three important policy measures that Tel-Aviv municipality considers of high importance: (1) putting pedestrians and cyclists at the top of the road users' pyramid (2) increasing public engagement in decision making processes, and (3) promoting more sustainable modes of transport. The use case outcomes contribute to upscaling these policy measures.

Time and resources required

The tasks conducted within this use case included:

- Literature review of research in the field, relevant standards and regulations, to identify road users' needs and relevant design attributes
- Focus groups (online and face-to-face) to identify and prioritise different sub-groups of pedestrians and cyclists' needs
- Experts' interviews, including transportation experts and decision makers, to determine design attributes and weight the relative importance of road users' needs
- Online survey design, including various design alternatives portraying the design attributes in the relevant context, to be ranked by local pedestrians and cyclists
- Survey results analysis and incorporating results to HoQ.
- Interpretation of the outcomes.
- Findings' assessment and presentation to various stakeholders at Tel-Aviv municipality and the Israeli ministry of Transport (still in process)

3.2.3 Impact Assessment

An online panel was used to distribute the survey. Targeting total of 200 pedestrians and 200 cyclists. Respondents included 61% females and 39% males. Age groups included: 28% age 18-30; 49% age 31-50; and 21% age 51+. Travel patterns were explored. The frequency of usage of electric bikes, bikes, scooters, and public transportation is presented in Figure 15

[5] A fractional design is a design in which experimenters conduct only a selected subset or "fraction" of the runs in the full factorial design.

Copyright © 20222 by SPROUT.

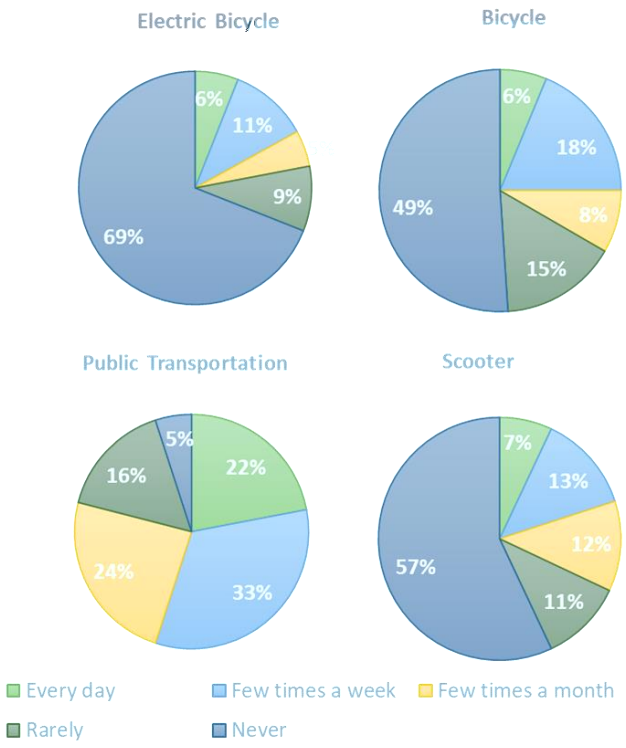


Figure 15. Frequency of usage of transportation modes

The Estimating Logistic Regression methodology was used to investigate the impact of each design attribute on road users' needs, based on the choice scenarios presented to the respondents. The effect of each attribute in street section design on respondents' choices was assessed with binary logistic regression estimation. The analysis was performed for each of the following four datasets: (1) Choices of **pedestrians with respect to perceived safety**, (2) Choices of **pedestrians with respect to perceived pleasantness**, (3) Choices of **cyclists with respect to perceived safety,** (4) Choices of **cyclists with respect to perceived pleasantness**.

In logistic regression the log odds of the outcomes are modelled as a linear combination of the predictor variables:

$$log(odds) = logit(P) = ln\left(\frac{P}{1-P}\right) = a + b1x1 + b2x2 + \ldots + bnxn$$

Where:

P = the probability that a case is in a particular category, i.e., the probability that a street section design is in category “chosen”

a = the constant of the equation

bi = the coefficient of the predictor i. bi is the expected change in log odds associated with one-unit increase in predictor xi. For categorical variable with m levels, the common practice is to specify one of the levels as a reference level and m -1 binary variables, for each of the

Copyright © 20222 by SPROUT.

remaining m -1 levels. Thus one-unit increase in binary variable means moving from specified baseline level to the level the binary variable represents.

The design attributes with the associated levels are presented in Table 7. According to the principles of variables construction, a total of 7 variables were analysed: 1 continuous variable (sidewalk width) and 6 binary variables.

Table 7: Design attributes with associated levels

Attributes	Levels
Sidewalk Width	Continuous variable
Bicycle Path Width	• 2.5 m – reference level • 1.5 m
Bicycle Path Location	• Behind – reference level • In Front
Separation	• No separation – reference level • Physical • Trees
Pedestrian Seating Facilities	• No – reference level • Yes
Bicycle Parking Facilities	• No – reference level • Yes

For each of the four databases, correlation analysis served as a basis for constructing different sets of variables to derive the model with the best fit measured with Akaike Information Criterion (AIC - an estimator of prediction error). The model giving the smallest AIC over the set of models is the one considered as lower AIC values indicate a better-fit model.

Results (Table 8) revealed the synergies and conflicts between the two groups of road users. Consent among pedestrians and cyclists that **Trees as a means of separation** considerably contributor to the safety and pleasantness of both pedestrians and cyclists. Results stress the high importance of trees for all road users, not only as a means of separation. On the other hand, pedestrians and cyclists had conflicting positions regarding the **location of bicycle paths relative to a bus stop**; while pedestrians preferred a bicycle path in front of the bus stop, cyclists preferred the path to be behind the bus stop. Another conflict was regarding the directional of cycling lanes, while pedestrians prefer to walk next to one-way cycle lanes, cyclists slightly prefer to ride in two-way cycle lanes. Differences in terms of perceptions of what contributes to the sense of safety and pleasantness were also revealed.

Most design attributes were statically significant, except the **Bicycle parking facilities** that were not significant for the pedestrians' safety and pleasantness. **Physical buffers separations** were not significant for the pedestrians' and cyclists' pleasantness. **Bicycle parking facilities** was not significant for pedestrians' pleasantness. **Bicycle path related to a bus stop and seating facilities** were not significant for the cyclists' pleasantness.

Copyright © 20222 by SPROUT.

It is noticeable that in the trade-off between capacity (sidewalk width) and safety or liveability (pleasantness), the safety and liveability measures were always preferred. However, the inability of the respondents to estimate the implication of width differences might have contributed to this result.

Table 8. Coefficients values of the model

	Sidewalk width	Bicycle path location relative to bus stop	Bicycle path directional and width characteristics	Separation between bicycle path and sidewalk		Pedestrian seating facilities	Bicycle parking facilities
Baseline							
variable	Continuous variable						
						Yes	Yes
Pedestrians safety	-0.35**	0.75**	0.85**	0.56**	0.67**	-0.78**	-0.14
Pedestrians pleasantness	-0.27**	0.30**	0.81**	-0.07	0.84**	-0.61**	0.04
Cyclist safety	-0.17**	-0.27**	-0.36**	0.42**	0.58**	0.35**	0.33**
Cyclist pleasantness	-0.30**	-0.09	-0.14**	0.15	1.12**	0.10	0.45**

** indicates significance at the 95%

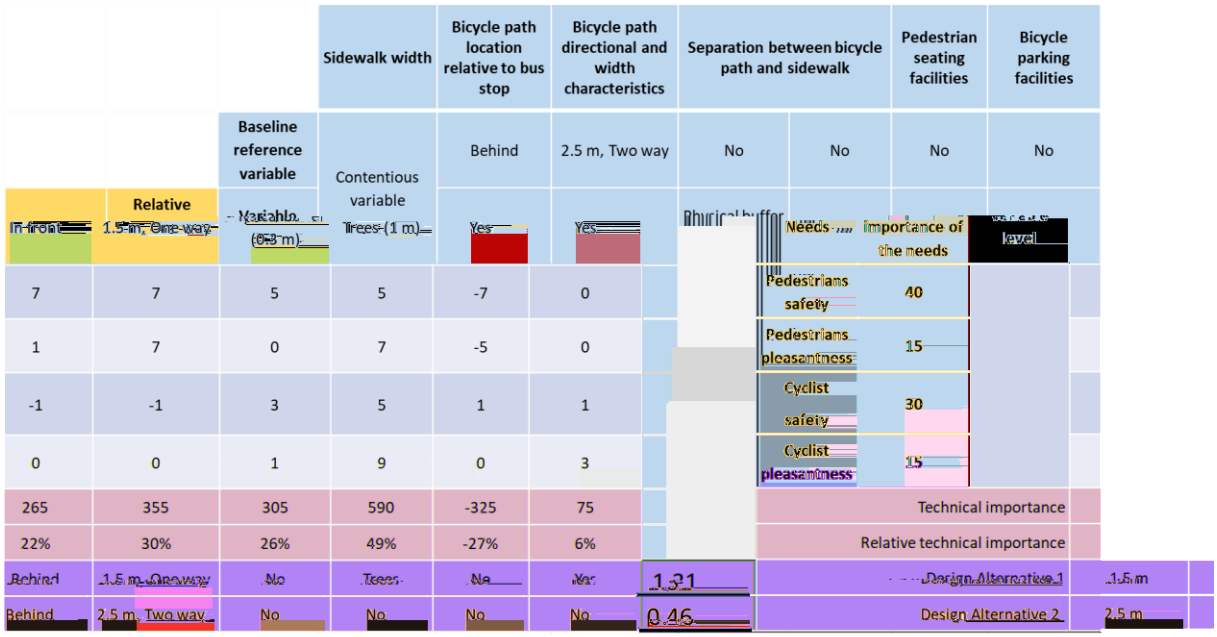
The Coefficients values presented in Table 8 were converted to present the relationship between design attributes and road users' needs in the HoQ (the relationship matrix). Scale from 0-9 was used. 0 represents no relationship, 1 weak relationship and up to 9 very strong relationship. The same scale applies to weak/strong negative relationship (-1 weak negative, -9 strong negative).

Decision-makers were asked to rank the importance of each of the needs of the two groups of road users. The agreed weights of each need for this demonstration are Pedestrians' safety – 40%, Pedestrians' pleasantness – 15%, Cyclist safety – 30%, Cyclist pleasantness – 15%. The methodology allows decision-makers to investigate the impact of other priorities easily and quickly on the preferred road section by changing the importance level of each need.

The technical importance representing the weight of each design attribute was calculated (combining the impact of each design attribute on road users' needs with the relative importance of each need). Each of the 17 configurations of the street section was benchmarked based on the relative technical importance of the design attribute, to reveal the street section design, best satisfying the needs of the stakeholders.

Copyright © 20222 by SPROUT.

Table 9. House of quality



Functional suitability evaluated based on one of the characteristics defined in the ISO/IEC 25010 standard: the **Completeness** – Degree to which the tool covers all the expected tasks and user objectives, i.e., the ability to provide the specific requirements according to the specifications). Practitioners in urban planning evaluated completeness based on the outcomes.

- Both the HoQ outcomes and insights derived from the survey provide urban planners and decisionmakers with a clear understanding of preferences, synergies, and conflicts. Survey outcomes also reflect the subjective point of view toward some of the design attributes, i.e., those that were not significant statistically.
- Achievement of the overall objective, to methodically incorporate the outcomes of public engagement processes into decision making.

Usability was evaluated based on the degree to which the methodology can be used to achieve specified goals with **effectiveness** and **efficiency**. The **effectiveness** was positively evaluated, depending among others on accurate definitions of the needs and design attributes in the initial phase. However, experts debated the **efficiency** of the methodology. The multi-phases process, time, and financial resources required to perform all tasks accurately, and efforts associated with trial and error to fine-tune the survey due to the complexity of public sphere re-allocation, question the efficiency of the methodology.

Portability the transferability was evaluated in terms of context and locations. The methodology can be used in various contexts as well as with various road users, and in different locations. It requires a dedicated survey which can examine different design alternatives in relation to an existing context. The survey results can then be integrated into the House of Quality methodology to acquire the design alternatives with the highest rankings,

Copyright © 20222 by SPROUT.

that are most widely acceptable by the different road users. The methodology is highly transferable; however, resources needed to perform the different task should be considered.

Table 10. Use case 2: KPIs results.

KPI	Description	
Functional suitability	Degree to which the tool covers all the expected tasks and user objectives.	85%
Usability	Degree to which the methodology can be used to achieve specified goals with effectiveness, efficiency.	55%
Portability	Transferability of the methodology in terms of context and locations	70%
Quality of public space and road user experience improvement	User experience regarding quality of public space was first discussed in the focus groups with pedestrians and cyclists. The conclusion from these focus groups led to the survey design. The focus groups revealed some common issues among both pedestrians and cyclists: foremost the issue of safety on sidewalks. Focus groups and survey results showed that safety and liveability are inseparable. To a large extent safety was recognized by both pedestrians and cyclists as a measure of liveability. Other liveability components are considered only in a safe environment. Separation between different road users, and especially between sidewalks and cycle lanes is viewed as essential. Trees and shade on sidewalks and cycle lanes also came up as a major need. The final configuration of the use case, and the project timeline did not allow measuring the improvement of the quality of public sphere and user experience. Road user experience improvement will be possible once the conclusions from the survey, outlined above, are implemented in the street design, with the erection of the new LRT purple line.	
Growth of safety of traffic users and pedestrians and growth of attractiveness or urban areas	The focus groups and survey exhibited the complex relationship between safety and liveability, and the specific concerns and conflicts between road users. The survey revealed that there are certain design attributes ranked high by both pedestrians and cyclist, such as trees and bollards as means of separation (bollards only in terms of safety, trees for both needs), while other indicators receive opposing rankings from pedestrians vs. cyclists, such as one/two way cycle lanes and lanes that pass in front or behind transit shelters.	

Copyright © 20222 by SPROUT.

	The ranking of different designed is derived from the weight decision makers will attribute to each road users' need. The demonstration showed how the engagement of road users can be methodologically incorporated into the decision-making process. The growth can be estimated once decisions are made. Measuring to what extent the chosen road section meets each group of road users' needs.	

3.2.4 Outcomes

The outcomes revealed interesting points of view regarding the preferences of different road users and how they perceive the public sphere, including agreements and disagreements. These understandings add valuable knowledge for decision-makers who can better accommodate road users' needs.

In addition, this use case and its outcomes stirred a debate among stakeholders and experts on the balance between safety and livability in the re-design of the public sphere and how to achieve it.

3.2.5 Conclusions

The outcomes of this use case are currently being presented in different forums including: The TLV Municipality Transportation & Parking Authority, Municipal Traffic Division, Municipal Architecture & Design Unit, Municipal Strategic Planning Unit, The Deputy Mayor Forum for Transport Development, and the Israeli Ministry of Transport Forum. Conclusions regarding the possible future implementations of the results is a continuous process that is still in progress. So far, the feedback received was controversial. Some professionals view the results as very interesting and eye-opening, providing a genuine opportunity to integrate road users' preferences into decision making processes and perceiving the value from this as significant for the municipality. Others view the methodology as too complex and too resource-consuming in order to implement in actual ongoing decision-making processes on a regular basis and suggest that it may be used only in very specific points of conflict when a solution is difficult to reach.

3.3 Use Case 3: Identifying and prioritizing vulnerable road users at signalized intersections – Assessment

3.3.1 Introduction

A common approach to managing the crossing opportunities at signalized intersections is to provide a predetermined pedestrian green light duration for each signal cycle. The duration is calculated based on the crossing length of the crosswalk and an estimated crossing speed, representing a normal walking speed of a healthy individual (1.2 m/s in according to the Traffic Signals Planning Guidelines in Israel). For VRU, however, the current state of practice may lead to an increased frequency of dangerous crossings – situations where a VRU encounters increased chances in which crossing period duration will be insufficient. Therefore, a VRU will

Copyright © 20222 by SPROUT.

still be present at the crossing when conflicting vehicular traffic is starting to enter the intersection. In this use case a methodology to reduce the frequency of such unsafe incidents efficiently was developed, demonstrated, and assessed.

Since regulations prevented real-world application of the concept in an intersection in Tel Aviv, the experiment was conducted in a microsimulation environment using real-world data.

An algorithm to identify VRU was developed and trained, an interface between the detector and traffic signal control algorithm was developed to extend the green light only according to defined criteria, i.e., only if extension is needed. The framework is described in Figure 16. Further specifications are discussed in D4.10.

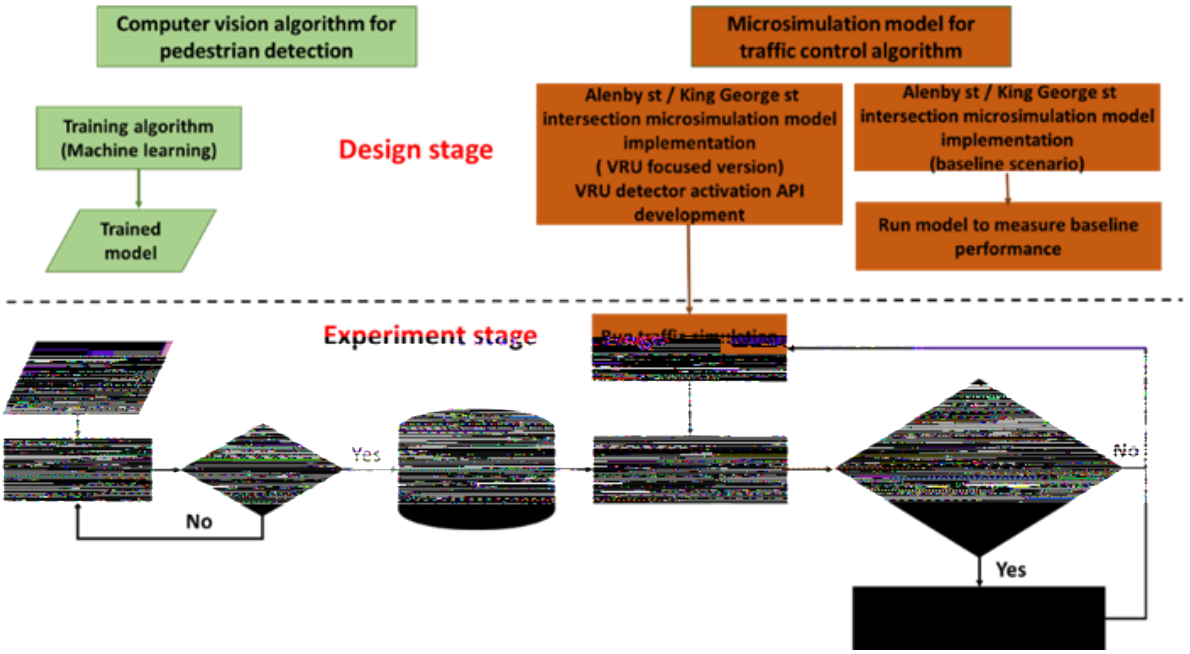


Figure 16. Use Case 3 framework

As illustrated in Figure 16 the design phase included developing and training the VRU identification model and developing a microsimulation model, calibrating the model, and measuring the baseline performances. Afterward, in the experiment phase, real-world video streams from the intersection were used to identify VRU, an interface between the detector and signal control algorithm was activated. Green light extension logic was activated only if a late crossing start by the VRU was detected. During the experiment phase, KPIs were measured.

3.3.2 Testing and data collection activities

Description

VRU video detection model was developed using deep-learning and computer vision methods. Real-world video data from cameras located in the intersection was used to train and assess the model. Video data is a sequence of images (frames) together, adding the temporal dimension. Due to the complexity of video data and the expensive computation of training and inference, it is acceptable to use image object detectors on videos to efficiently identify the objects in the video records, by adding the temporal dimension. Theoretically, applying image

Copyright © 20222 by SPROUT.

object detectors on video records can be done by detecting every single frame. However, this would not be efficient, especially for real-time detection. Several methodologies may be used to tackle this problem, such as Optical Flow Estimation ((Agarwal, Gupta, & & Singh, 2016))

Following deep learning practice, video data is separated into two sets – training set and validation set. The objects to be identified (strollers and wheelchairs in this use case) are manually tagged for all frames of the training set data. As deep learning-based methods require extensive training and a large number of examples, 1,720 images of relevant objects were manually tagged. The manual tags were then uploaded to YOLO[6] - an open-source, state-of-the-art image detector engine. YOLO is a single-stage detector that tends to be less accurate than two-stage detectors but significantly faster; this is particularly important since the detection model is designated to be activated in real-time—applying object detection, determining the object in an image and where the given object resides.

After the model is trained, a video detector configuration file is received and can be used on traffic video feeds. Two detection areas were configured at the start point of the crosswalk on both sides. The trained detection algorithm model was validated using a separate set of data by comparing manual observations versus algorithm detection records stored in a structured SQL database. For each video second, a separate record was saved, including the following data:

- Measurement Timestamp
- Video clip/source name
- Internal video timestamp (minute and second of the video)
- VRUs present in the detection zone – Manual observation (True/False)
- VRUs present in the detection zone – Algorithm detection (True/False)

A simulation framework was developed in cooperation with the Traffic Management Centre (TMC) of Tel Aviv. The traffic simulation model of the existing signalized intersection with heavy pedestrian activity was built using state-of-the-art VISSIM microsimulation software[7]. Real-time video feeds from the TMC cameras were used to calibrate the model in order to realistically represent the existing demand and flow patterns at the intersection of Alenby and King George Street in the middle of Tel Aviv.



Figure 17. An aerial view of Alenby St. /King George St. intersection

[6] https://pjreddie.com/darknet/yolo/
[7] Traffic Simulation Software | PTV Vissim | PTV Group

Copyright © 20222 by SPROUT.

Policy framework

This use case is aligned with two important policy measures that Tel Aviv municipality considers of high importance. Social inclusion of vulnerable inhabitants and locating pedestrians at the top of road users' hierarchy. Nevertheless, prioritizing the VRU aroused concerns regarding the impact on other modes, especially causing delays to public transport (who are also high in the hierarchy of road users).

Regulations in Israel obligates the approval of the Israeli Ministry of Transport, to implement new detection methods interfacing with real-time traffic control. Despite changes being discussed for a couple of years, the lengthy procedure did not change within the timeframe of the project, and the local authority wasn't capable to conduct a real-world experiment.

Time and resources required

The tasks conducted within this use case included:

- Training of VRU detecting model. This is a time-consuming task and requires a lengthy process especially the manual objects tagging.
  - Building and calibrating the microsimulation model required skilled workers familiar with simulation software. Traffic data required to calibrate the model collected by the Traffic Management Center in Tel Aviv Municipality.
  - Building the interface between VRU detectors and signal light logic.
  - Developing the algorithm for green signal extension only when needed.
  - Data collection was conducted using cameras already installed in the intersection and monitored by the Traffic Management Center in Tel Aviv Municipality (Figure 18).
  - Conducting the experiment.
  - Analysing the results and the assessment process.



Figure 18. Image captured by TRC camera

As mentioned before, the timeline of the use case implementation was affected by lockdown periods, during which traffic volumes have decreased significantly. In addition, the traffic of vulnerable pedestrians has decreased even more dramatically. VRU detection model training was possible to conduct during lockdown. However, the calibration of the microsimulation model required normal traffic patterns to reliably assess the impact of applying the prioritization method.

3.3.3 Impact Assessment

The impact assessment aimed to evaluate the accuracy of the video detection algorithm, the impact on the frequency of unsafe crossing of VRU, and assess the mobility impacts of the suggested traffic control schemes, specifically the delays encountered by the conflicting traffic.

Copyright © 20222 by SPROUT.

The video data gathering process was carried out twice. An initial process was performed during the COVID-19 lockdown period. This data was used only to train the detection model. Additional observations after the lockdown representing regular traffic patterns were used to assess the performances of the detection model and calibrate the traffic model.

Since the detection algorithm is active only during pedestrian's green, the accuracy was evaluated only during green periods. Each record was classified as one of the following cases – **True Positive (TP)**, **True Negative (TN)**, **False Positive (FP)**, and **False Negative (FN)**. The frequency of occurrence for each case was later used to evaluate the accuracy of the video detection algorithm.

The KPI defined in the initial proposal, “reduce the total crossing time of VRU by 12%,” changed to match the final configuration of the use case. Shifting from focusing on reducing waiting time at crosswalks to eliminating the frequency of unsafe crossing. Initial testing of the frequency of unsafe crossing in the specific intersection indicated potential unsafe crossings during 15-20% of the cycles. Reducing unsafe crossing of VRU by extending pedestrians green signal raises concerns about the impact on conflicting traffic by increasing delays at the intersection. The KPI’s defined to assess performances in this use case are:

- Reduce the frequency of potentially unsafe crossing of Vulnerable Road Users from 15-20% of cycles to less than 8% of cycles.
- Eliminate the additional vehicle delay for the conflicting traffic movements (compared to fixed green duration) to no more than 5%.

The values of the KPIs were calculated by running the VISSIM traffic simulation model and gathering performance data. A total of four and half hours of operation were simulated, equal in length to the total duration of video fragments acquired from Tel Aviv TMC cameras.

In preparation for the traffic simulation runs, a VRU video detection algorithm was activated, and all VRU detections were recorded into the SQL database. The database records were then synced with the simulation time frame to simulate the real-time detection of VRUs in the simulation environment.

The VRUs were introduced into the model during the simulation runs at the exact moments of their real-world detections. On each VRU arrival, a traffic algorithm control decision on whether to extend pedestrian green in order to prevent a potentially unsafe crossing was recorded. Afterwards, this data was used to calculate the potentially unsafe crossings' frequency.

As a built-in feature, VISSIM simulation constantly records the delay for every vehicle in the network. This data was used to estimate the impact of pedestrian green extensions on conflicting vehicle movements. Lastly, a set of baseline simulations were performed where the video detection algorithm was inactive, and no VRU green extensions were given. This allowed comparing the two scenarios and evaluating the proposed method's impacts on VRU mobility and vehicular traffic.

As the evaluations were carried out in the simulation environment, the COVID-19 impact on the experiment was rather small and affected only the data gathering process.

In order to evaluate video detection accuracy, based on the principle described above the confusion matrix was calculated as appears in Table 11:

Copyright © 20222 by SPROUT.

Table 11. VRU detector Confusion Matrix – total occurrences during pedestrian green (secs)

	Manual Observation Positive	Manual Observation Negative
Algorithm detection Positive	(TP) 494	(FP) 174
Algorithm detection Negative	(FN) 88	(TN) 2109

Based on results presented in Table 12, the following accuracy metrics were calculated:

- **Negative prediction (96%)** – the ability of the algorithm to correctly identify the cases where no VRUs are present in the detection zone.
- **False Positive Rate (7.6%)** – the frequency of video detection false alarms.
- **Recall (84.9%)** – the proportion of all positive video detections that were classified.

Table 12. Video Detection Accuracy Metrics

	Calculation Formula	Results
Negative Prediction	$\frac{TN}{FN+TN}$	96%
False Positive Rate	$\frac{FP}{FP+TN}$	7.6%
Recall	$\frac{TP}{TP+FN}$	84.9%

Several iterations of training, followed by calculating accuracy metrics, were conducted until satisfactory results were achieved. The accuracy of the detection model is determined, to a large extent, by the amount of training. It should be taken into account that training the model requires manual tagging and therefore is labour-intensive.

The impacts of green light extension events on the frequency of potentially unsafe crossings and vehicle delay for conflicting movements were investigated.

The total simulation period consists of 179 traffic signal cycles, each 90 seconds long. **The green light extension for VRUs late crossing events was activated in 15% of the cycles when in an additional 4% of the cycles, the extension was activated due to false alarm.** No False Negative events occurred at the end of pedestrian green period, meaning there were no events where VRUs did not get a required green extension. The resulting impact of the proposed control method is **a reduction from 15% to 0% in the frequency of unsafe crossings for vulnerable road users, showing better performances than the target value of 8%.** This might be attributed to the high percentage of True Positive detections and the reliability of the green extension algorithm. To minimize the situations in which the green extension was activated due to false alarm (4%), the False Negative detection ratio should be minimized.

In addition, an impact on conflicting vehicle movements was investigated. The green extension algorithm was implemented at the busiest pedestrian crossing at the intersection – pedestrian crossing "e" (please refer to Figure 19). The green extension comes at the expanse of vehicle signal group 5 and public transport signal group 2. When VRU is detected at the end of the

Copyright © 20222 by SPROUT.

pedestrian green, the end time of its signal stage is adjusted so that, under the assumption of lower crossing sped, there will be enough time to reach the other side safely. The list of possible green end time changes is presented in Table 13.

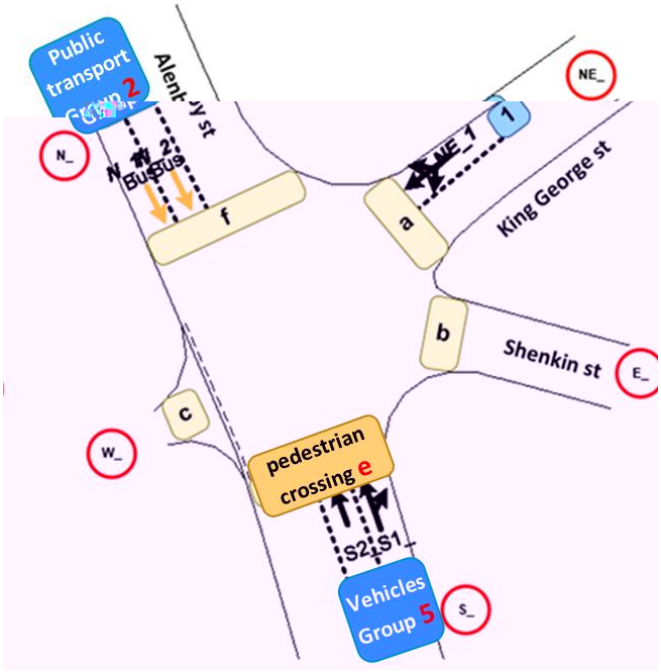


Figure 19. Intersection layout

The results show a negligible impact on bus and vehicle movements. The maximum delay for “vehicles group 5” is 2.59% (Table 4), less than the target KPI 5%. Two factors contributed to this outcome – low frequency of the required green extensions, as most pedestrians cross at the beginning of the green light period, and a very small additional duration of the required green extensions for VRUs.

Table 13. VRU signal stage End Time adjustments

VRU Detection Time (Cycle Second)	Original End Time	Adjust End Time
24	28	29
25	28	30
26	28	31
27	28	32
28	28	33

Copyright © 20222 by SPROUT.

Table 14. Average delay change due to VRU green extension

Signal Group	Baseline	With Pedestrian Green Extension	% change
2	20.88	21.42	2.59%
5	29.47	29.66	0.63%

Copyright © 20222 by SPROUT.

Table 15. USE CASE 3: KPI's

Indicator	Description	Value	Comments
Functional suitability	To what extent the algorithm: (1) Identifies VRU (2) Prioritizes VRU according to the specification defined.	84.9%	(1) Recall the proportion of all positive video detections that were classified correctly
		0% unsafe crossings	(2) Reduce frequency of unsafe crossings for VRU
Security	Degree to which the algorithm protects data		Security concerns were handled according to the regulations. No personal data, or any personal identification data was stored.
Usability	Achieve the specified goals with efficiency – **Delay of conflicting traffic**	Maximum delay - 2.6%	Conflicting traffic delays
Portability	Degree to which the algorithm is (1) transferable to other locations,	65%	(1) Identification model to be validated in the new location. Additional training might be required, depending on the angle of the camera towards the intersection. (2) The traffic light extension logic adjusted to the intersection characteristics.
	(2) to identify other types of VRU	75%	(2) Use the same identification model, however, should be trained and validated for the specific object

Copyright © 20222 by SPROUT.

Satisfaction	• perspective of traffic engineers/experts • stated preferences survey of road users	Estimation based on stakeholder's interviews 80%	Interviews with stakeholders revealed high levels of Satisfaction were expressed. The pilot is perceived as part of social equality measure for VRUs. Concerns included (1) request to expand the implementation to other types of vulnerabilities not addressed by the current pilot, and (2) concern regarding increased waiting times in other crosswalks.

3.3.4 Outcomes

This use case aimed to reduce unsafe crossing of VRU effectively with minimal impact on conflicting traffic. The VRU recognition model was trained, and accuracy measures were calculated until satisfactory detection results were achieved, i.e., recall measure ~ 85%.

The baseline data indicated that in 15%-20% of cycles, unsafe crossings of VRU occur. The simulation results showed that all unsafe crossings were detected, and pedestrians received green extensions preventing dangerous situations. The outcomes over-achieved the target of unsafe crossing in no more than 8% of cycles.

The impact of the algorithm in conflicting traffic was minimal. The maximum delays for conflicting traffic were 2.6%.

In addition to assessing the performances of the model, the use case implementation in a microsimulation environment contributed to the commitment of decision makers and politicians to wider implementation in real-world settings.

3.3.5 Policy-related and regulatory barriers

The initial plan of real-world implementation of this use case was cut-off due to regulation barriers related to lengthy approval procedures for demonstrations that involves applying new detection methods interfacing with real-time traffic control.

Aligning with two important policy measures, social inclusion of vulnerable inhabitants and locating pedestrians at the top of road users' hierarchy, the model's performance contributes to politicians' willingness to actually apply these policies, even if other traffic will be slightly impacted.

Copyright © 20222 by SPROUT.

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, The multi-actor, multi-criteria analysis methodology (MAMCA) for the evaluation of transport projects: Theory and practice, 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

Copyright © 20222 by SPROUT.

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.

Copyright © 20222 by SPROUT.

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 Tel Aviv, 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. The sections below give an overview of the identified problems and proposed policy solutions for the use case 3 of Tel-Aviv.

Table 16. T4.4: Tel-Aviv-Use case 3: identified problems and proposed solutions.

Problem encountered	How to minimize the negative impact (delays) imparted to other road users when vulnerable road users are prioritized (extended green to allow enough time to cross considering reduced walking speed) at crosswalks at signalized intersections.
Possible Solutions	Develop and apply a methodological approach to integrate vulnerable road users' priority strategies in the traffic signals logic
	Apply green extension only when required, e.g. late crossing start by the vulnerable road user
	Apply geometrical and physical changes to reduce crossing times
	Prioritize pedestrians in all crosswalks simultaneously (all crosswalks receive green at the same time)

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 use case three of the city of Tel-Aviv. To do this, the pilot partners 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:

- Government and infrastructure;
- Citizens;
- Cycling and public transport users' associations

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 the use case three of Tel-Aviv can be found below.

- Government and infrastructure;
    - Increased ease of crossing for pedestrian
    - Capacity of vulnerable pedestrians to cross
    - Reductions pf conflicts with PT
    - Reduction of conflicts involving pedestrians
    - Adjustability to varying needs at different times
    - Contribution to social inclusion
- Citizens;
    - Ease of crossing for pedestrians
    - Reduction in the number of traffic lights
    - Adjustability to varying needs at different times
- Biking and public transport users' associations.
    - Pedestrian safety
    - Level of public space accessibility
    - Reductions pf conflicts with PT
    - Contribution to social inclusion

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

Copyright © 20222 by SPROUT.

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.

Copyright © 20222 by SPROUT.

Table 17. T4.4 Use case 3: Experts evaluation.

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
Contribution to social inclusion	The situation as it is today: no prioritization of vulnerable road users at intersections. .	Vulnerable road users' priority strategies will be integrated in the traffic signal logic. Green extensions (=the signal being green for a prolonged period of time) will be applied only when required (for example if a vulnerable road user crosses late). Crossing times will be reduced by the application of geometrical and physical changes at crossings. Pedestrians at all crosswalks will be prioritized at the same time.	very postive	Contributing to social inclusion of vulnerable groups by providing a safer and more considerable environment, awareness to their needs, and prioritizing them.
Capacity of vulnerable pedestrians to cross			slightly positive	Might slightly improve the capacity of vulnerable pedestrians on specific crosswalks (extremely busy crosswalks).
Conflicts with PT			slightly positive	
Conflicts involving pedestrians			no change	
Adjustability to varying needs at different times			very postive	Dynamic traffic lights algorithm that can be adjustable and operate according to specified conditions and parameters
Pedestrian safety			very postive	Significant improvement of safety.

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
Level of public space accessibility			positive	Actual improvement of safety alongside the sense of safety in the public space.
Ease of crossing for pedestrians			slightly positive	A better sense of safety when crossing. No need to rush
Reduction in the number of traffic lights			slightly negative	Successful implementation might encourage using the algorithm in high-risk non-signalized intersections. (adding traffic lights and implementing the recognition and green extension)

Copyright © 20222 by SPROUT.

4.4 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 1. 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. The translation of the surveys was done between April 30 and May 18, 2021, and the surveys were launched on May 19, 2021.

4.5 Results

This section provides the result of the SIS analysis (steps 6 and 7).

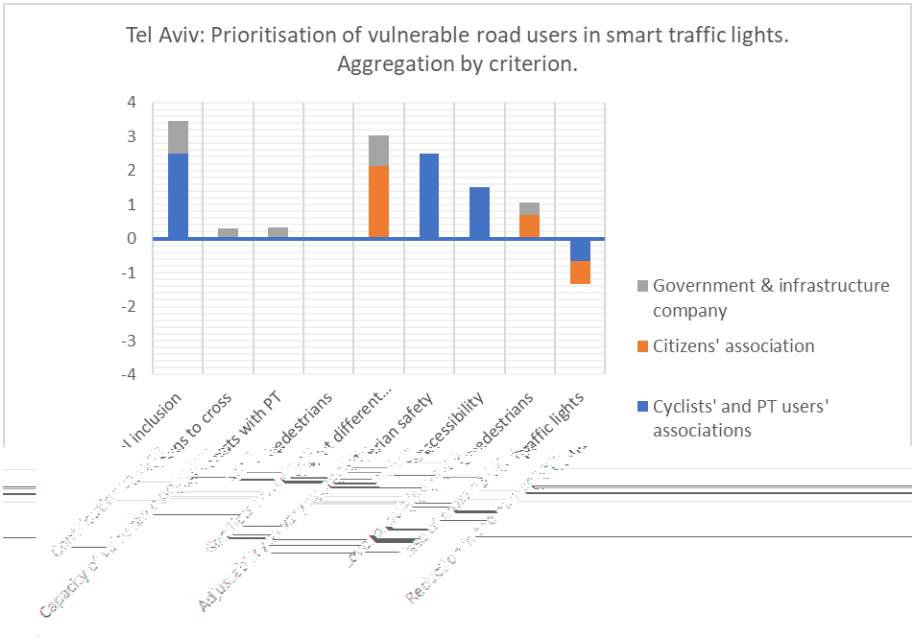


Figure 20. Regulations for Smart Traffic Lights. Aggregation by criterion.

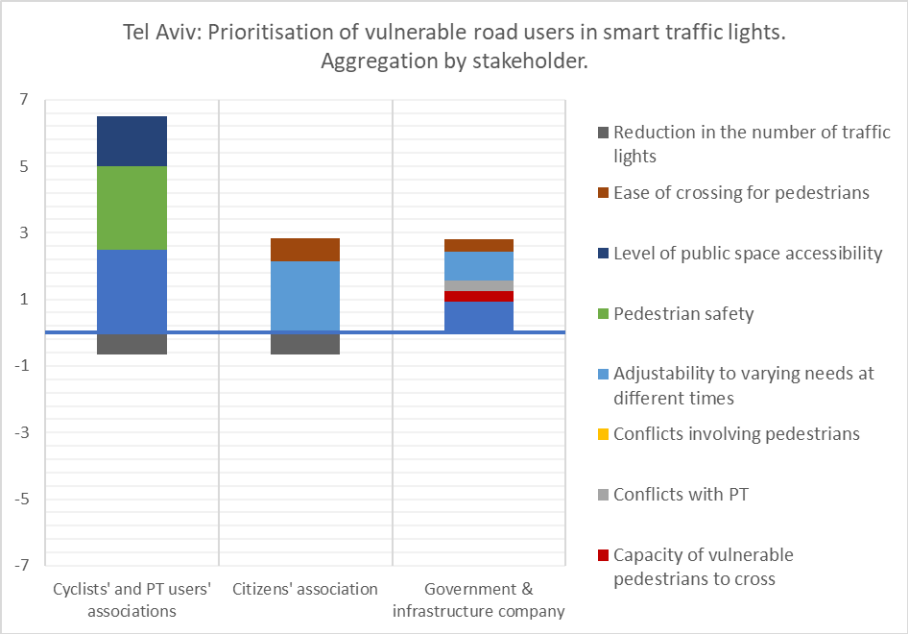


Figure 21. Regulations for Smart Traffic Lights. Aggregation by stakeholder.

Figure 20 and Figure 21 show the expected negative and positive impacts of the Tel Aviv pilot as compared to the current situation. While the current situation (smart traffic lights) is taken as a baseline, the pilot involves prioritisation strategies for vulnerable road users that will be integrated in the traffic signal logic. Green extensions (=the signal being green for a prolonged period of time) will be applied only when required (for example if a vulnerable road user crosses late). Crossing times will be reduced by the application of geometrical and physical changes at crossings. Pedestrians at all crosswalks will be prioritized at the same time.

As can be seen in Figure 20, ‘contribution to social inclusion’, ‘adjustability to varying needs at different times’ and ‘pedestrian safety’, are expected to be the most significant positive impacts, followed by ‘level of public space accessibility’ and ‘ease of crossing for pedestrians. The only negative impact is the increase in the number of traffic lights.

Figure 21 shows the distribution of positive and negative impacts over the different stakeholders. Here we see that for all stakeholders, impacts are generally considered positive, especially for the cyclists’ and public transport users’ associations.

4.6 Conclusion

Concluding from the analysis based on input from stakeholders, the suggested prioritisation strategies for vulnerable road users have largely positive impacts. The most important positive impacts are ‘contribution to social inclusion’ and ‘adjustability to varying needs at different times’. The only negative impact is an increase in the number of traffic lights. All stakeholders are affected positively by the project, although cyclists’ and public transport users’ associations are more positively affected. The increase in the number of traffic lights however does affect cyclists, PT users, and citizen associations somewhat negatively.

Copyright © 20222 by SPROUT.

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

Copyright © 20222 by SPROUT.

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

Copyright © 20222 by SPROUT.

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 Tel-Aviv 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.

- Traffic management experts from local authorities
- Traffic management experts from the private sector
- Project manager from the Transport Authority TLV municipality
- CEO of Tel Aviv living lab
- Representative from new mobility services company (only survey)
- Representative from transportation-oriented start-up (only survey)

Table 18. Alternative policy measures (PM): stakeholders involved and role.

Alternative policy response	Stakeholders involved and role
PM1: Support cooperation with data providers from the private sector to enhance data quality by supporting data fusion from multiple resources	• Traffic management experts from local authorities • Traffic management experts from the private sector

Copyright © 20222 by SPROUT.

Alternative policy response	Stakeholders involved and role
	• Project manager from the Transport Authority TLV municipality • CEO of Tel Aviv living lab
PM2: Provide clear measures for traffic data quality based on the application (traffic management, planning, etc.)	• Traffic management experts from local authorities • Traffic management experts from the private sector • Project manager from the Transport Authority TLV municipality • CEO of Tel Aviv living lab
PM3: Set agreements for data	• Traffic management experts from local authorities • Project manager from the Transport Authority TLV municipality
PM4: Define the data collection devices' maintenance policy (for example quick repair of identified damaged devices and periodic inspections)	• Traffic management experts from local authorities • Traffic management experts from the private sector • Project manager from the Transport Authority TLV municipality • CEO of Tel Aviv living lab

5.3.2 Set of alternative policy responses and interrelationships

Table 19 shows the most preferred policy measures included in the feasibility assessment and the interrelationship with the mobility solution:

Copyright © 20222 by SPROUT.

Table 19. Use case 1: Alternative policy measures (PM) and interrelationships.

	PM1: Support cooperation with data providers from the private sector to enhance data quality by supporting data fusion from multiple resources	PM2: Provide clear measures for traffic data quality based on the application (traffic management, planning, etc.)	PM3: Set agreements for data	PM4: Define the data collection devices' maintenance policy (for example quick repair of identified damaged devices and periodic inspections)
PM1: Support cooperation with data providers from the private sector to enhance data quality by supporting data fusion from multiple resources	X	Measures for traffic data quality are essential to successful partnership with data providers from the private sector and will enhance the public sector experience and benefits, when such cooperation occurs.	A framework of agreements will potentially ease the bureaucracy associated with PPP partnerships and streamline the related administrative procedures.	A clear maintenance policy might encourage long-term partnerships with data providers from the private sector, to ensure contentious benefits.
PM2: Provide clear measures for traffic data quality based on the application (traffic management, planning, etc.)	The increased need to involve data providers from the private sector to acquire data or collect data obligates unified formats and defined quality measures. Data quality measures become vital to enable data fusion and optimized outcomes from the overall data	X	To formulate any framework of agreements, the data quality measures should be clear. However, the specification of the data quality will be fine-tuned for each specific agreement according to the intended use of the data (e.g., real-time traffic management, long-term planning). These two measures complement each other to enhance the	Functioning data collection devices are essential to ensure that the data obtained meets minimal data quality requirements. However, there is no direct relationship between the maintenance policy and the definition of data quality measures.

	PM1: Support cooperation with data providers from the private sector to enhance data quality by supporting data fusion from multiple resources	PM2: Provide clear measures for traffic data quality based on the application (traffic management, planning, etc.)	PM3: Set agreements for data	PM4: Define the data collection devices' maintenance policy (for example quick repair of identified damaged devices and periodic inspections)
	collection procedures the authority performs.		effectiveness of new data collection procedures.	
PM3: Set agreements for data	Cooperation with the private sectors to collect data stimulates the need to set an agreement framework. Especially due to the surge of start-up companies offering data or devices, and various conceivable business models.	To formulate any framework of agreements, the data quality measures should be clear. However, the specification of the data quality will be fine-tuned for each specific agreement according to the intended use of the data (e.g., real-time traffic management, long-term planning). These two measures complement each other to enhance the effectiveness of new data collection procedures.	X	Maintenance policy might be relevant and included, if needed, in some of the framework of agreements.
PM4: Define the data collection devices' maintenance policy (for example quick repair of identified	The need for maintenance policy depends on the type of cooperation and the business model. It is	Data quality measures will dedicate the intensity and needs of devices maintenance.	Maintenance policy might be relevant and included, if needed, in some of the framework of agreements.	X

Copyright © 20222 by SPROUT.

	PM1: Support cooperation with data providers from the private sector to enhance data quality by supporting data fusion from multiple resources	PM2: Provide clear measures for traffic data quality based on the application (traffic management, planning, etc.)	PM3: Set agreements for data	PM4: Define the data collection devices' maintenance policy (for example quick repair of identified damaged devices and periodic inspections)
damaged devices and periodic inspections)	crucial when continuous data collection procedures are expected.			

Copyright © 20222 by SPROUT.

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 Tel Aviv pilot. Total of 25 stakeholders received the survey, and follow up calls were conducted to further elaborate about the questions and the policy measures.

An online workshop was scheduled twice for the second stage, with six stakeholders confirming their participation. However, due to COVID-19 affecting both participants and TLV pilot team, the workshops were twice postpended. An attempt to schedule the workshop for the third time, on short notice, failed due to the different schedules of each stakeholder. In order to accommodate the project timeline, individual interviews with stakeholders were conducted. Two persons from SPROUT team conducted each interview, representing a different point of view to stimulate the discussion.

In total 16 respondents participated in the Feasibility Survey. The structure of the respondents as well as their share is illustrated on Figure 22.

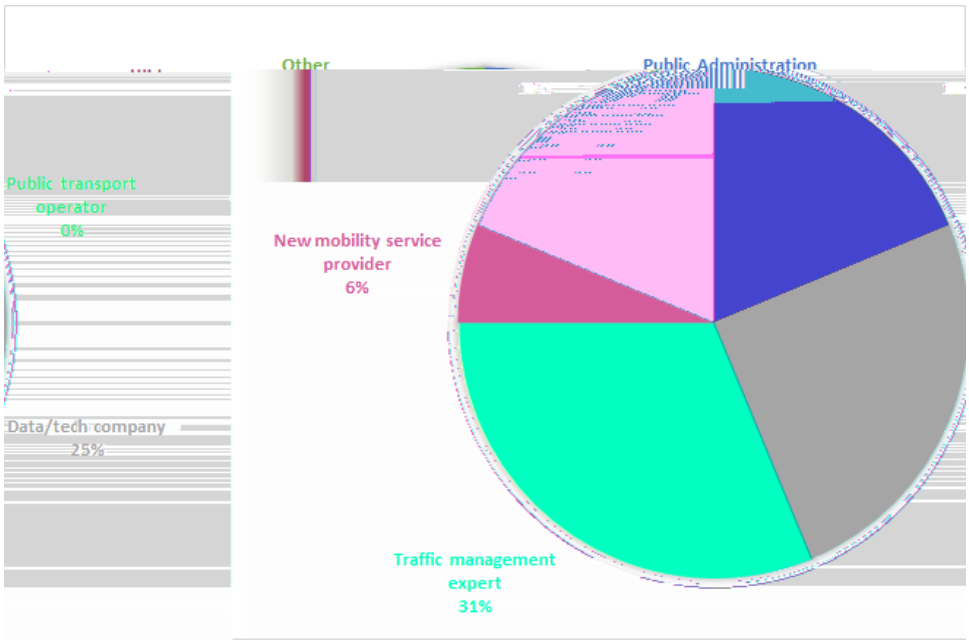


Figure 22. Use case 1 -Feasibility study: The structure and share of respondents.

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

Table 20. Use case 1: Implementation feasibility – Second stage: Responses to misalignments.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
PM1. Support cooperation with data providers from the private sector to enhance data quality by supporting data fusion from multiple resources	Financial: Indirect cost	What are the direct, indirect and fixed costs?	Depending on the business model. *"Will the data collection equipment be owned by the municipality or only the data itself?"; "Will the municipality own the data exclusively?*" Costs of providing infrastructure to allow installation of equipment Setting measures for data quality according to defined criteria and the designation of the data. Managing the security requirements according to characteristics of each database
		Will these costs be outbalanced by the benefits	Setting organizational procedures is necessary to outbalance the costs and derive the best benefits. This includes cooperation between different departments, data sharing, knowledge sharing. Ensure data quality and suitability to the specific designation, data quality measures, testing data reliability.
	Acceptability: Public administration	What are the reasons for unacceptability?	Stakeholders regarded the unacceptability to the barriers, rather than to unacceptance of the very cooperation with data providers from the private sector. Main barriers regarded: (1) A saturated market of data providers, lacking a standardized measure of data quality, (2) Various departments in the municipality with different or overlapping needs (3) Occasionally, the municipality units might not have the capabilities to utilize the data provided, (4) Data privacy concerns.
		Measures for overcoming/reducing the acceptability barriers	Two key measures: knowledge sharing and adapting the internal procedures. (1) Sharing information about the data availability and insights derived from the data between different departments (2)

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
			Enhance the municipality capabilities to handle the data or use outsourcing services (3) Set clear measures for cooperation with private data providers
PM2: Provide clear measures for traffic data quality based on the application (traffic management, planning, etc.)	Technical feasibility	What are the reasons for not being technically feasible?	Local authorities lack the capabilities to set data quality measures according to their designated usage, mainly the professional knowledge and skills needed
		Measures for making it feasible	Cooperation with other authorities sharing the same needs. Cooperation with independent entity, to provide the professional knowledge and skills. Using governmental resources. Using existing reliable data as ground truth
	Financial: Indirect Cost	What are the direct costs?	The authority should be the initiator in determining its requirements, data format, data quality measures, and how the reliability of the data will be assessed. Personnel costs to set the needs and data quality measures
		Will these costs be outbalanced by the benefits	Defining data quality metrics according to the purpose for which the data will be used and enforcing them will reduce cases where data acquired or collected doesn't provide their insights and designation. Reduce risk, outbalancing the cost and benefits.
	Financial operations and maintenance costs	What are the real operations and maintenance costs	Quality measures are not a one-time definition, and need to be adjusted (per time or event)
		Which party will be responsible for operations and maintenance costs	The responsibility for operations and maintenance costs should be for the local authorities and the data providers

Copyright © 20222 by SPROUT.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
		How this cost burden can be reduced	Cooperation with other authorities, Standardization of measurement, Uniform data format
		Will these costs be outbalanced by the benefits	Each update of the measures should be considered individually to assess the benefits.
PM3:Set agreements for data	Financial: indirect costs	What are the direct, indirect and fixed costs?	Identify the highlights of the legal aspects of such agreements, and the professional aspects and the specifications of each type of agreement.
		Will these costs be outbalanced by the benefits	creating a framework for each type of potential cooperation (business model) can ease the bureaucracy entailed with such agreements
	Financial operations and maintenance costs	What are the real operations and maintenance costs	Specifications for each individual agreement
		Which party will be responsible for operations and maintenance costs	The local authorities
		Will these costs be outbalanced by the benefits	Easing the bureaucracy entailed with each agreements
PM4 Define the data collection devices' maintenance policy (for example	Technical feasibility	What are the reasons for not being technically feasible?	An automatic procedure to real-time detection and alerting about failures is needed. Budget concerns
		Measures for making it feasible	Real-time dedicating and alerting mechanism, legal framework for devices maintenance, dedicated budget

Copyright © 20222 by SPROUT.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
quick repair of identified damaged devices and periodic inspections)	Financial: indirect and fixed costs	What are the direct, indirect and fixed costs?	Depending on the business model. “Total Risk” fixed monthly maintenance amount or payment per repair
		Will these costs be outbalanced by the benefits	If data is collected and processed regularly, the maintenance cost of the data collection devices will primarily be outbalanced by the benefits.

Copyright © 20222 by SPROUT.

5.3.4 User acceptance

The user acceptance questionnaire was distributed to relevant stakeholders. However, due to the specification of the use case and the type of the policy responses, stakeholders who are not familiar with both the technical and organizational context were not able to complete the questionnaire.

5.3.5 City-led policy response

The first mobility solution in Tel-Aviv reflects the clear path towards the city's ambition to merge the physical and digital worlds seamlessly. Although the Policy measures analysed may support the implementation feasibility and user acceptance, the misalignments encountered concern organic changes and best practices adoption to succeed in the digital transformation journey (Westerman et al., 2014). Embrace the collaborative culture and cooperative work, define knowledge sharing mechanisms, acknowledge a leader to coordinate the transition to the new paradigm, deploy standardization for sharing data (protocols, agreements), ensure data quality and maintenance operations, and capacity building.

In a nutshell, the digital transformation culture and the supportive policy measures will help overcome the costs justified by the enhanced policymaking decisions in designing and adapting the urban mobility needs to the real-time operations and foreseen needs.

5.4 Application to Tel-Aviv 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 3U) 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.

- Urban planner from Tel Aviv municipality
- Urban planner from the Ministry of Transportation and Road safety
- Representative from Israel Bike Association
- Urban planner from the private sector

Table 21. Use case 2_ Alternative policy measures (PM): stakeholders involved and role.

Alternative policy response	Stakeholders involved and role
PM1: Adoption of a structured methodological approach to mediate and prioritize competing needs and conflict resolution between road users/stakeholder needs	• Urban planner from Tel Aviv municipality • Urban planner from the Ministry of Transportation and Road safety • Representative from Israel Bike Association • Urban planner from the private sector
PM2: Define measures and guidelines for transportation planners to prioritize transport modes	• Urban planner from Tel Aviv municipality • Urban planner from the Ministry of Transportation and Road safety • Representative from Israel Bike Association • Urban planner from the private sector
PM3: Application of techniques for stakeholder involvement in decision-making process	• Urban planner from Tel Aviv municipality • Urban planner from the Ministry of Transportation and Road safety • Representative from Israel Bike Association • Urban planner from the private sector
PM4: Provision of adequate and safe public space for pedestrians and cyclists, consisting of wide, shaded sidewalks with urban furniture and protected bike-lanes	• Urban planner from Tel Aviv municipality • Urban planner from the Ministry of Transportation and Road safety • Representative from Israel Bike Association • Urban planner from the private sector

Copyright © 20222 by SPROUT.

Copyright © 2022

Table 22. Use case 2: Alternative policy measures (PM) and interrelationships.

	PM1: Adoption of a structured methodological approach to mediate and prioritize competing needs and conflict resolution between road users/stakeholder needs	PM2: Define measures and guidelines for transportation planners to prioritize transport modes	PM3: Application of techniques for stakeholder involvement in decision-making processes	PM4: Provision of adequate and safe public space for pedestrians and cyclists, consisting of wide, shaded sidewalks with urban furniture and protected bike-lanes
PM1: Adoption of a structured methodological approach to mediate and prioritize competing needs and conflict resolution between road users/stakeholder needs	X	There is no direct relationship between these two policy measures.	The willingness to incorporate stakeholders' opinions into the decision-making processes, intensifies the need for a methodological approach to mediate and prioritize competing needs and conflict resolution between road users/stakeholder needs.	There is no direct relationship between these two policy measures.
PM2: Define measures and guidelines for transportation planners to prioritize transport modes	There is no direct relationship between these two policy measures.	X	Stakeholders' needs should be considered and taken into account when defining measures and guidelines for transportation planners to prioritize transport modes.	Provision of adequate and safe public space for pedestrians and cyclists should be one of the main pillars of the guidelines for transportation planners

	PM1: Adoption of a structured methodological approach to mediate and prioritize competing needs and conflict resolution between road users/stakeholder needs	PM2: Define measures and guidelines for transportation planners to prioritize transport modes	PM3: Application of techniques for stakeholder involvement in decision-making processes	PM4: Provision of adequate and safe public space for pedestrians and cyclists, consisting of wide, shaded sidewalks with urban furniture and protected bike-lanes
PM3: Application of techniques for stakeholder involvement in decision-making processes	A structured methodology will support and enhance the outcomes of stakeholders' involvement processes and provide a clear framework to incorporate stakeholders' opinions into the decision-making processes.	Two different approaches can be implemented in stakeholder involvement procedures, either follow the guidelines for transportation planners to prioritize transport modes or investigate beyond the guidelines to better meet stakeholders' needs.	X	The perception of how adequate and safe public space for pedestrians and cyclists should be, might vary among different groups of stakeholders. Stakeholders' involvement in decision-making processes will help resolve conflicts and adapt the public space to the needs.
PM4: Provision of adequate and safe public space for pedestrians and cyclists, consisting of wide, shaded sidewalks with urban furniture and protected bike-lanes	There is no direct relationship between these two policy measures.	Provision of adequate and safe public space for pedestrians and cyclists should be one of the main pillars of the guidelines for transportation planners	The perception of how adequate and safe public space for pedestrians and cyclists should be, might vary among different groups of stakeholders. Stakeholders' involvement in decision-making processes will help resolve	X

Copyright © 20222 by SPROUT.

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 Tel Aviv pilot. Total of 18 stakeholders received the survey and follow up calls were conducted to further elaborate about the questions and the policy measures.

An online workshop was scheduled twice for the second stage, with four stakeholders confirming their participation. However, due to COVID-19 affecting both participants and TLV pilot team, the workshops were twice postpended. An attempt to schedule the workshop for the third time, on short notice, failed due to the different schedules of each stakeholder. In order to accommodate the project timeline, individual interviews with stakeholders were conducted. Two persons from SPROUT team conducted each interview, representing a different point of view to stimulate the discussion.

In total 12 respondents participated in the Feasibility Survey. The structure of the respondents as well as their share is illustrated on Figure 23

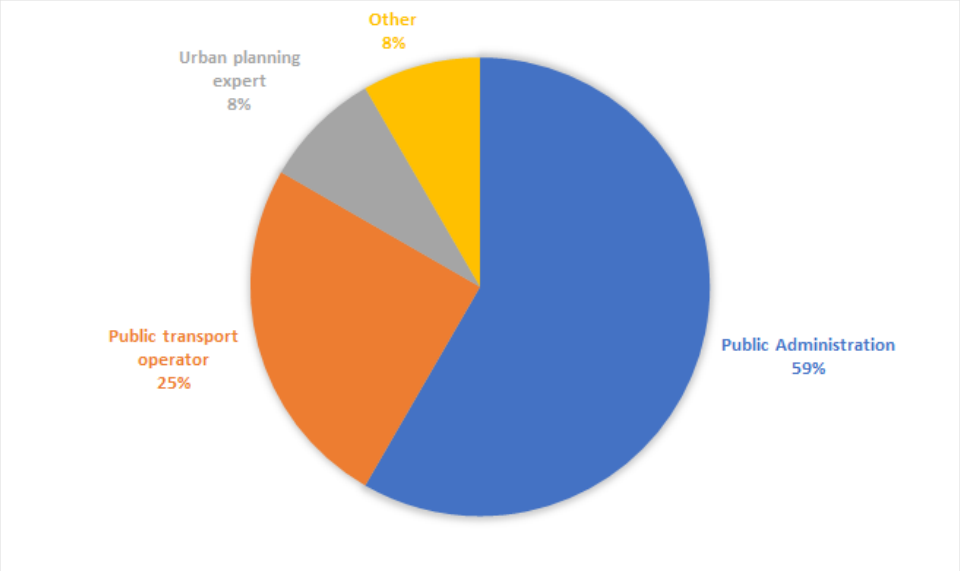


Figure 23. Use case 2 -Feasibility study: The structure and share of respondents.

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 20 contains the relevant questions for PM implementation, risk identification, analysis and mitigation in Tel Aviv Pilot. Column four includes a summary of the responses collected during the workshop. Annex 3 includes complete response

Table 23. 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. Adoption of a structured methodological approach to mediate and prioritize competing needs and conflict resolution between road users/stakeholder needs	Acceptability: Public administrations and Public transport operator	Why is PM1 technically unacceptable?	The perception is that public involvement promotes prioritizing pedestrians' and cyclists' needs. Public transport operators tend to believe that these procedures might harm their interests. Concerns that the methodology will replace the existing decision-making process and neutralize personal and professional judgment. Public administrations' primary concern is safety, and they aren't flexible about safety measures.
		How to overcome the gap?	Implement new conflict resolution principles. Encourage openness to major changes in the public sphere design.
	Administrative operability	What are the reasons for inoperability?	Multi-steps methodology. Perceived as a sophisticated process to be implemented. Should be used only to resolve very specific conflicts.
		Measures for overcoming/reducing the operability barriers	Automation of some of the procedures. Creating an online panel of inhabitants interested in participating in surveys/focus groups.
PM2: Define measures and guidelines for transportation planners to prioritize transport modes	Technical feasibility	What are the reasons for not being technically feasible?	Complicated lengthy process. Requires multidisciplinary knowledge.
		Measures for making it feasible	A clear policy of the road user's hierarchy. Pedestrians at the top of the hierarchy, followed by cyclists, then public transport, and last private vehicles. (execution and not only statements)
	Financial indirect and costs	What are the direct, indirect and fixed costs?	Personnel (skilled professionals) and research costs

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
		Will these costs be outbalanced by the benefits	Doubts that the costs will outbalance the benefits. Developing the measures to cover all urban scenarios encounters comprehensive research and involvement of policymakers.
		Which party will be responsible for operations and maintenance costs	Local authorities with cooperation with the ministry of transportation
		How this cost burden can be reduced	Cooperation between authorities
		Will these costs be outbalanced by the benefits	Doubts that the costs will outbalance the benefits. Developing the measures to cover all urban scenarios encounters comprehensive research and involvement of policymakers.
	Political feasibility/Local business	What are the reasons for unfeasibility?	The hierarchy between road users is transparent; however not consistently implemented. Getting into detailed measures and guidelines entails border research
PM4: Provision of adequate and safe public space for pedestrians and cyclists, consisting of wide, shaded sidewalks with urban furniture and protected bike-lanes	Technical feasibility	What are the reasons for not being technically feasible?	Existing narrow streets. Existing street infrastructure (sewage, drainage, trees, electricity) relocation of infrastructure is costly and requires the consent of all relevant stakeholders.
		Measures for making it feasible	Sidewalks and cycle paths at the expense of reducing lanes and parking for private vehicles
	Financial indirect costs	What are the direct, indirect and fixed costs?	Infrastructure relocation costs. Congestion costs as a result of reduced capacity for private vehicles.

Copyright © 20222 by SPROUT.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
		Will these costs be outbalanced by the benefits	Benefits to measure in terms of increased quality of life, health measures, environmental advantages.

Copyright © 20222 by SPROUT.

5.4.4 User acceptance

Figure 24 shows the structure and share of respondents of the user acceptance tests for the use case 2 in the city of Tel Aviv. There were 12 participants.

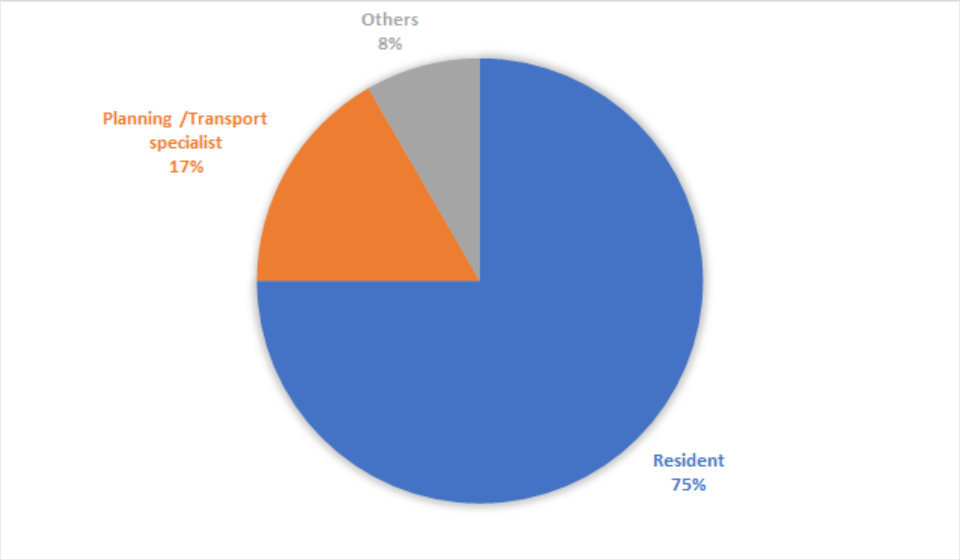


Figure 24. Use case 2 -User acceptance study: The structure and share of respondents.

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. However, the participants feel there is a lack of awareness of policy action regarding PM2 and PM3 (Table 24).

Table 24. Use case 2: User acceptance - Second stage: Responses to misalignments

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Response
PM2: Defining guidelines and metrics for transportation planners to prioritize transport modes	Awareness of policy action	How to increase the awareness of the policy action of PM2?	Engage all relevant stakeholders in the formulation process
PM3: Application of techniques for stakeholder involvement in decision-making processes	Awareness of policy action	How to increase the awareness of the policy action of PM3?	Demonstrate (to decision-makers) the potential of successful stakeholders involvement process to reveal synergies and conflicts.

5.4.5 City-led policy response

Public transport operators and public administration considered “PM1: Adoption of a structured methodological approach to mediate and prioritize competing needs and conflict resolution between road users/stakeholder needs" as unacceptable. Furthermore, the stakeholders that responded to the survey thought there is a lack of administrative operability to adopt this policy measure to support the use case 2. The instruments to make this supportive policy measure feasible and acceptable are new policy measures based on building conflict resolution guidelines and the automation of citizens participatory process to collect their feedback as online panels.

Regarding “PM2 Define measures and guidelines for transportation planners to prioritize transport modes”, the surveyors assessed it as not politically, financially and technically feasible. The lengthy process, the lack of personal skills and research costs are the main reasons that could be overcome with the cooperation with the ministry of transport and improved coordination. Furthermore, there are doubts that the potential research costs may justify the benefits.

The stakeholders involved did not identify any feasibility factor regarding “PM3: Application of techniques for stakeholder involvement in the decision-making process”. However, they believe there is a lack of awareness of policy action of this policy measure could be overcome emphasizing meaningful input of the stakeholders into the decision-making process.

Regarding “PM4: Provision of adequate and safe public space for pedestrians and cyclists, consisting of wide, shaded sidewalks with urban furniture and protected bike lanes”, the technical unfeasibility and indirect cost are linked. The relocation of existing infrastructure is costly and requires the consent of all the relevant stakeholders. The mechanism to increase technical feasibility is continuous with the trend of reducing space for private cars. In any case, the social and environmental benefits justify this policy measure.

In summary, PM1 and PM2 may increase the complexity of this methodology. However, the identification of the reasons for misalignments and solutions to overcome them help reinforce the message from Use case 1. Coordination, cooperation and personal skills are the foundation to support the future digital user-centric mobility based on co-creation methodologies. PM4 is not technically and financially feasible, but the benefits may justify the implementation of this supportive policy measure. Finally, PM3 is the one that may support the implementation of the methodology for cases when reaching an agreement among the different parties is tremendously challenging.

5.5 Application to Tel-Aviv pilot: use case 3

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.

5.5.1 Set of alternative policy responses and stakeholders involved and role

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

- Traffic management experts from local authorities

- Traffic management experts from the private sector
- Transportation planner from local authority
- Representative of organization supporting people with disabilities
- Representative from public transportation operator (only survey)
-

Table 25. Use case 3: Alternative policy measures (PM): stakeholders involved and role.

Alternative policy response	Stakeholders involved and role
PM1: Develop and apply a methodological approach to integrate vulnerable road users priority strategies in the traffic signal logic	• Traffic management experts from local authorities • Traffic management experts from the private sector • Transportation planner from local authority • Representative of organization supporting people with disabilities
PM2: Apply green extension only when required e.g. late crossing start by the vulnerable road user	• Traffic management experts from local authorities • Traffic management experts from the private sector • Transportation planner from local authority
PM3: Grant local authorities the option to examine and apply pilots for innovative traffic signals methodologies (such as novel detectors)	• Traffic management experts from local authorities • Traffic management experts from the private sector • Transportation planner from local authority
PM4: Political commitment to prioritize vulnerable road users safety at signalized intersections	• Traffic management experts from local authorities • Traffic management experts from the private sector • Transportation planner from local authority • Representative of organization supporting people with disabilities

5.5.2 Set of alternative policy responses and interrelationships

Table 19 shows the most preferred policy measures included in the feasibility assessment and the interrelationship with the mobility solution:

Copyright © 20222 by SPROUT.

Table 26. Use case 3: Alternative policy measures (PM) and interrelationships.

	PM1: Develop and apply a methodological approach to integrate vulnerable road users priority strategies in the traffic signal logic	PM2: Apply green extension only when required e.g. late crossing start by the vulnerable road user	PM3: Grant local authorities the option to examine and apply pilots for innovative traffic signals methodologies (such as novel detectors)	PM4: Political commitment to prioritize vulnerable road users safety at signalized intersections
PM1: Develop and apply a methodological approach to integrate vulnerable road users priority strategies in the traffic signal logic	X	These two measures complement each other. Applying green extension only when needed will decrease the impact of prioritizing vulnerable road users need on other road users by minimizing the delay of conflicting traffic. Minimal impact on conflicting traffic help also to tackle objections from other stakeholders.	Local authorities need to examine and apply pilots for innovative traffic signals methodologies requiring less complex and lengthy approval procedures. Without the option for real-world pilots (yet in a controlled environment), the technological capabilities will not be fully utilized.	political commitment to prioritize vulnerable road users safety need is prerequisite to any implementation priority strategies in real-world
PM2: Apply green extension only when required e.g. late crossing start by the vulnerable road user	These two measures complement each other. Applying green extension only when needed will decrease the impact of prioritizing vulnerable road users need on other road users by minimizing the delay of	X	Local authorities need to examine and apply pilots for innovative traffic signals methodologies requiring less complex and lengthy approval procedures. Without the option for real-world pilots, the technological capabilities will not be fully utilized. The	political commitment to prioritize vulnerable road users safety need is prerequisite to any implementation priority strategies in real-world

	conflicting traffic. Minimal impact on conflicting traffic help also to tackle objections from other stakeholders.		more the local authorities can apply these technologies, the more they can optimize the performances.	
PM3: Grant local authorities the option to examine and apply pilots for innovative traffic signals methodologies (such as novel detectors)	Local authorities need to examine and apply pilots for innovative traffic signals methodologies requiring less complex and lengthy approval procedures. The technological capabilities, without the option for real-world pilots will not be fully utilized.	Local authorities need to examine and apply pilots for innovative traffic signals methodologies requiring less complex and lengthy approval procedures. The technological capabilities, without the option for real-world pilots will not be fully utilized.	X	No direct relationship between these two policy measures
PM4: Political commitment to prioritize vulnerable road users safety at signalized intersections	Availability of approved and reliable technology potentially encourages policymakers to commit to prioritizing vulnerable road users needs.	Reducing the impact on conflicting traffic provides one more incentive to policymakers and ease handling with other stakeholders' objections.	No direct relationship between these two policy measures	X

Copyright © 20222 by SPROUT.

5.5.3 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 3 in Tel Aviv pilot. Total of 22 stakeholders received the survey and follow up calls were conducted to further elaborate about the questions and the policy measures.

An online workshop was scheduled twice for the second stage, with seven stakeholders confirming their participation. However, due to COVID-19 affecting both participants and TLV pilot team, the workshops were twice postpended. An attempt to schedule the workshop for the third time, on short notice, failed due to the different schedules of each stakeholder. In order to accommodate the project timeline, individual interviews with stakeholders were conducted. Two persons from SPROUT team conducted each interview, representing a different point of view to stimulate the discussion. In total 10 respondents participated in the Feasibility Survey. The structure of the respondents as well as their share is illustrated on Figure 25.

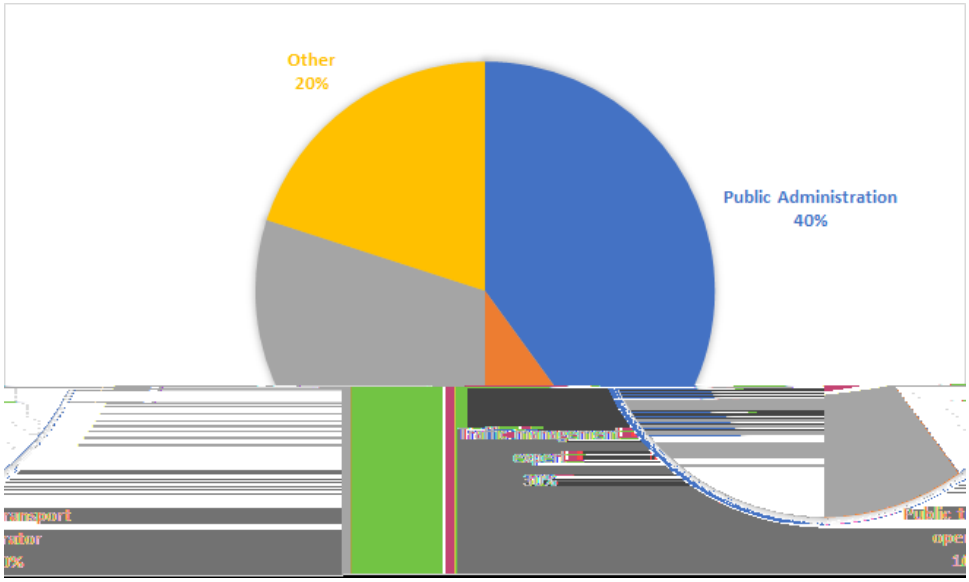


Figure 25. Use case 3 -Feasibility study: The structure and share of respondents.

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

Table 27. Use case 3: Implementation feasibility - Second stage: Responses to misalignments.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
PM1. Develop and apply a methodological approach to integrate vulnerable road users priority strategies in the traffic signal logic	Financial indirect costs	What are the direct, indirect and fixed costs?	Costs of the development and training of identification model. Development of the traffic lights logic according to the intersection characteristics. Indirect costs: delays for other road users
		Will these costs be outbalanced by the benefits?	Benefits - Reducing VRU unsafe crossing and social inclusion measures. Intersection characteristics and the frequency of unsafe events could serve as considerations if benefits outbalance the costs
	Financial feasibility/operations and maintenance costs	What are the real operations and maintenance costs?	Costs of computing power entailed with real-time operation of the identification model, and the recording equipment
		Which party will be responsible for operations and maintenance costs?	The local authorities
		How this cost burden can be reduced?	Cooperation between authorities, sharing capabilities
		Will these costs be outbalanced by the benefits	Benefits - Reducing VRU unsafe crossing and social inclusion measures. Intersection characteristics and the frequency of unsafe events could serve as considerations if benefits outbalance the costs
	Acceptability: Public transport operator	What are the reasons for unacceptability?	Delays for public transportation. Reduce the efficiency of public transportation prioritization in signalized intersections
		Measures for overcoming/reducing the acceptance barriers	Demonstrate the negligible delays to PT
PM2: Apply green extension only when required	Technical feasibility	What are the reasons for not being technically feasible?	Regulatory barriers. Objections from other stakeholders
		Measures for making it feasible	Address regulations requirements. Raise awareness

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
e.g. late crossing start by the vulnerable road use	Financial indirect costs	What are the direct, indirect and fixed costs?	Direct: Development of the extension algorithm. Indirect: delays of conflicting traffic.
		Will these costs be outbalanced by the benefits?	Benefits - Reducing VRU unsafe crossing and social inclusion measures. Intersection characteristics and the frequency of unsafe events could serve as considerations if benefits outbalance the costs
	Financial operations and maintenance costs	What are the real operations and maintenance costs?	The main costs include operating and maintaining the recording equipment (cameras) from the intersections and the computing power needed for the identification model
		Which party will be responsible for operations and maintenance costs?	The local authorities
		How this cost burden can be reduced?	Optimization of the performances of the identification model, use recording equipment designated for other purposes.
		Will these costs be outbalanced by the benefits?	Benefits - Reducing VRU unsafe crossing and social inclusion measures. Intersection characteristics and the frequency of unsafe events could serve as considerations if benefits outbalance the costs
PM3: Grant local authorities the option to examine and apply pilots for innovative	Financial fixed costs	What are the direct, indirect and fixed costs?	An agreement that the curTm13pidel(c)-5(ui)5(de)4endh u-9(n a)-(an)4()-360(en)4 - 2) Exh(i)5(de)4atam(v)6(en)4(ten)4(t)-10[(v)6(u)-dan b-445((p)-9

Copyright © 20222 by SPROUT.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Workshop responses
traffic signals methodologies (such as novel detectors)	maintenance costs	How this cost burden can be reduced?	(4) Central administration capabilities to scrutinize the technology and the experiment settings might be better than the local authorities experiments they need to deal with. To be able to conduct pilot experiments, local authorities will need to handle bureaucracy, the procedures of proper administration, tackle all professional aspects, including safety, and handle the overall responsibility of the risks associated with the experiments. The impact might be conservatism and avoidance to conduct pilots to avoid additional costs and the responsibility entailed in using it.
		Will these costs be outbalanced by the benefits?	
PM4: Political commitment to prioritize vulnerable road users safety at signalized intersections	Technical feasibility	What are the reasons for not being technically feasible?	The gap between statements about policy and the implementation
		Measures for making it feasible.	To promote the perception that prioritizing public transportation is prioritizing the passengers rather than the vehicles
	Financial: direct, indirect and fixed costs	What are the direct, indirect and fixed costs?	Costs are not relevant for the political commitment. They are relevant for the implementation which were mentioned in the PM's
		Will these costs be outbalanced by the benefits?	
	Financial operations and maintenance costs	What are the real operations and maintenance costs?	
		Which party will be responsible for operations and maintenance costs?	
		How this cost burden can be reduced?	
		Will these costs be outbalanced by the benefits	
		What are the reasons for unacceptability?	Concerns to cause delays for PT

Copyright © 20222 by SPROUT.

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	

Copyright © 20222 by SPROUT.

5.5.4 User acceptance

Figure 26 shows the structure and share of respondents of the user acceptance tests for the use case 3 in the city of Tel Aviv. There were 8 participants.

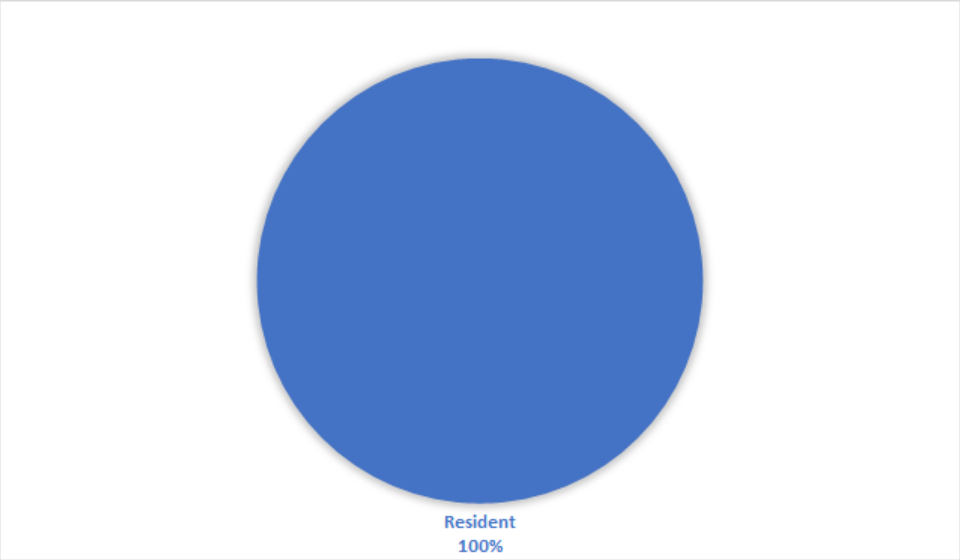


Figure 26. Use case 3 -User acceptance study: The structure and share of respondents.

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. PM2 is considered unaffordable and analysed during the second stage of the T4.5 methodology (Table 28).

Table 28. Use case 3: User acceptance - Second stage: Responses to misalignments

Policy measure	Dimension Criteria	Questions for PM implementation risk identification, analysis and mitigation	Response
PM2: Implementation of extending the duration of the green only when necessary (for example, a vulnerable pedestrian who started crossing late)	Awareness of policy action	How to increase the awareness of the policy action of PM2?	Applying the algorithm in a simulation environment, and assessing the impact on traffic.

5.5.5 City-led policy response

Use case 3 is one the most controversial Tel-Aviv mobility solution and requires supportive policy measures to overcome the real-implementation concerns. There is not only one supportive policy measure but a combination of several ones. The ones examined during the final steps of the pilot implementation may help overcome these barriers. However, they require additional mechanisms to tackle the reasons of unfeasibility and unacceptance. As in the two previous cases, the mobility solution and the package of policy measures require specific labour skills, sharing knowledge, coordination efforts, leading capabilities, collaborative and cooperative culture. Indeed, the future city trends that prioritize active and shared urban mobility should be considered the main reason to handle the public transport barriers.

Moreover, the benefits of the simulation testing environments and the neglectable impact on the traffic flows should be visualized to demonstrate the benefits to the stakeholders' concerns of reducing the urban traffic efficiency.

6 Summary and outlook

The three use cases of Tel Aviv's pilot built upon the transition in the transportation system in the city due to the construction of a new LRT system. An initial plan of a Metropolitan Metro Network was recently approved. In the long term, both transportation systems will revolutionize the transit network as well as the public sphere. The city will continue to undergo massive construction, road closures, capacity reduction, and revolutionizing of streets cross-sections during the transition period. Several outcomes and lessons learned during the project will be applied in the medium-term during the construction of the Metropolitan Metro Network, and for the long term after the two-transportation system are running. This includes

1. A recommendation to integrate the travellers' trajectory patterns dashboard into Tel-Aviv municipality's traffic division decision-making processes regarding traffic re-arrangement during LRT and Metro lines construction period,
2. Integrating outcomes of use case 2 into future masterplans, such as the National Metro Master plan currently being formulated, which includes principles for the re-allocation of public space and the 5500 Tel-Aviv Master Plan update, as well as improving various stakeholders' involvement in local decision-making processes,
3. Integrating VRU prioritization at intersections into road regulations as part of the Equal Rights Law for people with disabilities, and
4. Discussion to adopt policy measures and internal work procedures to support the implementation of the mobility solutions.

Use case 1 presented the potential benefits derived from understanding travel patterns to optimize traffic management strategies, and reduce delays associated with road closure due to construction. The decision support tool that was developed and presented to decision-makers demonstrated the capability to simplify complex geo-spatial data and present it to decision-makers and traffic experts in an accessible approach that fits their needs and enables data-driven decision process.

Alongside technological challenges, this use case uncovered that the current administrative and policy measures might impede large-scale implementation. Fusion of data from multiple sources will potentially enhance the accuracy of the outcomes. Cooperation with the private sector is needed to fuse data, alongside a1reets cross

Copyright © 20222 by SPROUT.

COVID-19 restrictions affected the data collection methodology, which was steered from revealed preferences approach through field experiment and observations to stated preference approach through an online survey. Outcomes showed the consensus between pedestrians and cyclists regarding the importance of separation means and the vital role that trees provide for the pleasantness and attractiveness of the public sphere.

Professionals' evaluation of the methodology was controversial. The multi-stages and iterative process to achieve the outcomes considered complex and too resource-consuming by some experts, while other professionals view the results as very interesting and eye-opening, providing a genuine opportunity to integrate road users' preferences into decision making processes and perceiving the value from this as significant for the municipality. Nevertheless, all the professionals involved acknowledge the need to methodologically incorporate public-engagement processes outcomes into decision-making.

Even though Use case 3 is aligned with two important policy measures that Tel Aviv municipality considers of high importance; Social inclusion of vulnerable inhabitants and locating pedestrians at the top of road users' hierarchy, additional supportive policy measures are required to overcome the real-implementation concerns.

Due to regulatory barriers and the lengthy and complex approval procedure to implement new detection methods interfacing with real-time traffic control, the application was conducted in a simulation environment by the Israeli Ministry of Transport. Outcomes revealed satisfactory outcomes of the VRU detection model (Recall value of ~ 85%), reducing unsafe crossings of VRU due to late crossing start by VRU to 0%, and the maximum delay of conflicting traffic was neglectable (2.5%). These outcomes showed the efficiency of the extension algorithm and encouraged decision-makers to align the political commitment to prioritize pedestrians and social inclusion of vulnerable citizens and the actual implementation of the policy, addressing the concerns regarding the impact on other traffic.

The initial specification of the three use cases were to tackle strategic level (use case 1), tactic level (use case 2), and operational level (use case 3). Despite the changes in the detailed specifications of the use cases due to COVID-19 restrictions and other regulatory barriers, all three use cases provided valuable outcomes, lessons were learned to enable large-scale implementation and policy measures to support implementation were identify and discussed.

The municipality off Tel Aviv intends to incorporate some of the outcomes into regular work-procedures and future masterplans. Policy measures will be further discussed, and the relevant ones will be adopted.

Copyright © 20222 by SPROUT.

References

Agarwal, A., Gupta, S., & & Singh, D. K. (2016). Review of optical flow technique for moving object detection. *2016 2nd International Conference on Contemporary Computing and Informatics (IC3I)*, 409-413.

Aghaabbasi, M., Moeinaddini, M., Shah, M. Z., Asadi-Shekari, Z., & & Kermani, M. A. (2018). Evaluating the capability of walkability audit tools for assessing sidewalks. *Sustainable cities and society*, 475-484.

Crawford, F., Watling, D. P., & Connors, R. D. (2018). Identifying road user classes based on repeated trip behaviour using Bluetooth data. *Transportation research part A: policy and practice*, 55-74.

Hauser, J. R., & & Clausing, D. (1988). The house of quality.

Holmes, T. P., Adamowicz, W. L., & Carlsson, F. (2017). Choice experiments. In T. P. Holmes, W. L. Adamowicz, & F. Carlsson, *A primer on nonmarket valuation* (pp. 133-186). Springer, Dordrecht.

Macharis, C., De Witte, A., & Ampe, J. (2009). The multi-actor, multi-criteria analysis methodology (MAMCA) for the evaluation of transport projects: Theory and practice. *Journal of Advanced transportation, 43*(2), 183-202.

Macharis, C., Turcksin, L., & Lebeau, K. (2012). Multi actor multi criteria analysis (MAMCA) as a tool to support sustainable decisions: State of use. *Decision Support Systems, 54*(1), 610–620. doi:https://doi.org/10.1016/j.dss.2012.08.008

Tan, K. C., Xie, M., & & Chia, E. (1998). Quality function deployment and its use in designing information technology systems. *International Journal of Quality & Reliability Management*.

te Boveldt, G. (2019). All aboard? A new evaluation approach for institutionally complex transport projects. . Brussels: VUBPress. doi: 10.1016/S0262-4079(17)31776-1.

Copyright © 20222 by SPROUT.

Annexe 1: 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

Copyright © 20222 by SPROUT.

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

Copyright © 20222 by SPROUT.

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

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

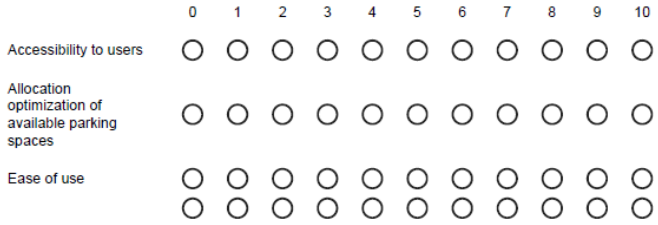
Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).

	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	○	○	○	○	○	○	○	○	○	○	○

Copyright © 20222 by SPROUT.

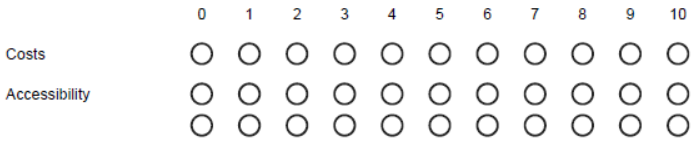
Infrastructure

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).



Business Incubator

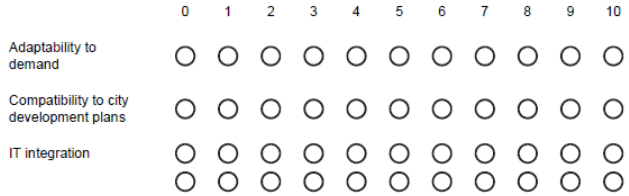
Below you can see the criteria that you indicated as being important for a successful project. Please indicate how important you feel each criterion is for you, on a scale from 0 to 10 (0 = not important at all, 10 = extremely important).



Copyright © 20222 by SPROUT.

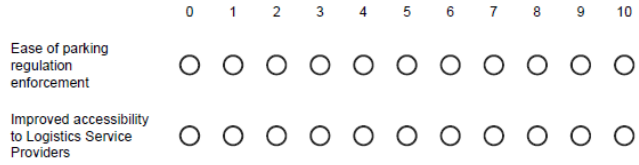
School

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).



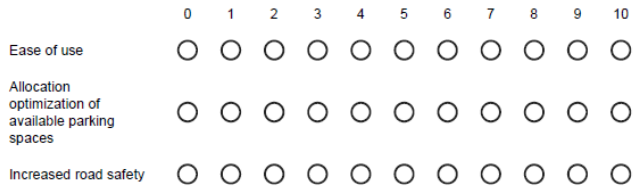
Entrepreneurs and companies

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).



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).



Copyright © 20222 by SPROUT.

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

Copyright © 20222 by SPROUT.

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.

Copyright © 20222 by SPROUT.

Annexe 2: T4.5 Implementation feasibility

Use case 1: Data-driven analysis and visualization of current travel behavior mobility patterns using Bluetooth detectors data - Mobility solution description

Technical feasibility dimension aims at assessing the pool of resources that each of the alternative policy responses requires (Figure 27). As PM2 and PM4 were not evaluated, they were reconsidered during the second step of the methodology.

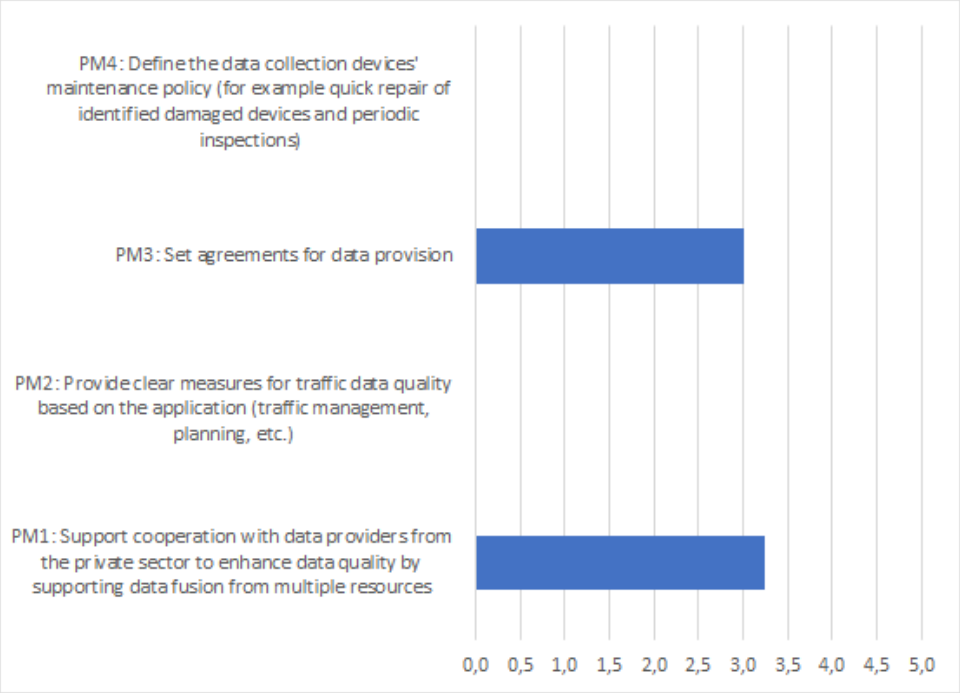


Figure 27. Use case 1 - Assessment of policy measures against the technical feasibility dimension

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 28 - Figure 33) the following conclusions are derived:

1. From the aspect of indirect costs, all the PM2, PM3 and PM4 require an additional analyses. From the aspect of fixed costs PM4 require additional analysis. PM2 and PM3 require an additional analysis for the operations and maintenance
2. From the aspect of indirect benefits, all policy measure will produce positive outcomes.

Copyright © 20222 by SPROUT.

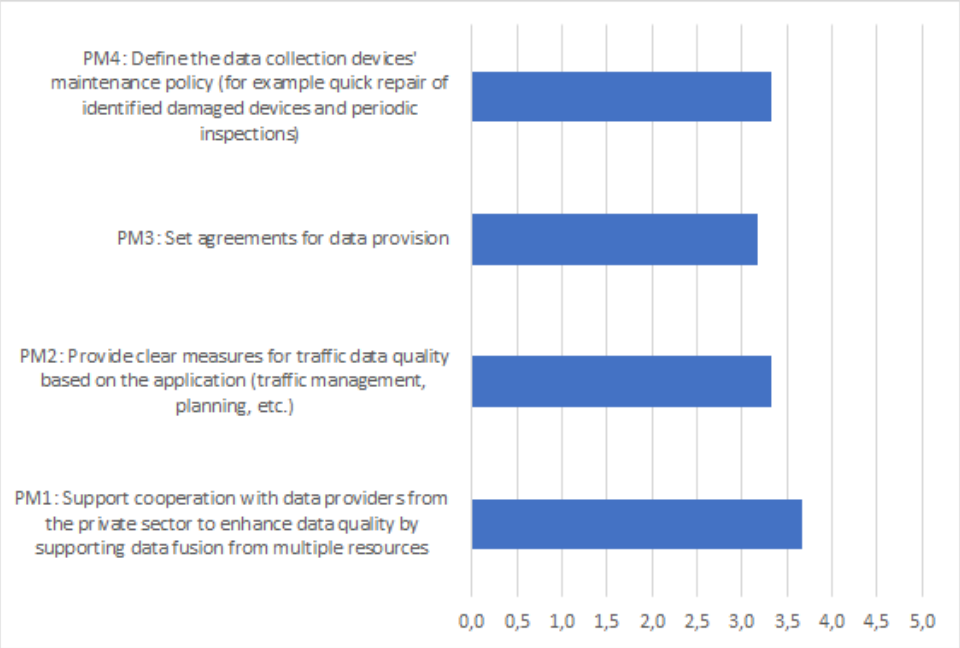


Figure 28. Use case 1 -Assessment of policy measures against the financial feasibility dimension: Direct costs

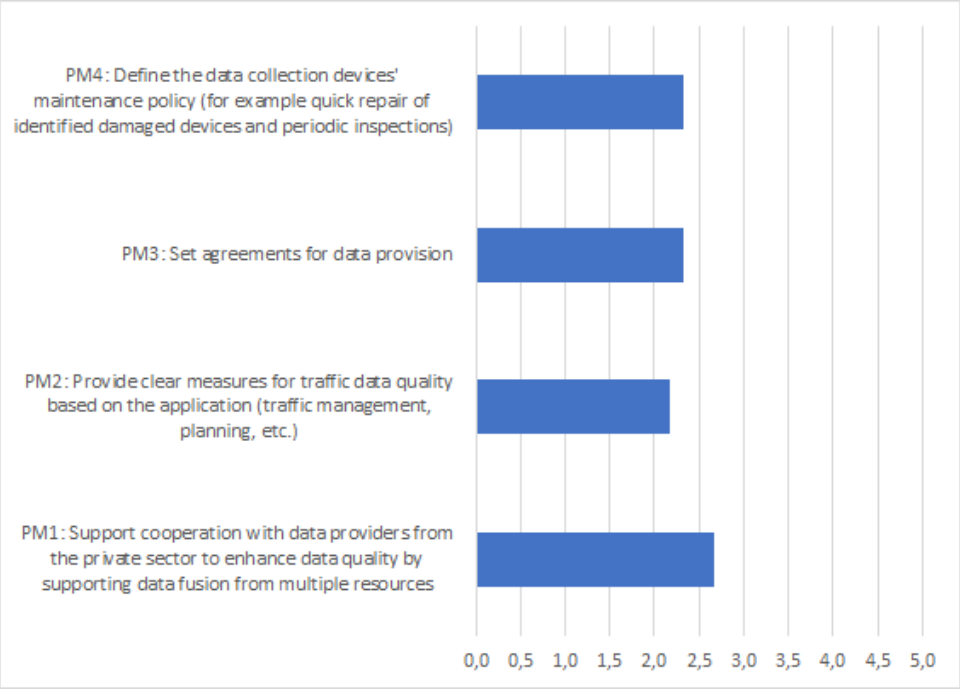


Figure 29. Use case 1 -Assessment of policy measures against the financial feasibility dimension: Indirect costs

Copyright © 20222 by SPROUT.

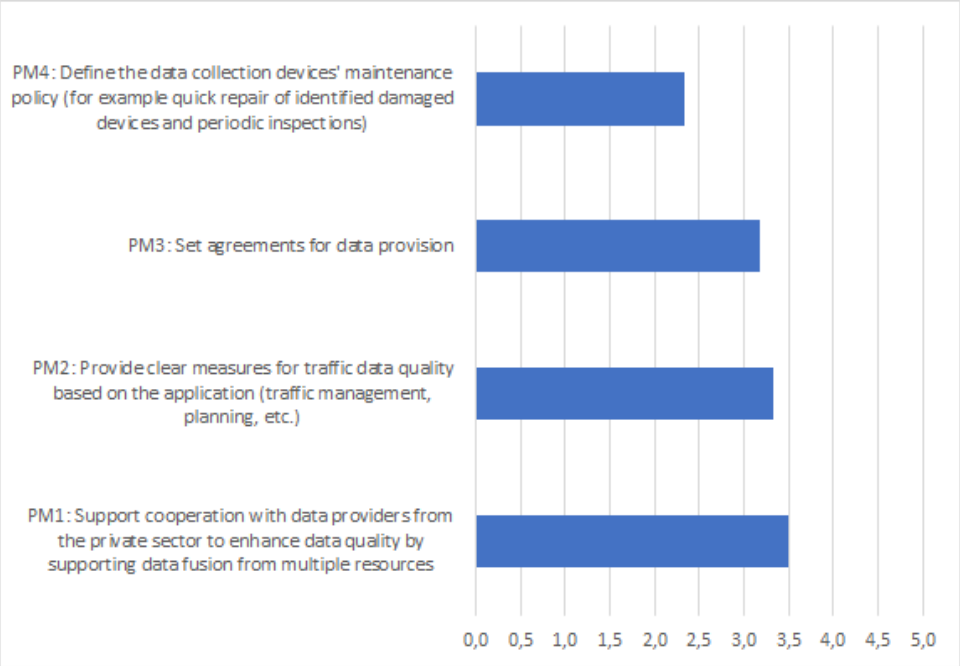


Figure 30. Use case 1 -Assessment of policy measures against the financial feasibility dimension: Fixed costs

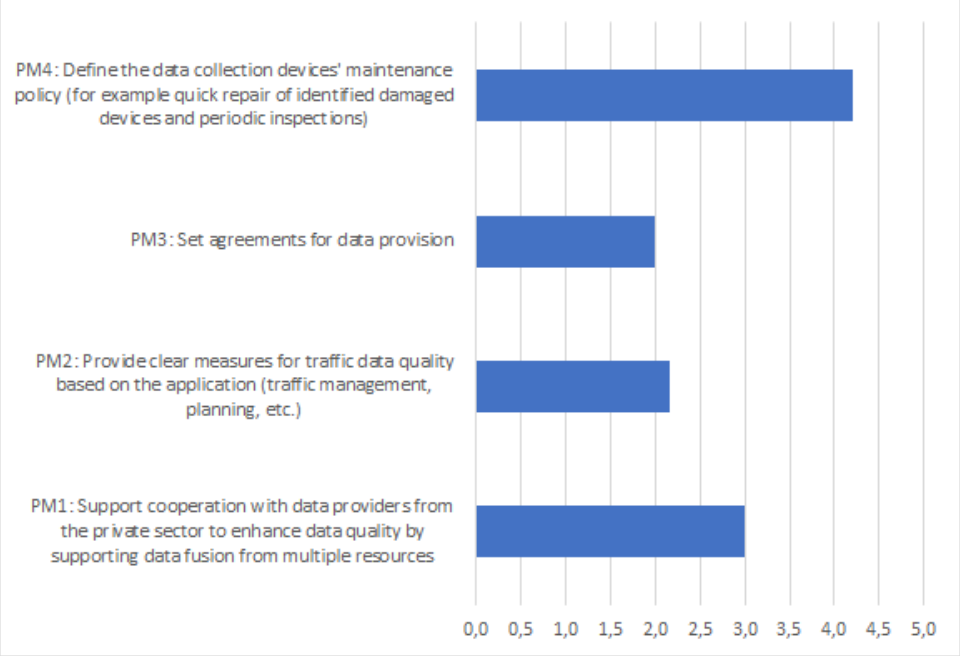


Figure 31. Use case 1 -Assessment of policy measures against the financial feasibility dimension: Operations and maintenance costs

Copyright © 20222 by SPROUT.

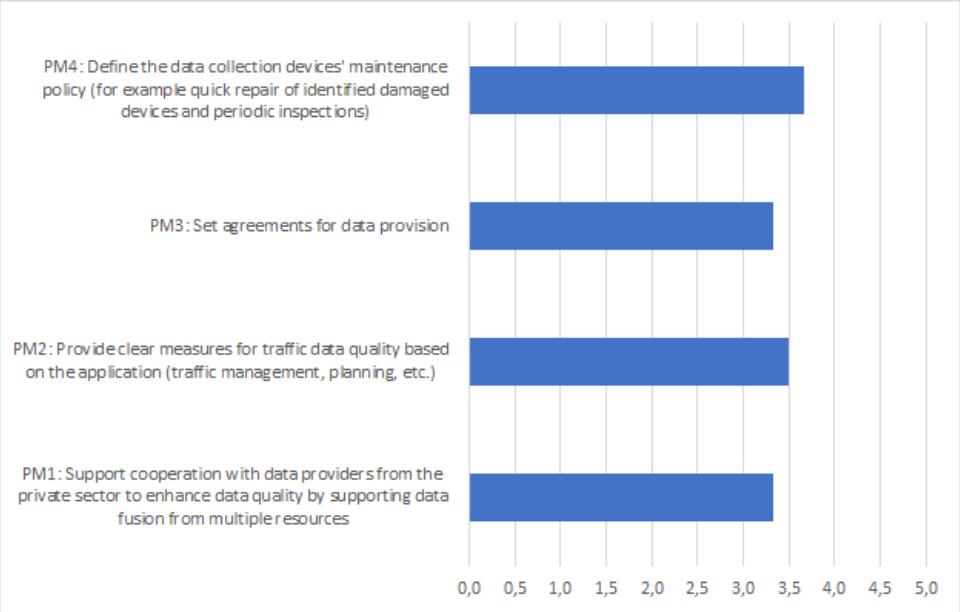


Figure 32. Use case 1 -Assessment of policy measures against the financial feasibility dimension: Direct benefits

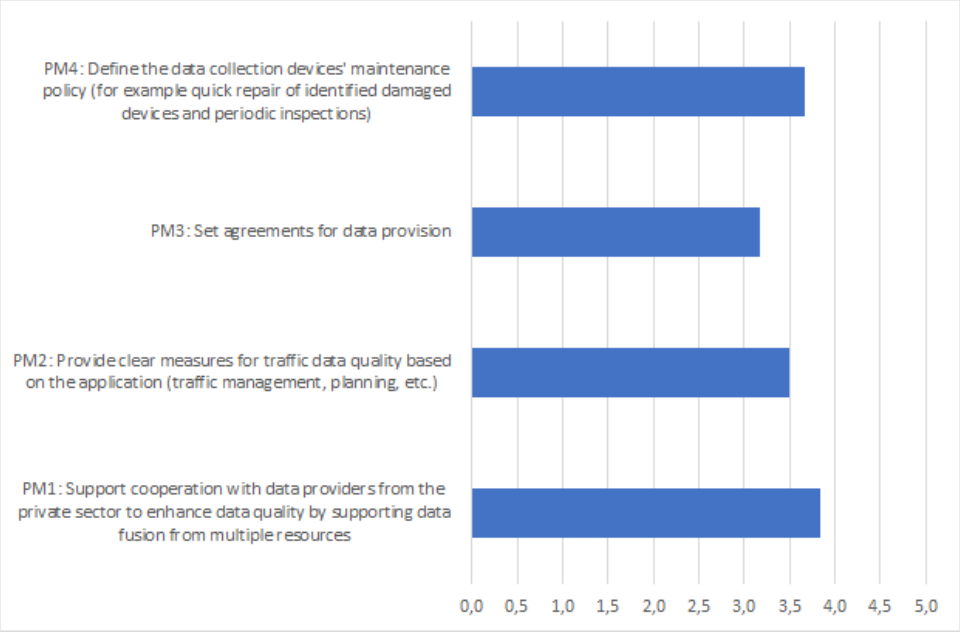


Figure 33. Use case 1 -Assessment of policy measures against the financial feasibility dimension: Indirect benefits

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 except PM1 evaluated by Public administration (this requires an additional analyses)

Copyright © 20222 by SPROUT.

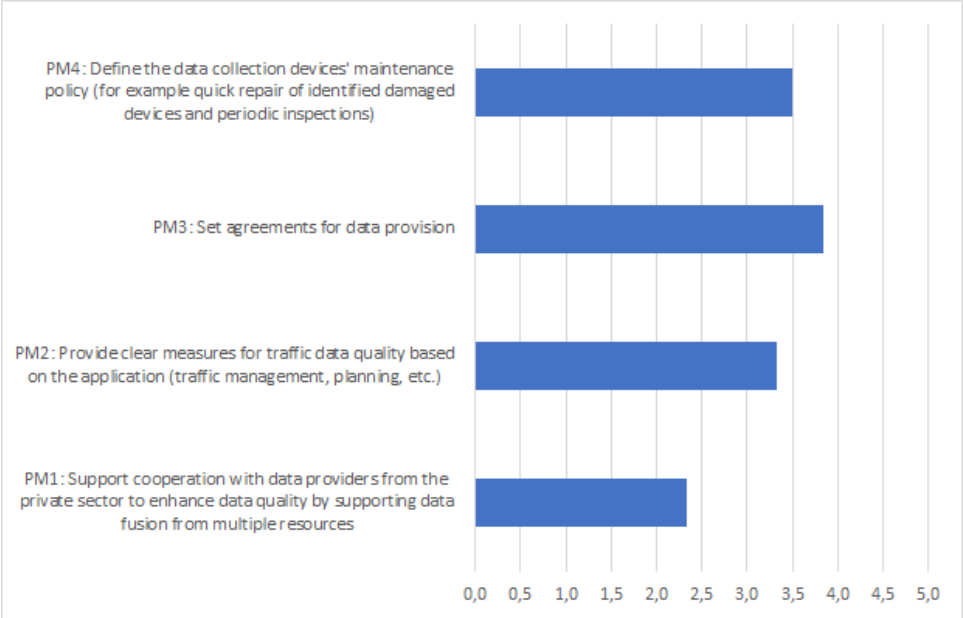


Figure 34. Use case 1 -Acceptability of alternative policy measures from the aspect of Public Administration.

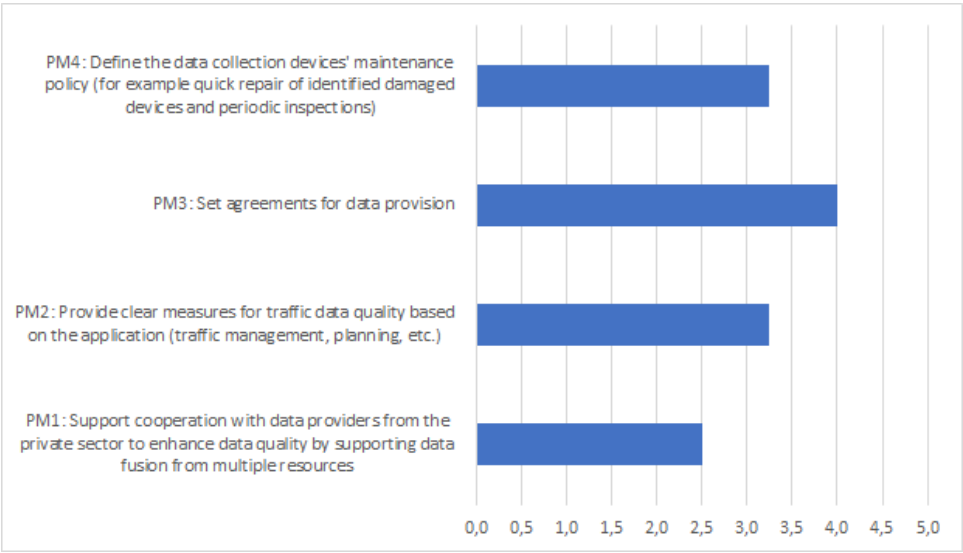


Figure 35. Use case 1 -Acceptability of alternative policy measures from the aspect of Public transport operator.

Copyright © 20222 by SPROUT.



Figure 36. Use case 1 -Acceptability of alternative policy measures from the aspect of Traffic management expert

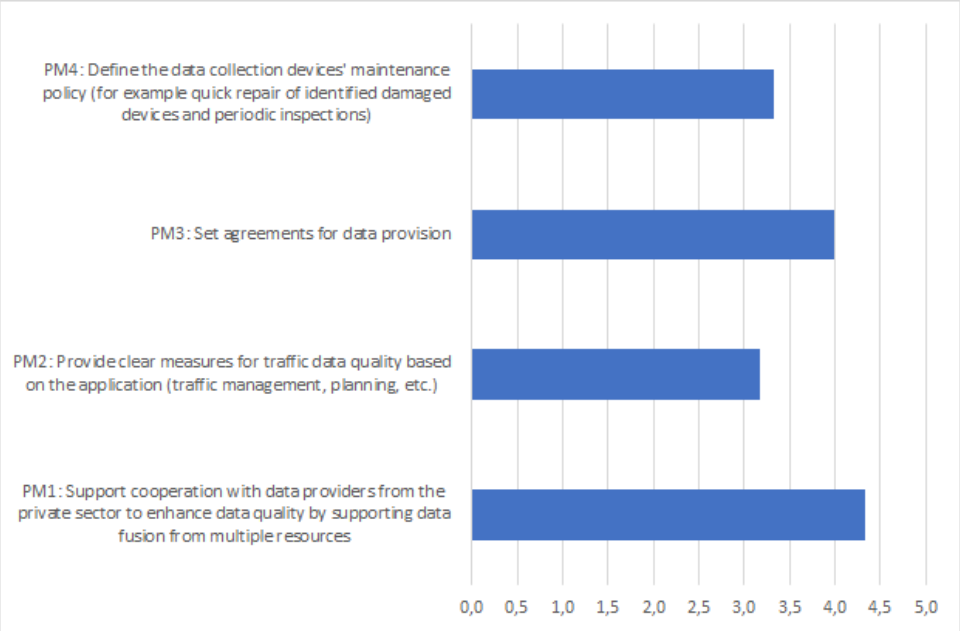


Figure 37. Use case 1 -Acceptability of alternative policy measures from the aspect of Data/ Tech Company

Copyright © 20222 by SPROUT.

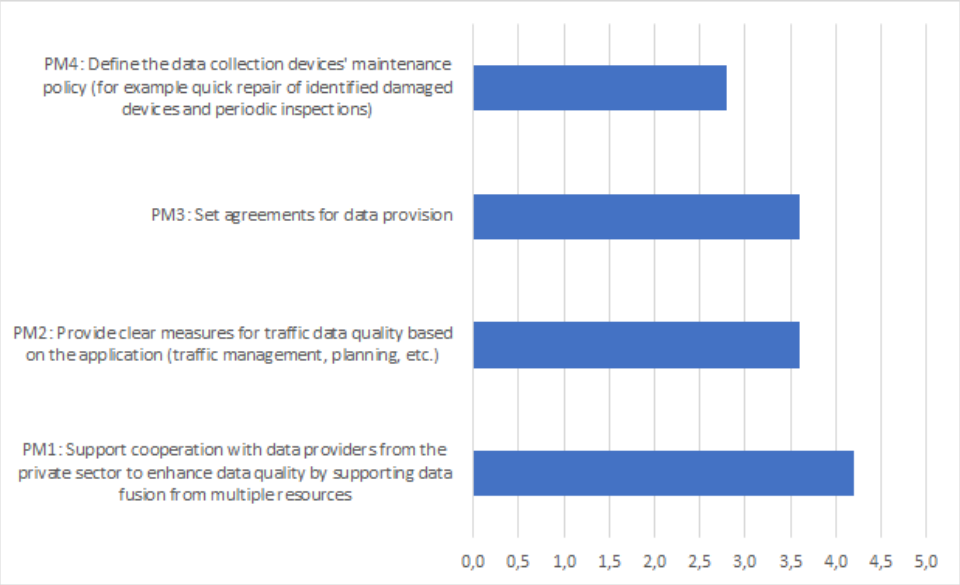


Figure 38. Use case 1 - Acceptability of alternative policy measures from the aspect of New mobility service operator.

Administrative operability and capability are the main criteria for assessment of policy measures against the political feasibility. (Figure 39 - Figure 40)



Figure 39. Use case 1 -Assessment of policy measures against the political feasibility dimension: Administrative operability

Copyright © 20222 by SPROUT.

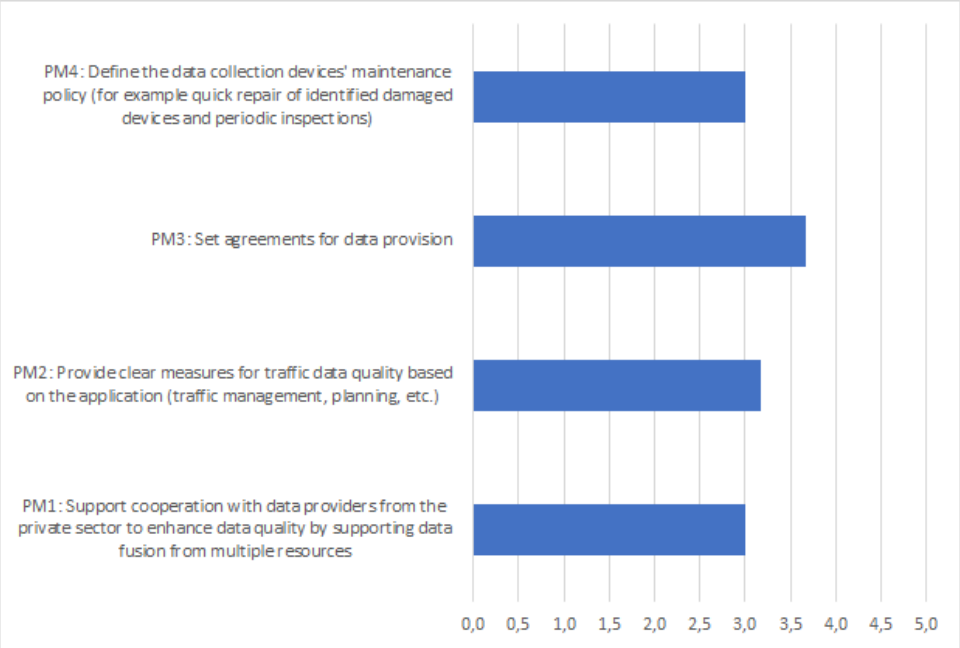


Figure 40. Use case 1 -Assessment of policy measures against the political feasibility dimension: Administrative capability

Copyright © 20222 by SPROUT.

Use case 2: Re-allocating the public sphere - balance between liveability and capacity - Mobility solution description

Technical feasibility dimension aims at assessing the pool of resources that each of the alternative policy responses requires (Figure 41).

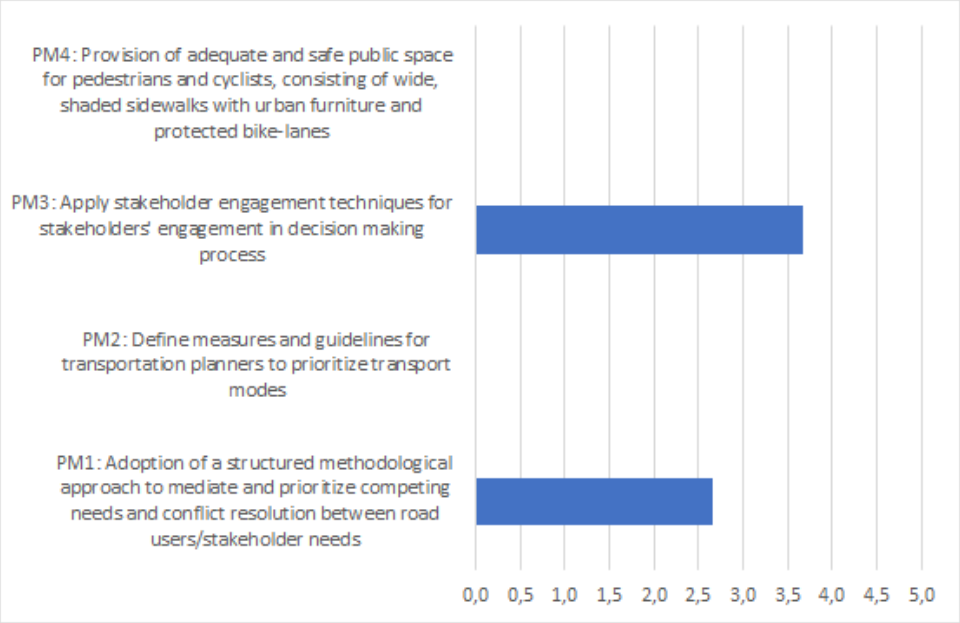


Figure 41. Use case 2-Assessment of policy measures against the technical feasibility dimension

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 28 - Figure 33) the following conclusions are derived:

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

Copyright © 20222 by SPROUT.

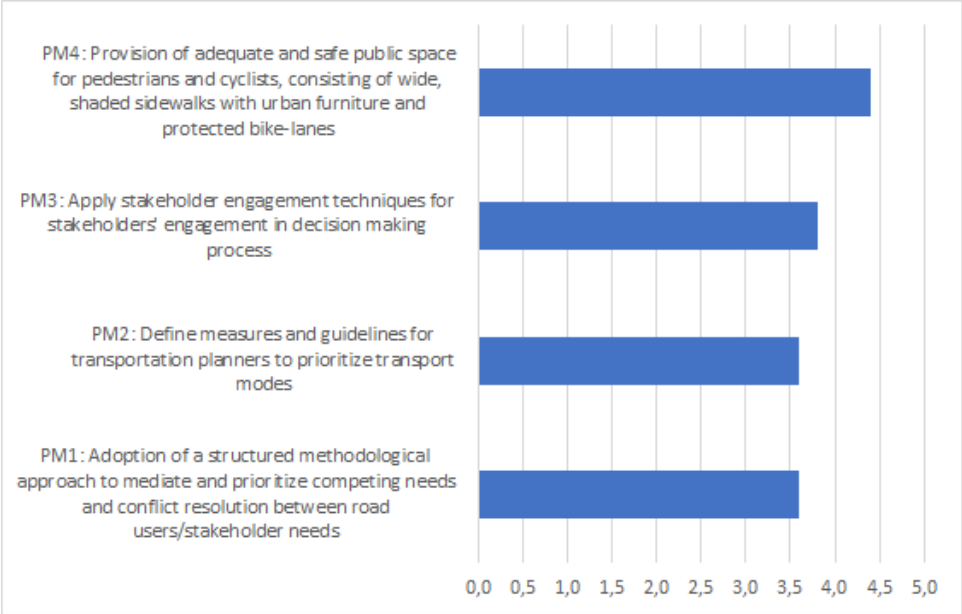


Figure 42. Use case 2-Assessment of policy measures against the financial feasibility dimension: Direct costs

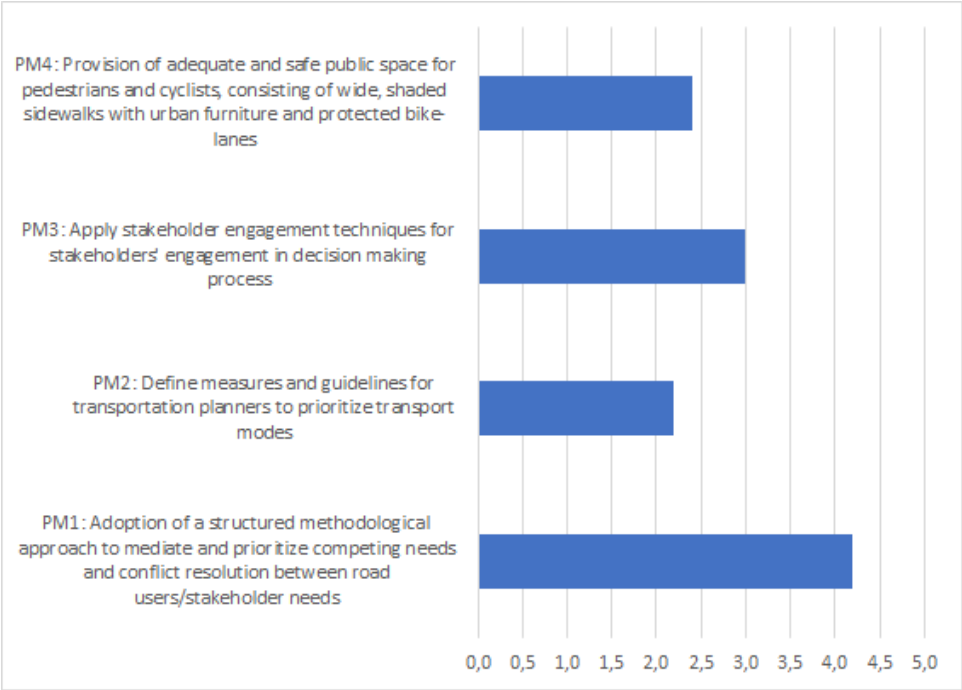


Figure 43. Use case 2- Assessment of policy measures against the financial feasibility dimension: Indirect costs

Copyright © 20222 by SPROUT.

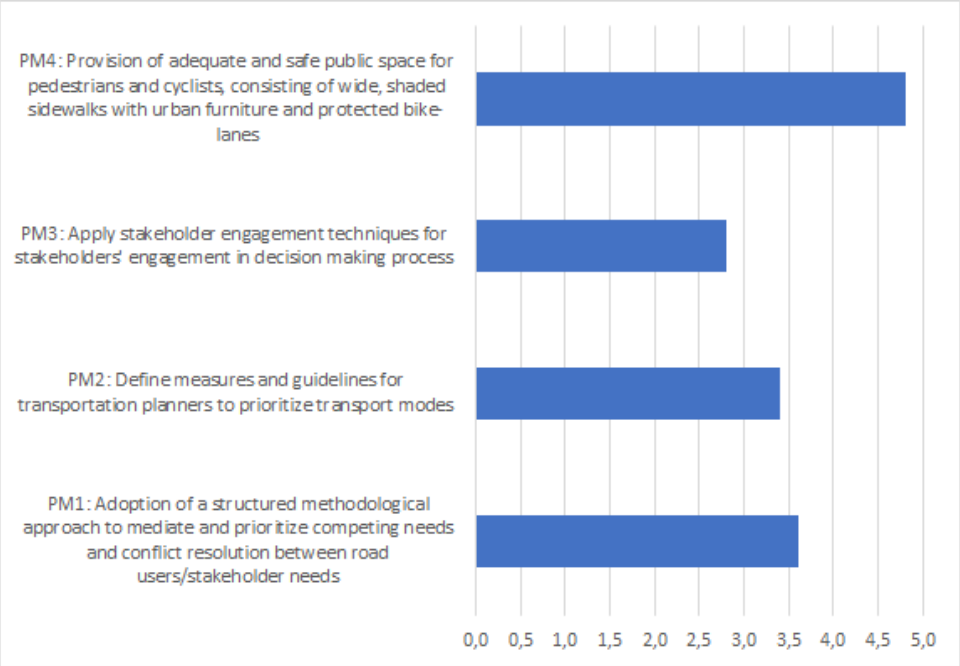


Figure 44. Use case 2-Assessment of policy measures against the financial feasibility dimension: Fixed costs

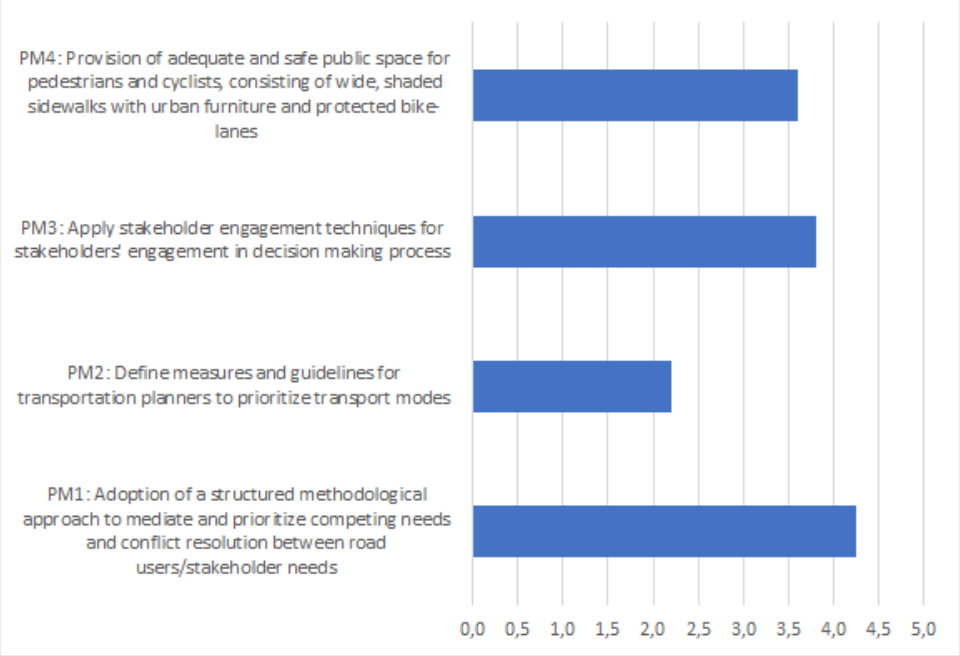


Figure 45. Use case 2-Assessment of policy measures against the financial feasibility dimension: Operations and maintenance costs

Copyright © 20222 by SPROUT.

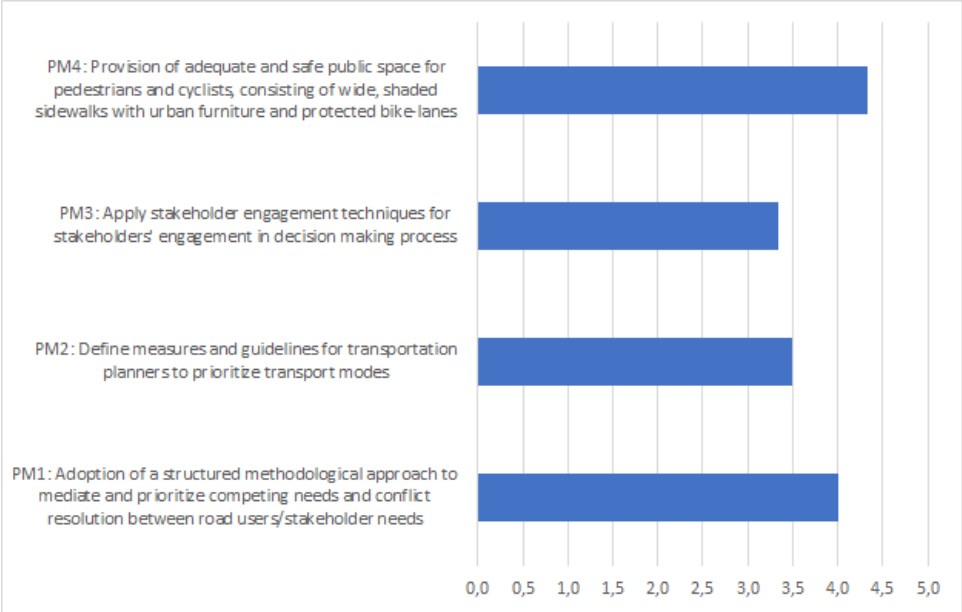


Figure 46. Use case 2-Assessment of policy measures against the financial feasibility dimension: Direct benefits

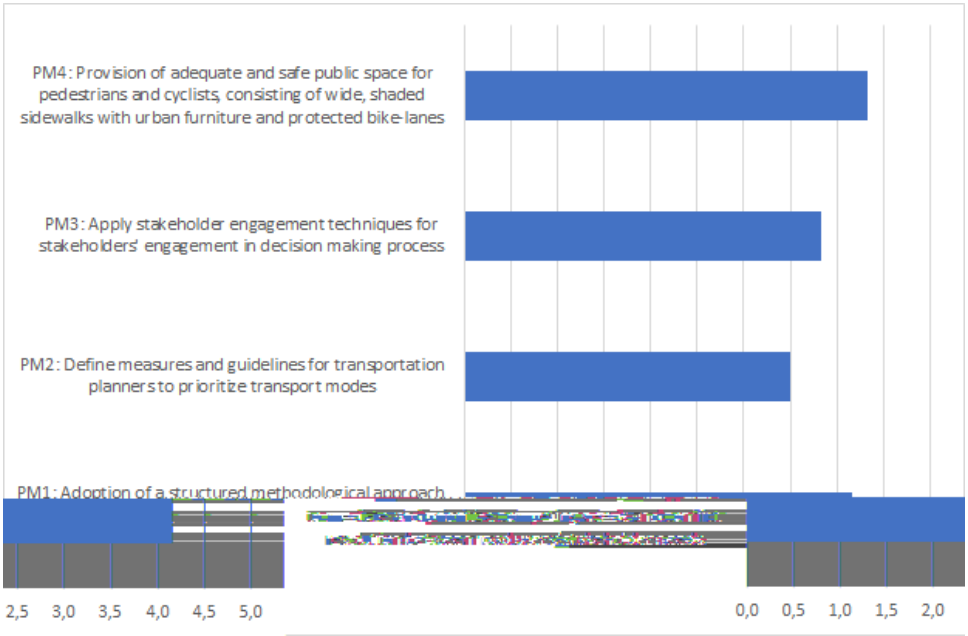


Figure 47. Use case 2-Assessment of policy measures against the financial feasibility dimension: Indirect benefits

Political feasibility includes evaluation of acceptability of alternative policy measures from the aspect of relevant stakeholders. According to the graphs below, PM1 evaluated by Public administration and by Public transport operator requires an additional analyses.

Copyright © 20222 by SPROUT.

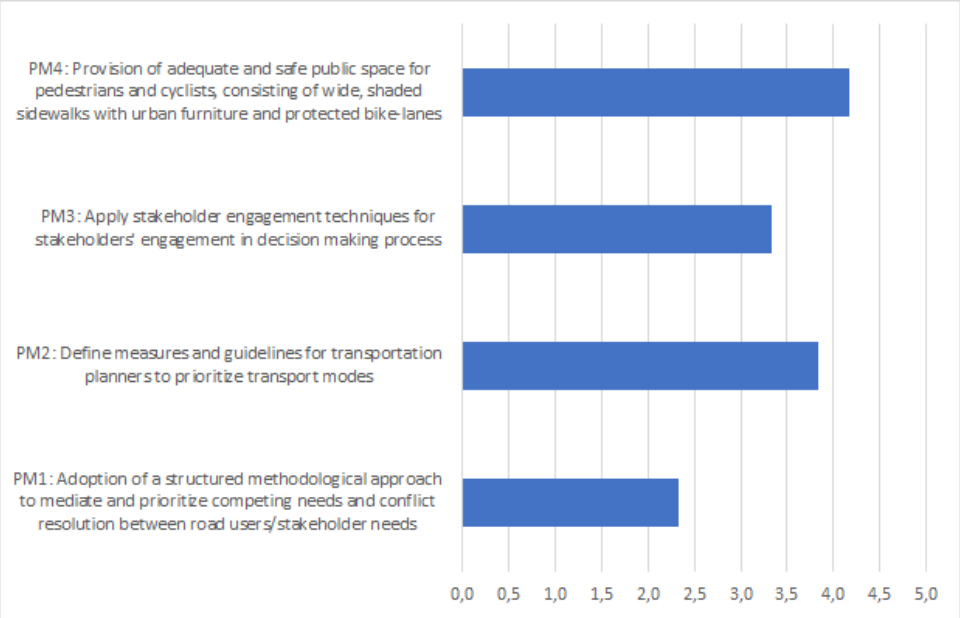


Figure 48. Use case 2-Acceptability of alternative policy measures from the aspect of Public Administration.

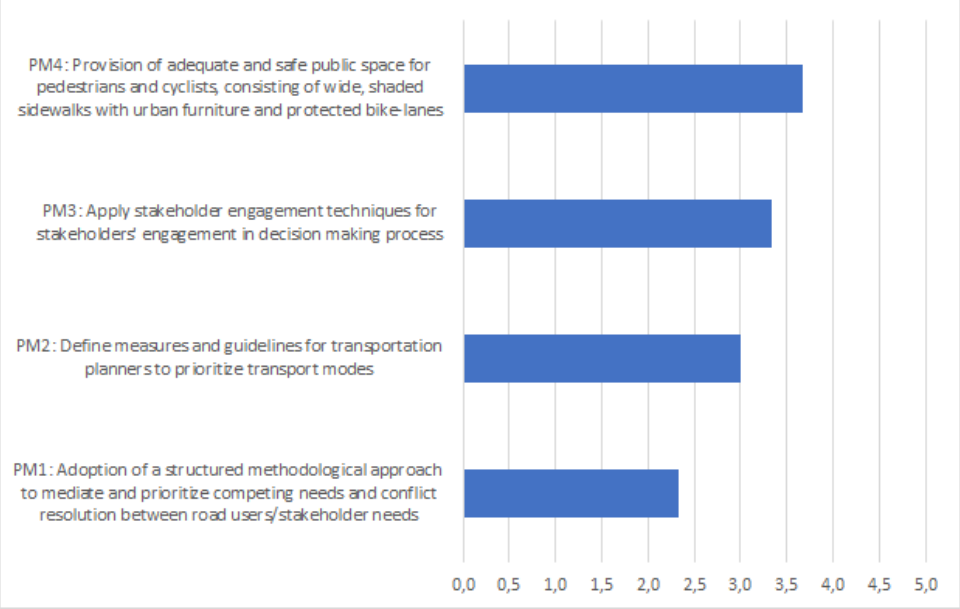


Figure 49. Use case 2-Acceptability of alternative policy measures from the aspect of Public transport operator.

Copyright © 20222 by SPROUT.

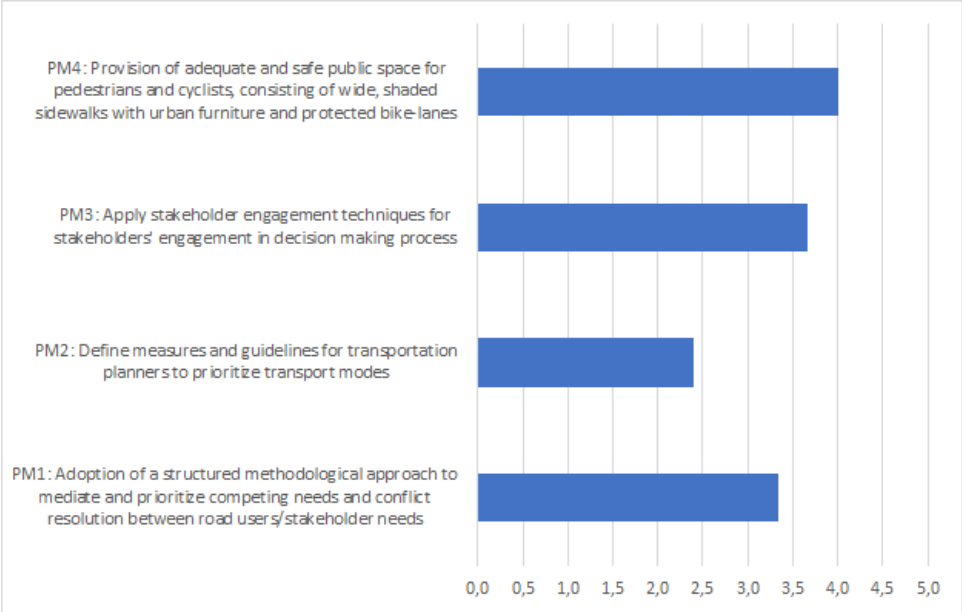


Figure 50. Use case 2-Acceptability of alternative policy measures from the aspect of Local business

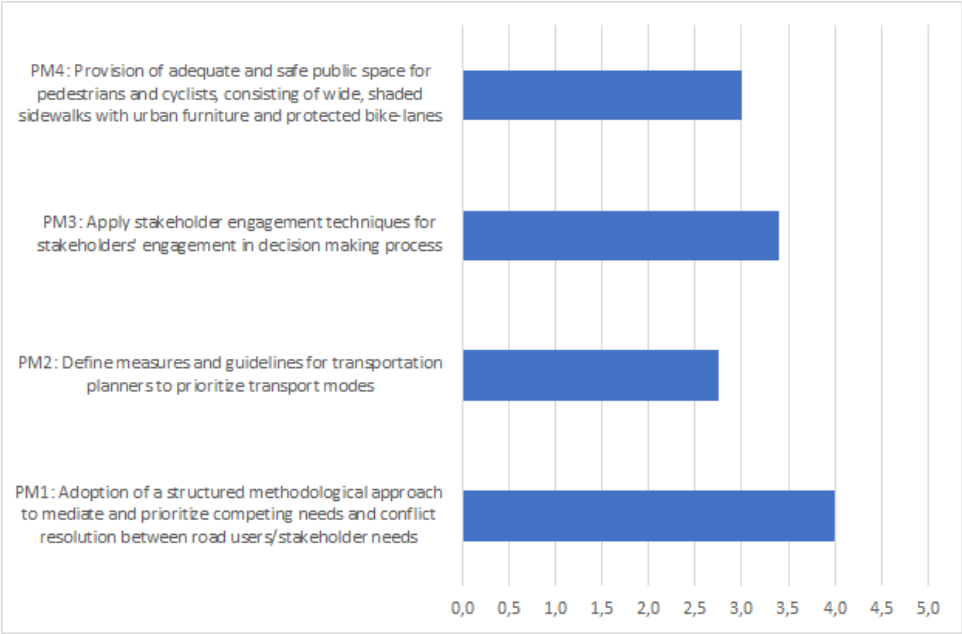


Figure 51. Use case 2-Acceptability of alternative policy measures from the aspect of Data/ Tech Company

Copyright © 20222 by SPROUT.

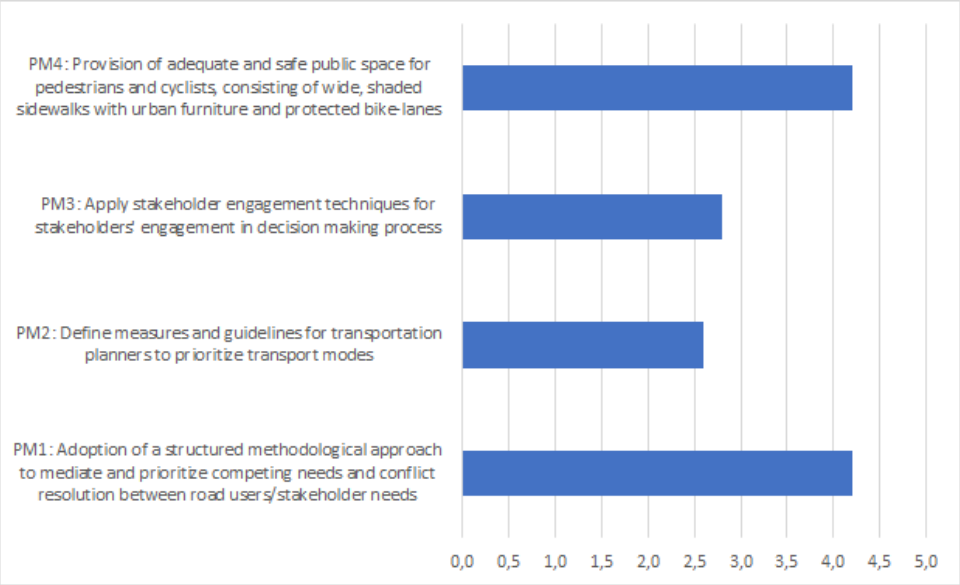


Figure 52. Use case 2-Acceptability of alternative policy measures from the aspect of New mobility service operator.

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 following conclusion is derived:

- From the aspect of administrative operability PM1 requires additional consideration.

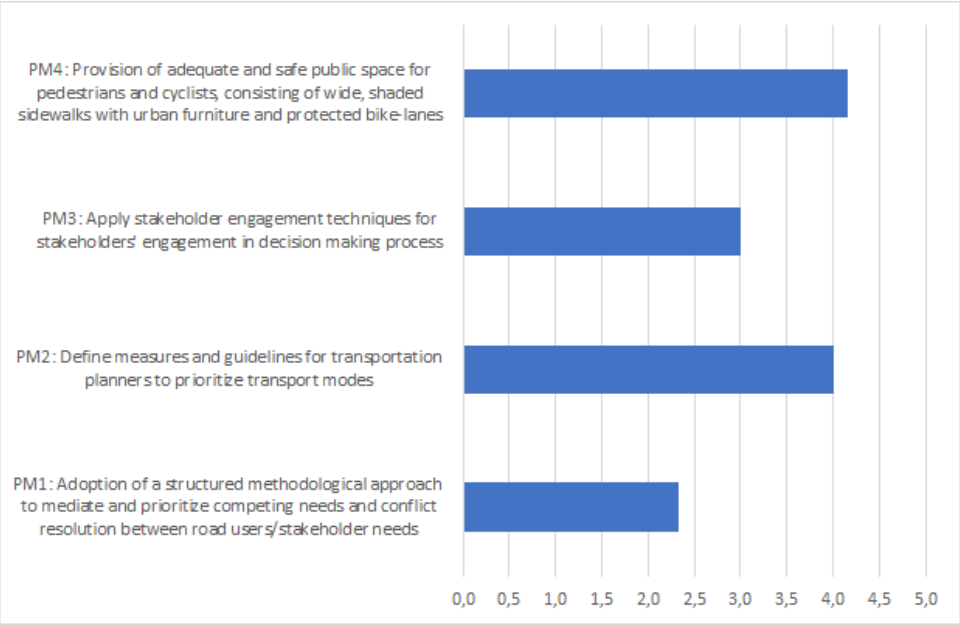


Figure 53. Use case 2-Assessment of policy measures against the political feasibility dimension: Administrative operability

Copyright © 20222 by SPROUT.

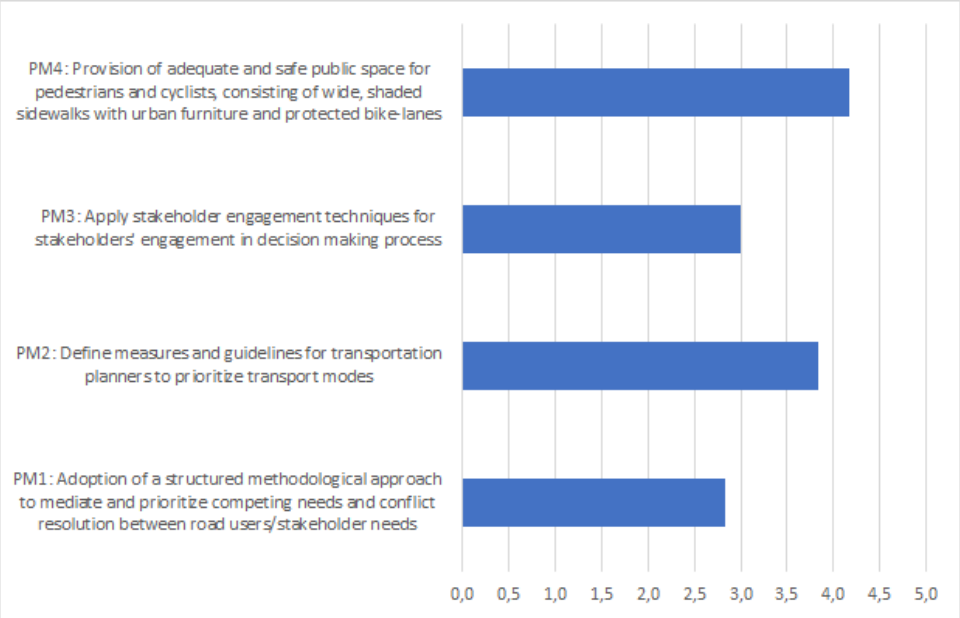


Figure 54. Use case 2-Assessment of policy measures against the political feasibility dimension: Administrative capability.

Use case 3: Identifying and prioritizing vulnerable road users at signalized intersections - Mobility solution description

Technical feasibility dimension aims at assessing the pool of resources that each of the alternative policy responses requires. (**Error! Reference source not found.**Figure 55).

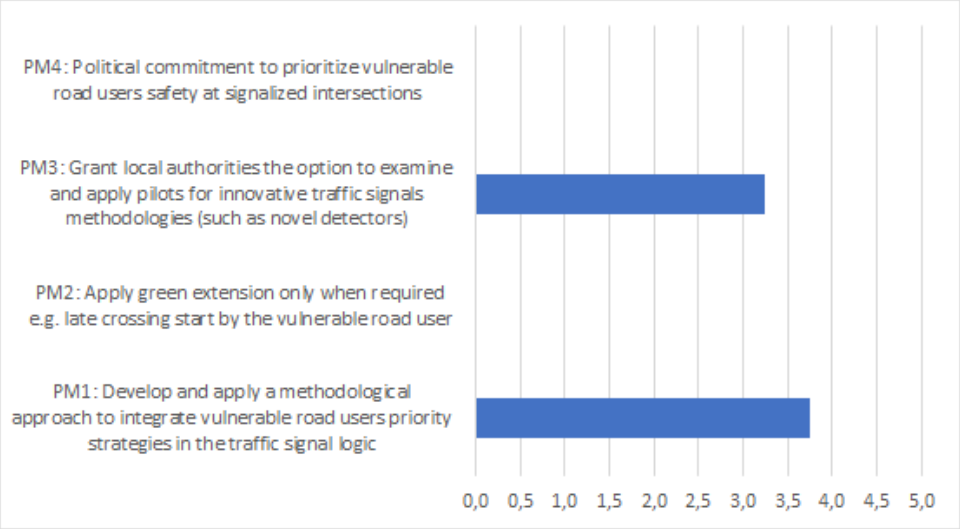


Figure 55. Use case 3-Assessment of policy measures against the technical feasibility dimension

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 28 - Figure 33) the following conclusions are derived:

1. From the aspect of indirect costs PM1, PM2 and PM4 require additional analysis.

Copyright © 20222 by SPROUT.

2. From the aspect of direct costs PM4 requires additional analysis.
3. From the aspect of fixed costs PM3 and PM4 require additional analysis.
4. PM1, PM2, PM3 and PM4 require an additional analysis for the operations and maintenance
5. From the aspect of indirect benefits, all policy measure will produce positive outcomes.

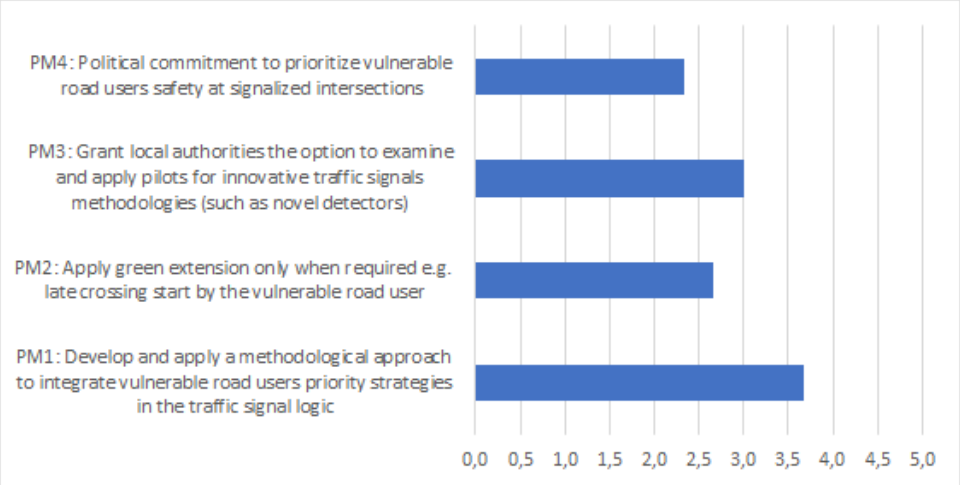


Figure 56. Use case 3-Assessment of policy measures against the financial feasibility dimension: Direct costs

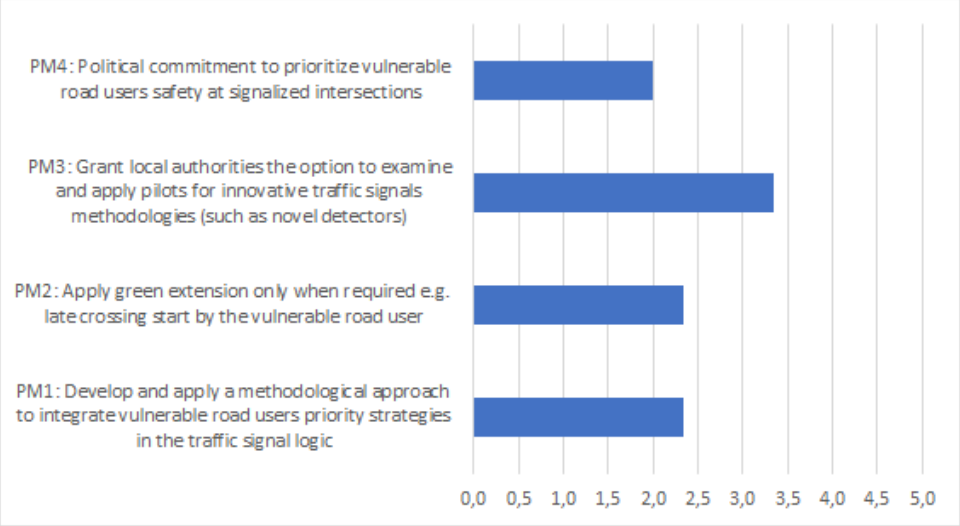


Figure 57. Use case 3-Assessment of policy measures against the financial feasibility dimension: Indirect costs

Copyright © 20222 by SPROUT.

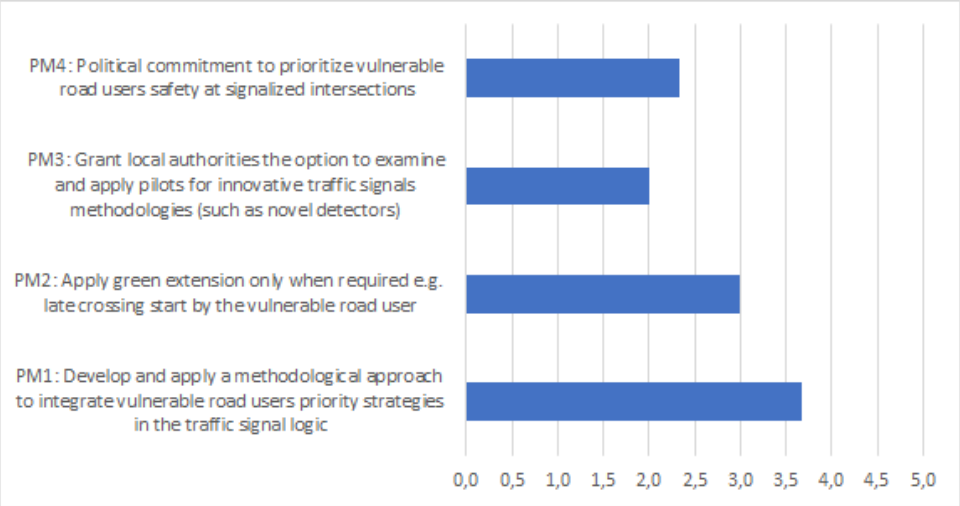


Figure 58. Use case 3-Assessment of policy measures against the financial feasibility dimension: Fixed costs

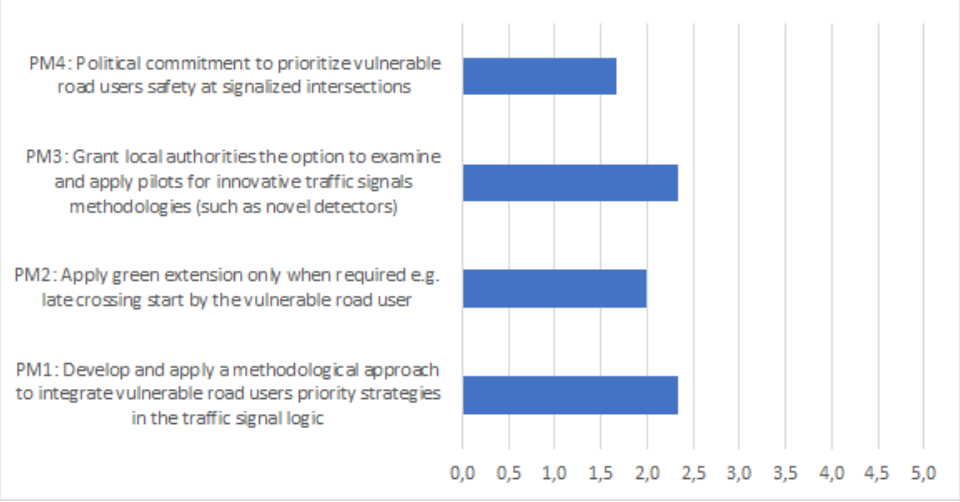
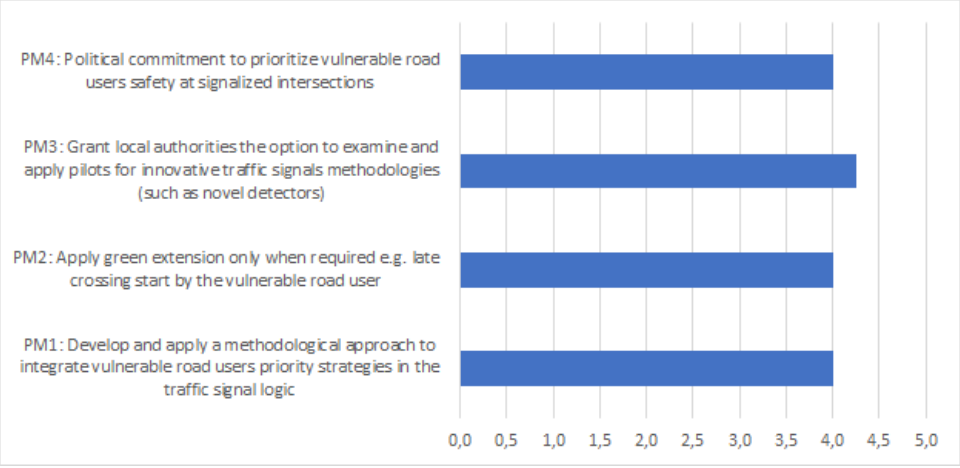


Figure 59. Use case 3-Assessment of policy measures against the financial feasibility dimension: Operations and maintenance costs



Copyright © 20222 by SPROUT.

Figure 60. Use case 3-Assessment of policy measures against the financial feasibility dimension: Direct benefits

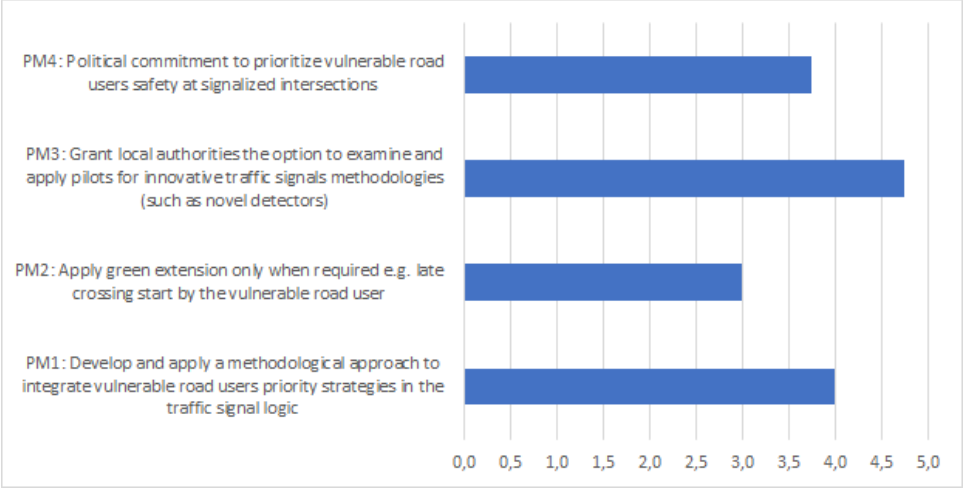


Figure 61. Use case 3-Assessment of policy measures against the financial feasibility dimension: Indirect benefits

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 except PM1 and PM4 evaluated by public transport operator. These PMs require an additional analyses

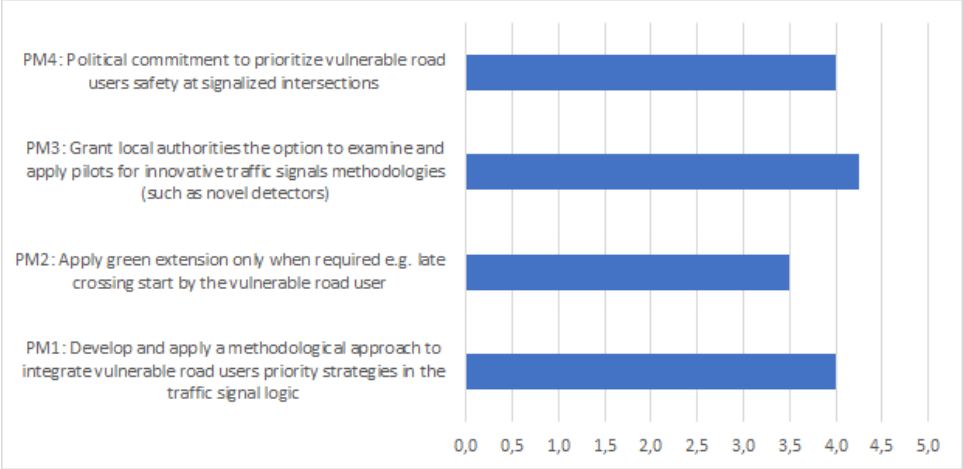


Figure 62. Use case 3- Acceptability of alternative policy measures from the aspect of Public Administration.

Copyright © 20222 by SPROUT.

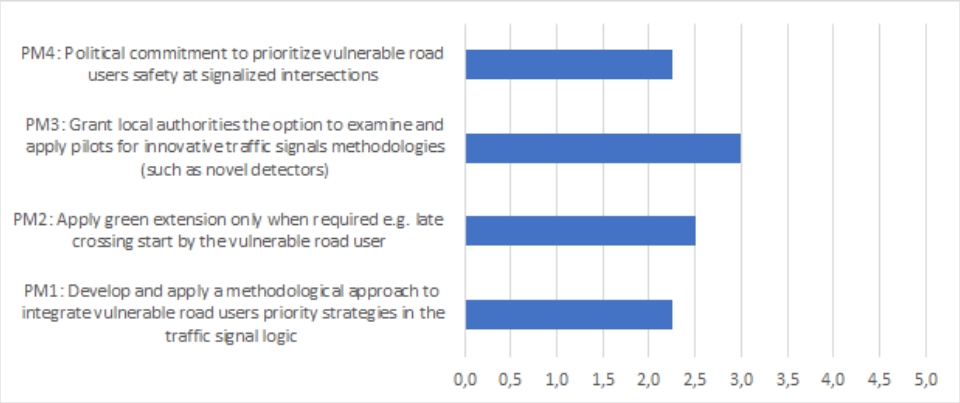


Figure 63. Use case 3-Acceptability of alternative policy measures from the aspect of Public transport operator.

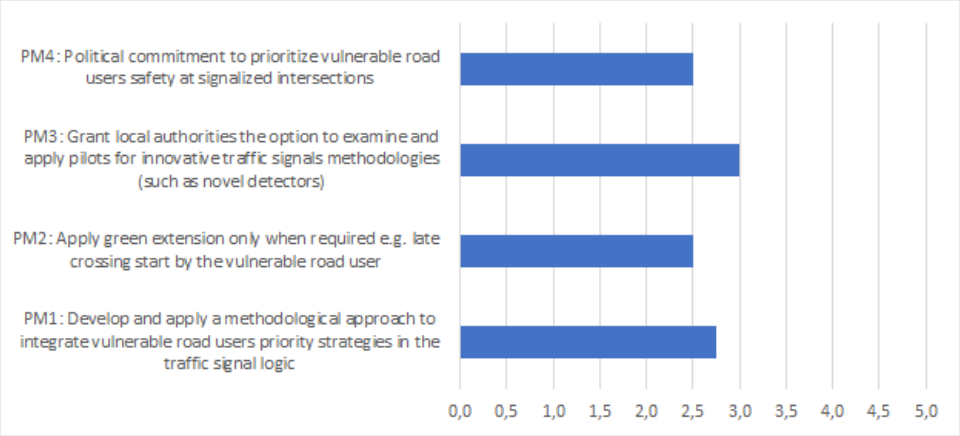


Figure 64. Use case 3-Acceptability of alternative policy measures from the aspect of Local business

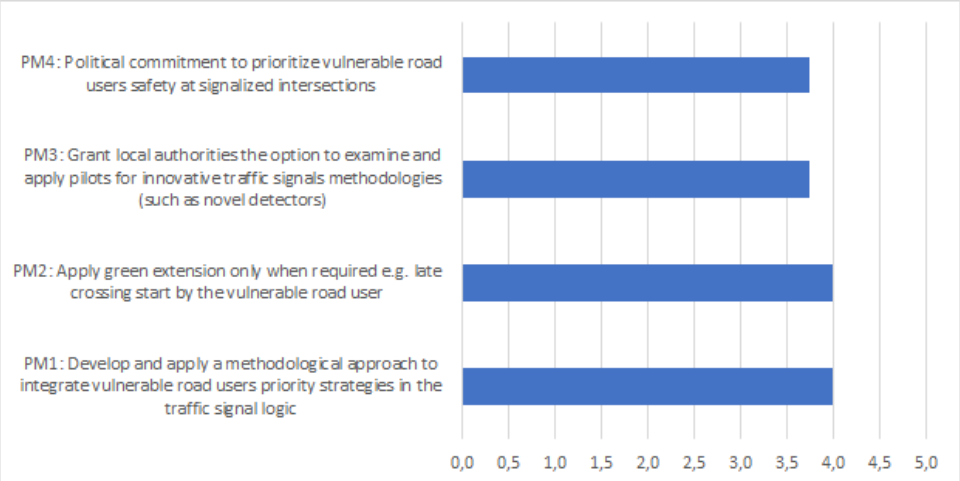


Figure 65. Use case 3-Acceptability of alternative policy measures from the aspect of Data/ Tech Company

Copyright © 20222 by SPROUT.

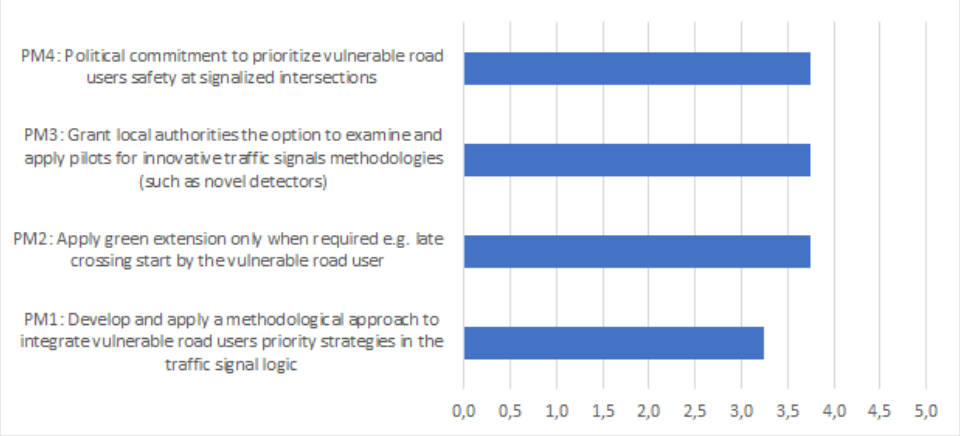


Figure 66. Use case 3-Acceptability of alternative policy measures from the aspect of New mobility service operator.

Administrative operability and capability are the main criteria for assessment of policy measures against the political feasibility. (Figure 39 - Figure 40)

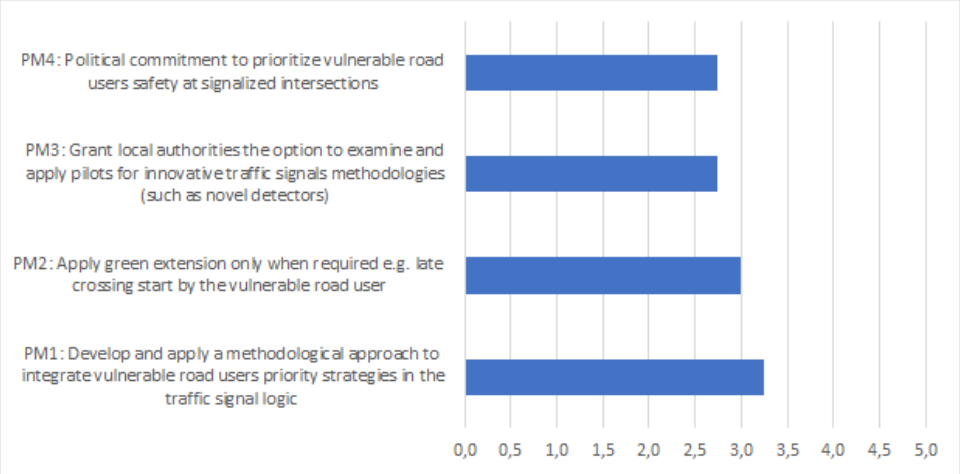


Figure 67. Use case 3-Assessment of policy measures against the political feasibility dimension: Administrative operability

Copyright © 20222 by SPROUT.

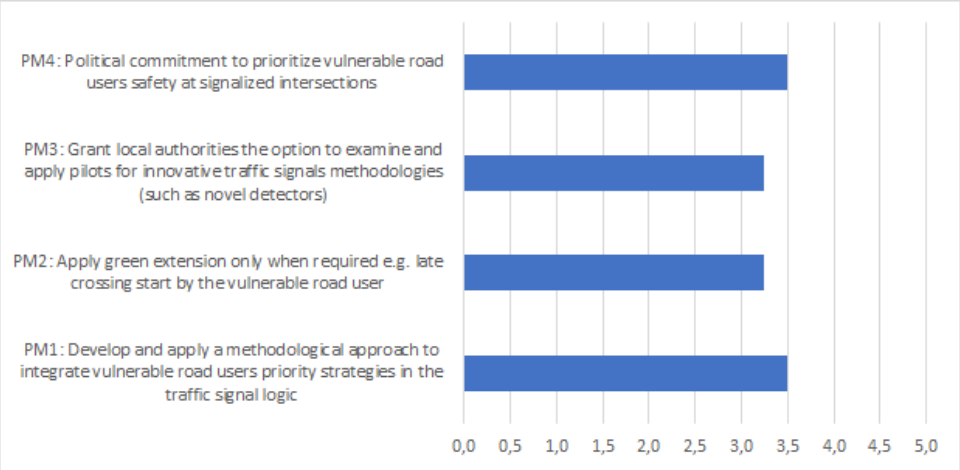


Figure 68. Use case 3-Assessment of policy measures against the political feasibility dimension: Administrative capability

Copyright © 20222 by SPROUT.

Annexe 4: T4.5 User acceptance

Use case 1: Data-driven analysis and visualization of current travel behavior mobility patterns using Bluetooth detectors data - Mobility solution description

The user acceptance questionnaire was distributed to relevant stakeholders. However, due to the specification of the use case and the type of the policy responses, stakeholders who are not familiar with both the technical and organizational context were not able to complete the questionnaire.

Use case 2: Re-allocating the public sphere - balance between liveability and capacity - Mobility solution description

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 69**) all PMs are fully reflecting the social and personal aims of the users.

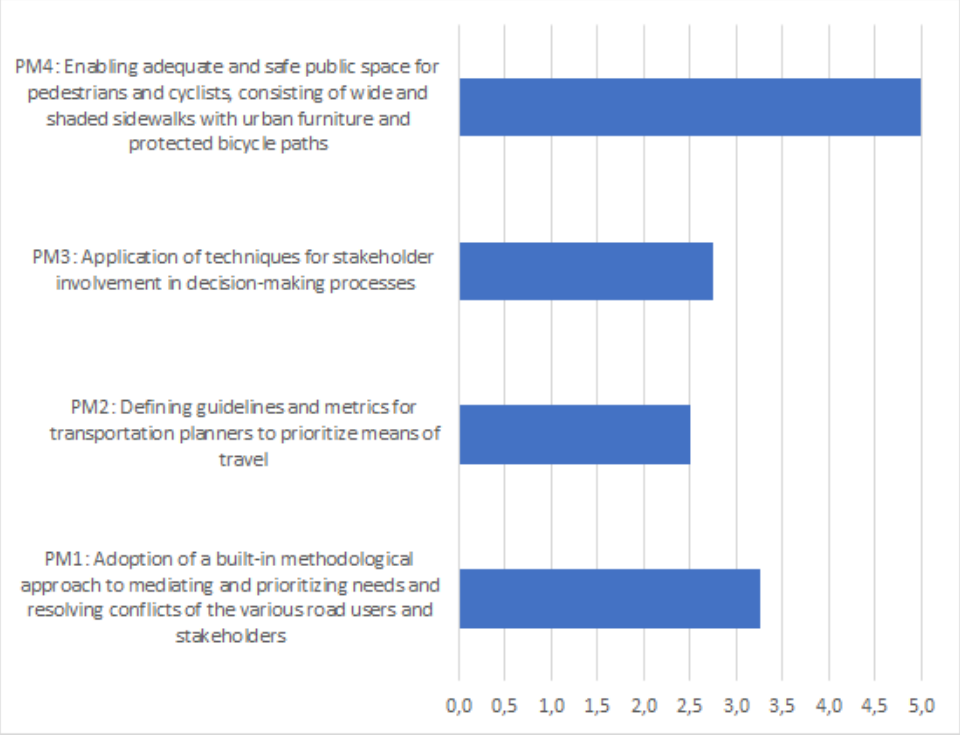


Figure 69. Use case 2 - Assessment of policy measures against the user’ personal and social aims

High problem perception reflects an increased willingness to accept a specific policy measure. According to the survey results (below UC2 respondents have a good user’ perception of the urban mobility challenges except PM2 and PM3 about awareness of policy action. These measures need a additional analysis.

Copyright © 20222 by SPROUT.

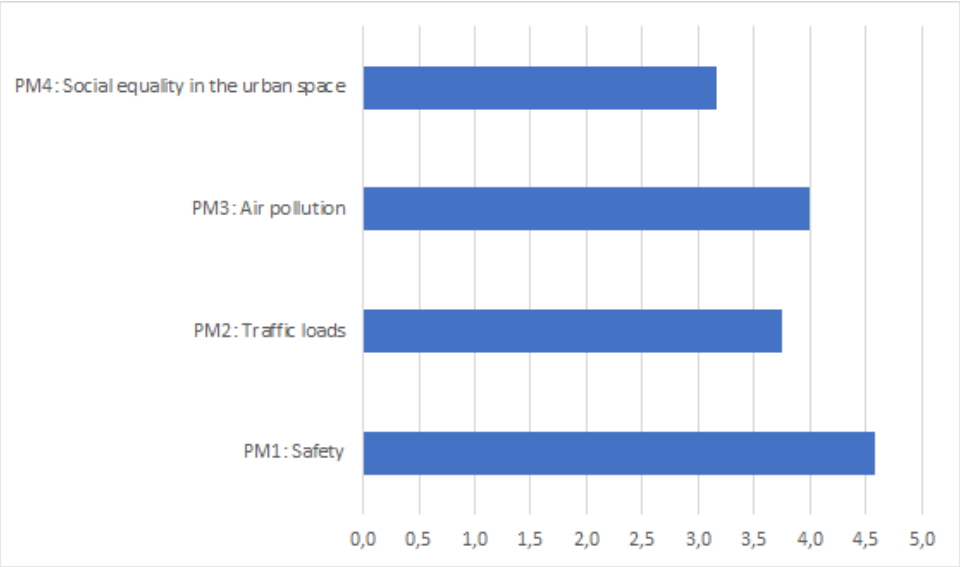


Figure 70. Use case 2 - Assessment of policy measures against the user's problem perception

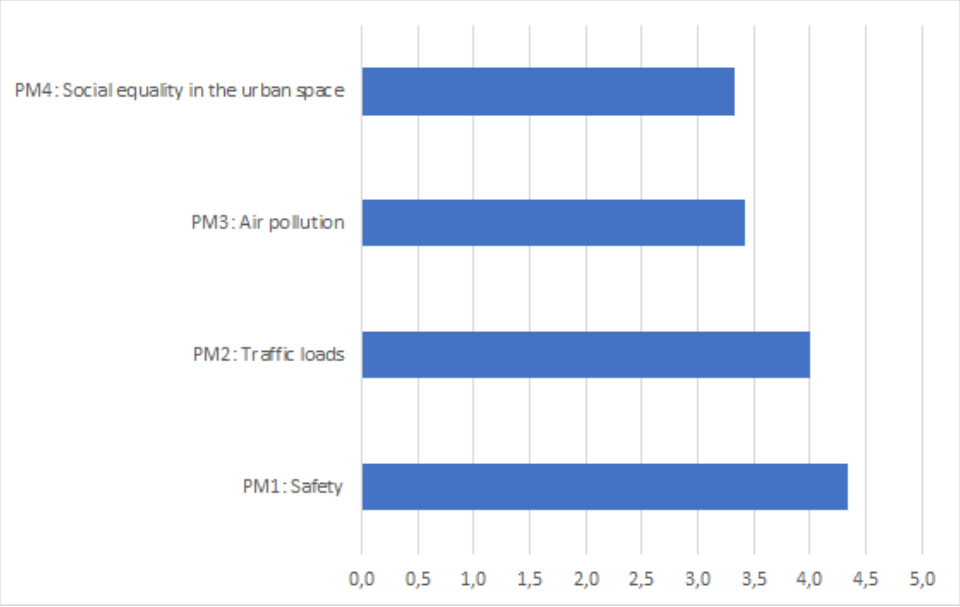


Figure 71. Use case 2 - Assessment of policy measures against the user' problem awareness

.

Copyright © 20222 by SPROUT.

Figure 72. Use case 2 - Assessment of policy measures against the user' awareness about policy measure

Copyright © 20222 by SPROUT.

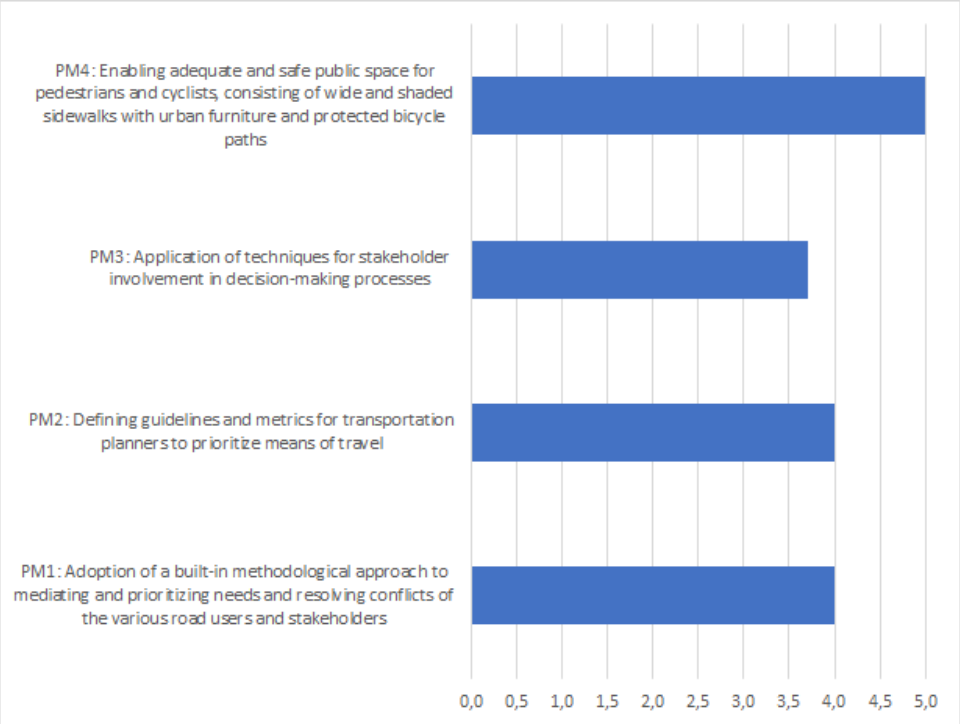


Figure 73. Use case 2 - Assessment of policy measures against the user' satisfaction with a policy measure.

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 PM1 and PM2 are considered unaffordable.

Copyright © 20222 by SPROUT.

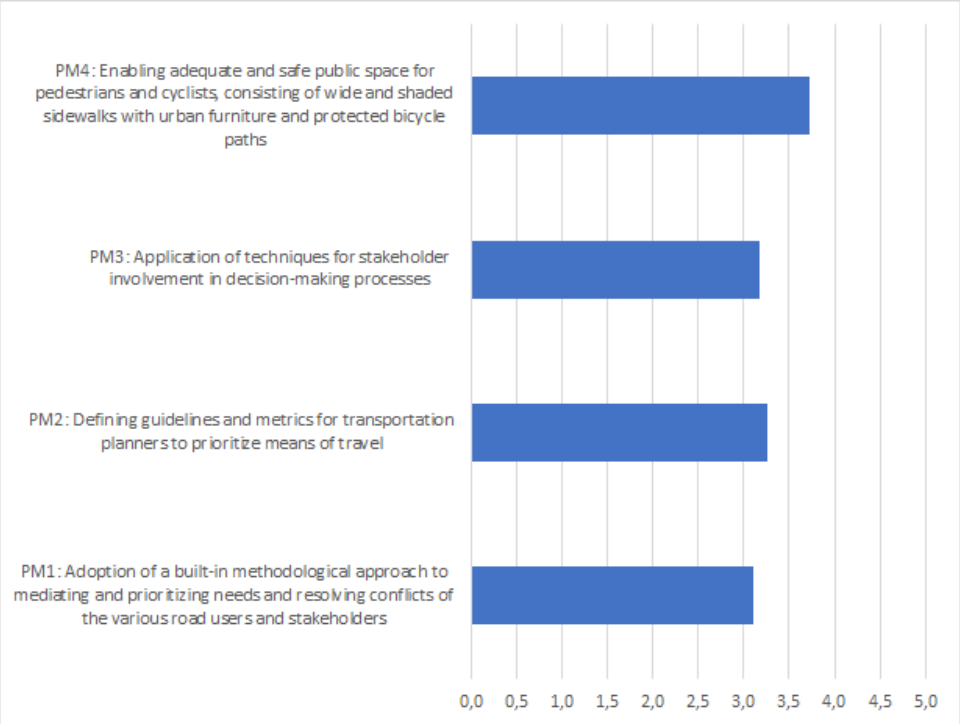


Figure 74. Use case 2 - Assessment of policy measures against the users' affordability of policy measures.

Use case 3: Identifying and prioritizing vulnerable road users at signalized intersections - Mobility solution description

Criteria "Personal and social aims" is assessed by the extent a specific PM fulfills the needs of the respondents. According to the survey results (**Error! Reference source not found.**) all P Ms are fully reflecting the social and personal aims of the users.

Copyright © 20222 by SPROUT.

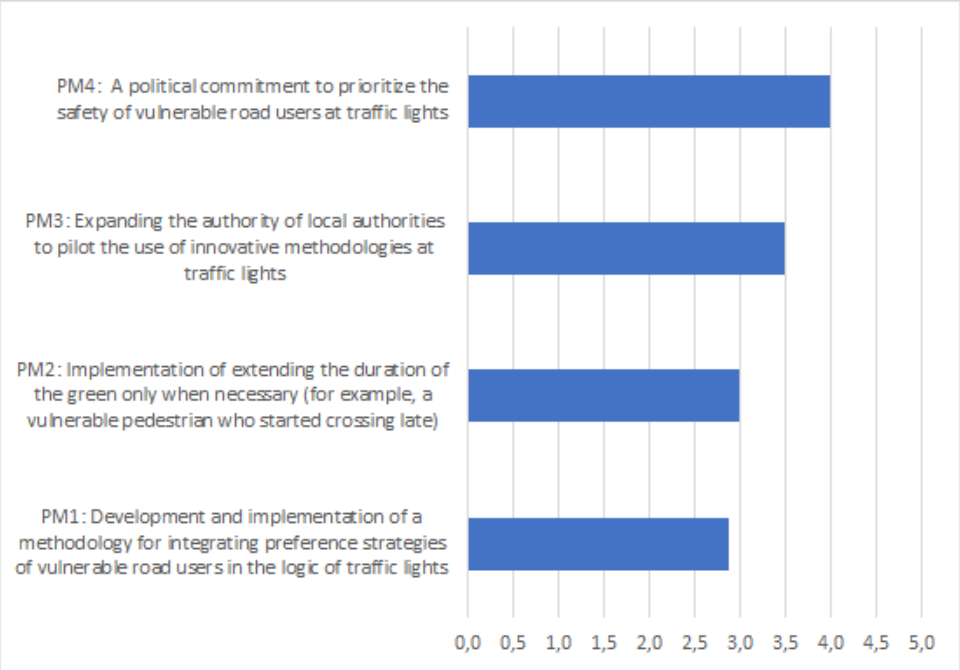


Figure 75. Use case 3 - Assessment of policy measures against the user' personal and social aims

High problem perception reflects an increased willingness to accept a specific policy measure. According to the survey results belowUC3 respondents have a good user' perception of the urban mobility challenges except PM2 according to awareness of policy action. This measure needs an additional analysis.

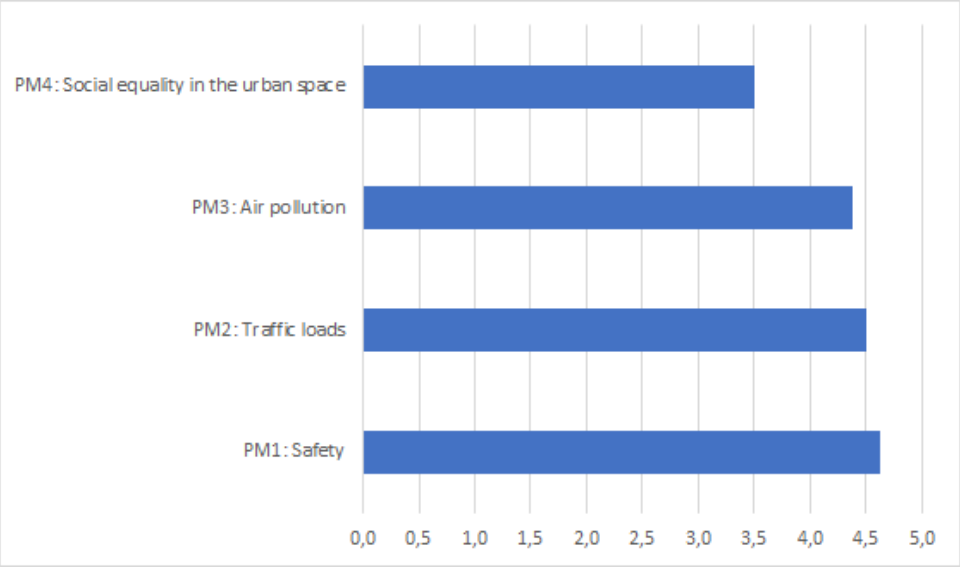


Figure 76. Use case 3 - Assessment of policy measures against the user's problem perception

Copyright © 20222 by SPROUT.

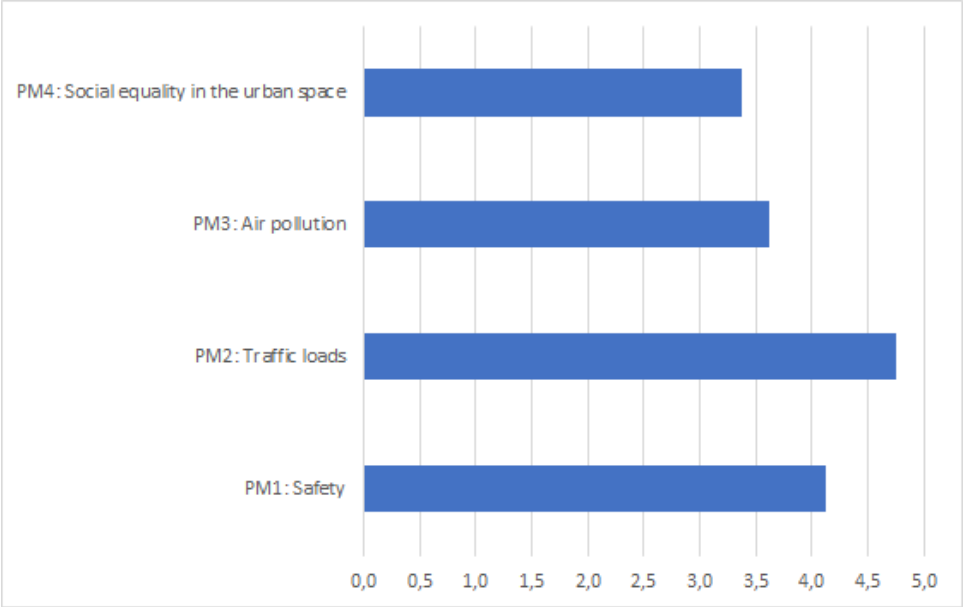


Figure 77. Use case 3 - Assessment of policy measures against the user' problem awareness

.

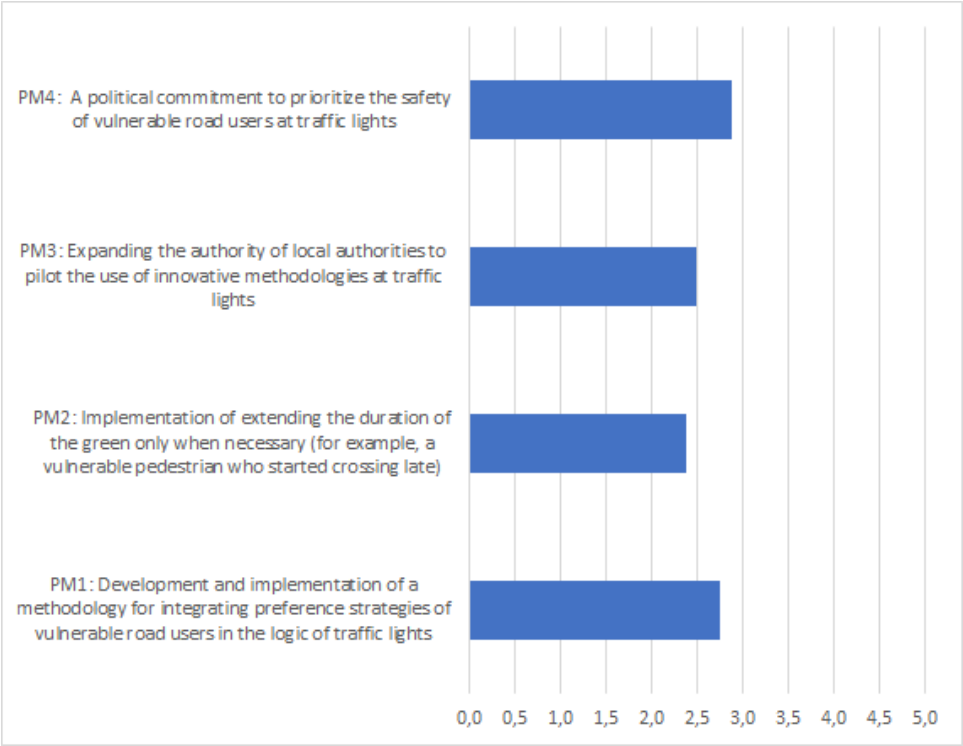


Figure 78. Use case 3 - Assessment of policy measures against the user' awareness about policy measure

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.

Copyright © 20222 by SPROUT.

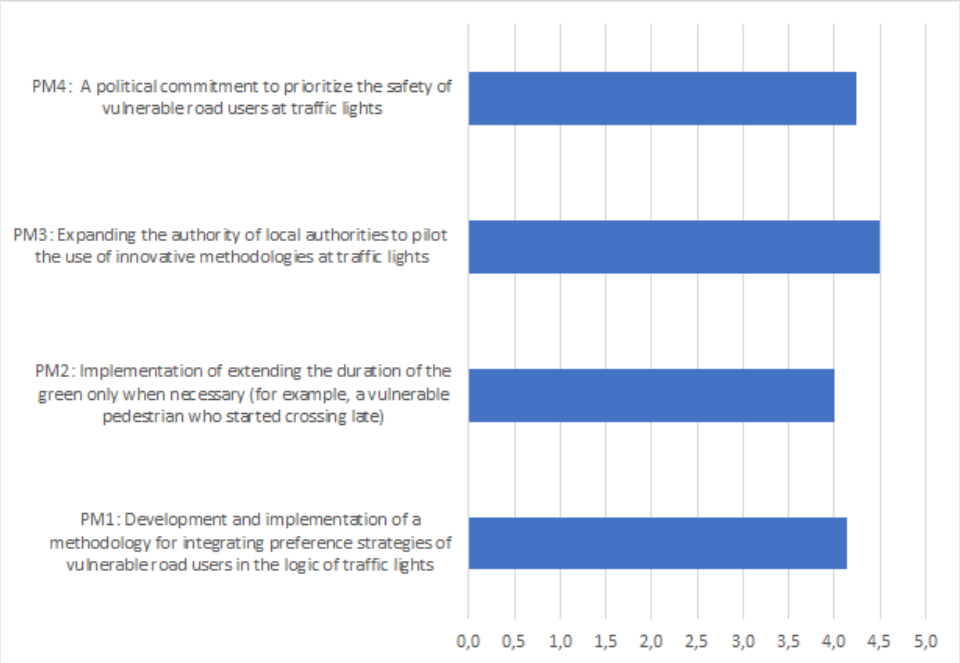


Figure 79. Use case 3 - Assessment of policy measures against the user' satisfaction with a policy measure.

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.

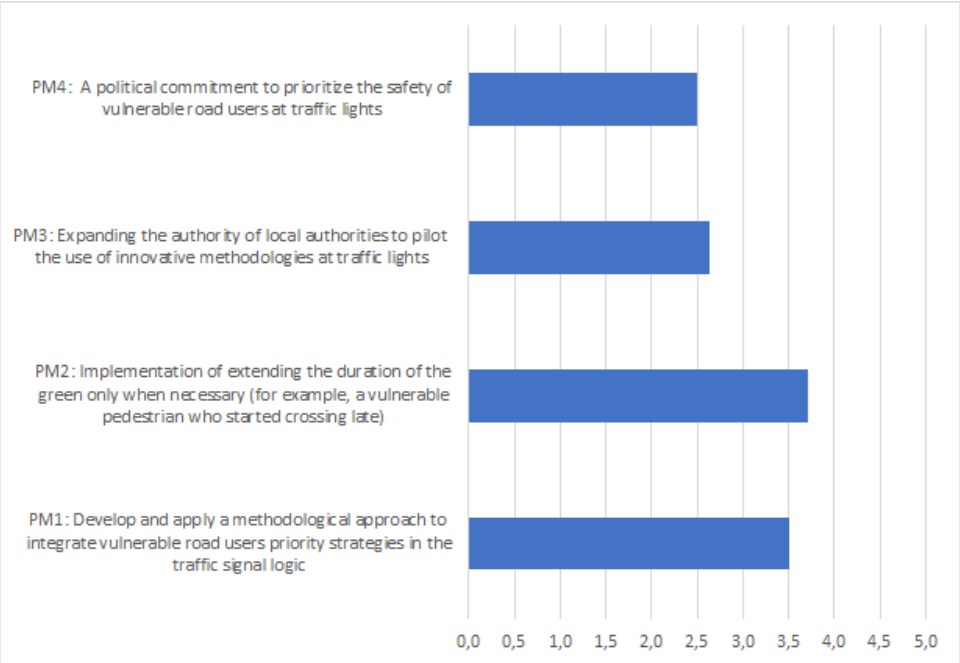


Figure 80. Use case 3 - Assessment of policy measures against the users' affordability of policy measures.

Copyright © 20222 by SPROUT.