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SmartHubs

Smart Mobility Hubs as Game Changers in Transport

WP3. Development of co-creation, participatory planning and design tools.

T3.5. SmartHubs Appraisal Tool for sustainability and stakeholder assessment

Deliverable D 3.5

SmartHubs Appraisal Tool for sustainability and stakeholder assessment

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Executive summary

This deliverable is part of the SmartHubs project, a JPI funded research project with living labs in Anderlecht, Eastern Austria, Munich, and Rotterdam-The Hague. The SmartHubs project examines mobility hubs, dedicated on-street locations where citizens can choose from different shared and sustainable mobility options. The main objective of the project is to assess if a co-designed, user-centric development can enable mobility hubs to act as a game changer toward inclusive sustainable urban mobility and accessibility. Moreover, the inclusion of stakeholders and the consideration of their preferences regarding mobility hubs is a central element of the democratic integration of a SmartHub (Geurs & Münzel, 2022).

This deliverable focuses on the co-evaluation stage of the co-design process of smart mobility hubs, and presents the SmartHubs Appraisal Tool for sustainability and stakeholder assessment and its planned application in the SmartHubs Living Labs. The SmartHubs Appraisal Tool includes three participatory appraisal methods that have been adapted to co-evaluate co-designed options of mobility hubs. This deliverable provides guidelines for introducing three formal evaluation methods into the SmartHubs co-creation process: multi-criteria analysis (MCA), multi-actor multi-criteria analysis (MAMCA) and stakeholder-based impact scoring (SIS). MCA is used to rank different solutions according to criteria. MCA can be used to define how sustainable (in an economic, environmental and social sense) the co-designed mobility hubs are; MAMCA can be used to rank the different co-designed solutions according to the criteria of stakeholders; and SIS quantifies the negative and positive impacts of the co-designed mobility hubs on stakeholders.

Using evaluation techniques can make sustainability impacts and stakeholder preferences more explicit, facilitating consensus-making among several stakeholders and leading to the implementation of a widely supported, sustainable and co-created mobility hub. This deliverable explains how these evaluation methods are applied in the SmartHubs co-creation process and provides practical guidelines to carry out the analysis with the help of the MCA and MAMCA software (www.mamca.eu).

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1 Introduction

This deliverable presents how the SmartHubs Appraisal Tool for sustainability and stakeholder assessment has been developed in Task 3.5. It also shows how the tool can be used in practice and in other tasks of the SmartHubs project, such as in WP4. Through task 3.5, three ex-ante participatory appraisal methods, have been adapted to evaluate mobility hubs and create the SmartHubs Appraisal Tool. In this regard, ex-ante methods are used in participatory process to decide on the basis of scenarios, rather than facts. This deliverable also specifies how the resulting tool can be integrated into the SmartHubs co-creation process to co-evaluate the mobility hubs that have been co-designed in each living lab (Anderlecht, Eastern Austria, Munich, and Rotterdam-The Hague).

The SmartHubs Appraisal Tool visualises the sustainability impacts of different SmartHubs designs as well as the stakeholder support for each design. The tool also shows stakeholders and decision-makers the positive as well as the negative impacts of the co-designed options The outcome of the tool supports the opinion-forming process of each stakeholder group and can also lead to changes in evaluation regarding different alternatives as well as new better understanding of the evaluation of other stakeholder groups. Thus, the tool can facilitate reaching a consensus between the different stakeholders on a co-created mobility hub that is both considered sustainable and supported by (most) stakeholders.

The SmartHubs Appraisal Tool combines three methods: Multi-Criteria Analysis (MCA), Multi-Actor Multi-Criteria Analysis (MAMCA), and Stakeholder-based Impact Scoring (SIS). Relying on criteria and weights, these ex-ante evaluation methods are used to appraise the potential impact of a range of alternatives. In the SmartHubs Appraisal Tool, MCA is used to show how sustainable the co-designed mobility hub alternatives are in terms of economic, environmental, and social impacts. MAMCA and SIS both give an overview of the impact of each co-designed alternative on stakeholders' criteria. The decision to apply MAMCA or SIS depends on the number and types of alternatives as on the aim of the stakeholder-based assessment. For instance, if there is only one alternative, or the main attributes of the co-designed alternatives overlap, SIS should be applied. Furthermore, if the aim of the Stakeholder assessment is to compare impacts and to work on the co-designed options without having to make a choice, SIS is also recommended.

This deliverable is part of SmartHubs work package 3 'Development of co-creation, participatory planning and design tools.' Other tasks that this document links to are task 4.1 'Setup and evaluation framework of Mobility Hubs within Living Labs' and the implementation of the four living labs in Eastern Austria (task 4.2), Anderlecht (task 4.3), Rotterdam-The Hague (task 4.4) and Munich (task 4.5), taking place from month 6 (September 2021) to month 24 (April 2023). Moreover, by applying the SmartHubs Appraisal Tool in the SmartHubs Living Labs, we can investigate to what extent the co-creation process of a mobility hub can be supported by a sustainability and stakeholder assessment tool.

This document is structured as follows. In the next section, terms and methods relevant to this deliverable are explained. Section 3 then explains how MCA, MAMCA and SIS are integrated into the SmartHubs co-creation process. This is followed by section 4, which provides practical guidelines to use the sustainability MCA and the MAMCA software programme. The key points of this deliverable are summarised in the conclusion. The appendices provide Living Lab coordinators with practical tools to use for evaluation methods.

2 Definition of terms and methods

Mobility hubs and their impacts have received recent attention among researchers (see, for example, Anderson et al. (2017), Bell (2019), and Bösehans et al. (2021). Moreover, design strategies for mobility hubs have been developed (Edwards, 2011; Martinez & Rakha, 2017). Furthermore, different methods to appraise mobility hubs have been developed. For instance, Hernandez et al. (2016) propose a methodology to identify the potential strengths and weaknesses of urban transport interchanges based on a two-step analytical procedure: a classification and regression tree model, and importance-performance analysis. Aydin et al. (2022) apply a Multi-Criteria Decision-Analysis (MCDA) methodology to appraise and identify preferred locations for mobility hubs. Nonetheless, the co-design of mobility hubs has been overlooked in literature, and the development of a specific appraisal method to be used during a co-creation process is lacking.

As the main objective of the SmartHubs project is to assess if a co-creation process can enable mobility hubs to act as a game changer, the development of tools to support the co-creation process is relevant. In this regard, the SmartHubs Appraisal Tool aims to facilitate the co-design process of a smart mobility hub, filling the knowledge gap identified in the literature. Co-design refers to the process in which multiple stakeholders are involved and their input is used to solve a problem. Co-design has been defined by Blomkamp (2018) as "a design-led process, involving creative and participatory principles and tools to engage different kinds of people and knowledge in public problem solving," and by Bradwell & Marr (2017) as "the effort to combine the views, input and skills of people with many different perspectives to address a specific problem".

As part of the co-design process, appraisal methods allow stakeholders to identify the most optimal option among a range of alternatives. Although different definitions of stakeholders exist, Grimble & Wellard (1997) define a stakeholder as "any group of people, organised or unorganised, who share a common interest or stake in a particular issue or system; they can be at any level or position in society, from global, national and regional concerns down to the level of household or intra-household, and be groups of any size or aggregation."

The method used to appraise the co-designed options depends on the type of project or element being evaluated, as well as on the approach to decision making. In cases where objectives are set by experts or where stakeholders are involved in all stages of the decision-making process, project appraisal techniques are useful tools to reach consensus and facilitate decision-making (Pappers et al., 2018). Cost-benefit analysis (CBA), and MCA or MCDA are often used methods to appraise transport projects (Browne & Ryan, 2011). In the following sub-sections, four methods that can be used to appraise mobility hubs are presented: CBA, MCA, MAMCA, and SIS

2.1 Cost-Benefit Analysis (CBA)

In a CBA, the economic costs and benefits of alternatives are compared to ascertain which alternative is most effective. The social CBA (SCBA) is a variation of CBA which includes the ecological and societal costs and benefits into the calculation, by translating the environmental and societal effects of each alternative into monetary units. Thus, the social and ecological costs must be quantified, making the use of this method more complicated and impeding its use. Moreover, the SCBA is often criticised due to the difficulty to translate environmental and societal effects into financial terms (te Boveldt et al., 2022).

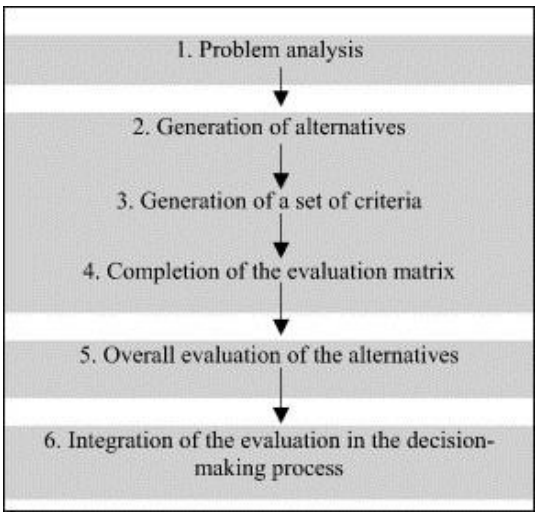
2.2 Multi-Criteria Analysis

Multi-criteria analysis (MCA) is a method used to identify the optimal alternative among several options by using criteria to give comparable scores to each alternative (Vermote et al., 2014).

Compared to CBA, MCA can more easily incorporate economic, environmental and social impacts of alternatives (Browne & Ryan, 2011) because they do not have to be monetized. MCA techniques are frequently used for the evaluation of transport projects, which often have complex decision-making processes due to their impacts (i.e., economic, social, environmental), the range of possible alternative solutions, and the number of stakeholders involved (Macharis & Bernardini, 2015).

An MCA normally has six steps, as shown in Figure 1. First, the problem is identified and analysed. Second, alternatives or scenarios are generated. In the third step, criteria relevant to the alternatives are developed to provide a quantitative or qualitative score for each alternative. The criteria are also assigned weights, depending on the importance of each criterion. Fourth, the evaluation matrix is completed. This means the alternatives are evaluated based on the criteria and the weights. In the fifth step, the results of this matrix are then shown. This step can be done by scoring methods, such as the Analytical Hierarchy Process (AHP) or SMART. In the sixth step, the results of the evaluation are used to inform decision-making (Brucker et al., 2004).

Figure 1. The six steps of the multi-criteria analysis (Brucker et al., 2004)



The results of an MCA often inform stakeholders about the different preferences rather than offering the best solutions (Browne & Ryan, 2011). Due to the transparency of the process, its fairness, and understandability, MCA is well-regarded and often legitimated by stakeholders (Nordström et al., 2010). However, stakeholder participation in MCA is often limited to defining the alternatives, criteria and/or weights. Furthermore, MCAs often use a set of criteria and weights which are common for all stakeholders. This may be problematic because stakeholders can have different criteria, and as transport projects are sometimes controversial, achieving consensus between stakeholders through a common set of criteria and weights may be impossible (Macharis et al., 2012; Macharis & Bernardini, 2015).

MCA can be used to evaluate different impacts of transport projects, such as their sustainability. In the "Brundtland report", sustainability is defined by referring to three pillars: economy, environment, and society (World Commission on Environment and Development, 1987). Mobility activities can have positive and negative effects on these three pillars (Browne & Ryan, 2011). Thus, public investment into transport projects has to balance government expenditures with improving sustainability. In this regard, MCA can be useful to rank alternatives according to sustainability criteria. MCA can address complex problems featuring conflicting objectives, different forms of data, diverging interests and perspectives, and accounts for dynamic biophysical and socio-economic systems (Wang et al., 2009).

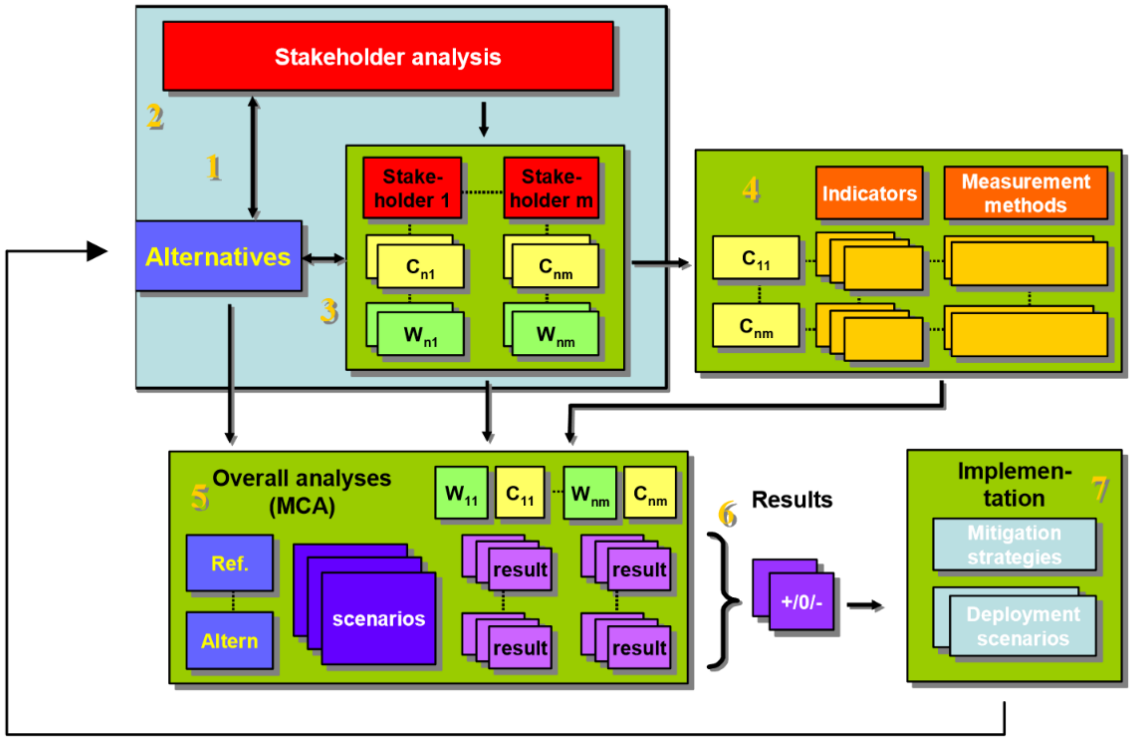
2.3 Multi-Actor Multi-Criteria Analysis (MAMCA)

Multi-actor multi-criteria analysis (MAMCA) is a methodology to assess stakeholder preferences by taking the stakeholders explicitly into account (Macharis, 2000, 2004). MAMCA is an extension of MCA, differing from the latter by explicitly introducing stakeholders before the criteria and weights are defined (Macharis et al., 2012). Furthermore, the MAMCA methodology encourages stakeholders "to reflect on what they want and on the rationale for these wants" (Macharis et al., 2009, p.197), which can facilitate reaching consensus.

The MAMCA approach was conceived to evaluate transport projects, in which the interests of stakeholders are competing and conflicting. MAMCA has been applied on several occasions, to decide about the improvement of mobility in the city centre of Leuven (Keseru et al., 2016); the possible extension of a logistics operator at Zaventem International Airport (Macharis et al., 2009); policy measures that can improve mobility and logistics in Flanders (Macharis et al., 2010); and measures to improve traffic safety in Brussels (Pappers et al., 2021).

The MAMCA methodology consists of seven steps that are shown in Figure 2. First, the possible alternatives that will be evaluated are identified and classified. Second, a stakeholder analysis, in which the groups whose opinions should be taken into account are identified and contacted, is conducted. In step three, each stakeholder group defines their criteria and gives weights to the criteria, according to the importance they give to each criterion. In step four, the criteria established by stakeholders are 'operationalised' by designating indicators to measure the impact of an alternative concerning each criterion. In step 5, the alternatives are analysed by using indicators and are consequently ranked. In step 6, results are shown, and consensus-making is encouraged. However, if consensus is not reached, new alternatives can be created and a new MAMCA is conducted. Lastly, the results of the MAMCA inform the implementation of the chosen alternative (Macharis et al., 2009).

Figure 2. The steps of multi-actor multi-criteria analysis (Macharis et al., 2009)



2.4 Stakeholder-based Impact Scoring (SIS)

Stakeholder-based Impact Scoring (SIS) is a participatory ex-ante appraisal method developed by te Boveldt et al. (2022), based on the concept of weighted impact. SIS is useful to quantify the negative and positive impacts of projects on stakeholders, assuming that impact is the result of objective estimations or observations done by experts, and subjective value judgements done by stakeholders. As such, it can be considered a middle ground between CBA and MAMCA. As in MAMCA, SIS acknowledges the subjective aspect of appraisal by involving stakeholders in coupling objective impact estimations with subjective value judgements. As is the case of CBA, it does not lead to an aggregated preference ranking but enables the identification of positive and negative impacts of alternatives compared to the current situation. Nonetheless, SIS still requires a certain degree of aggregation, by summating scores from different stakeholders to obtain numerical results. The very goal of SIS is to synthesise what is possible while leaving the value-laden trade-offs and decision-making open for political debate. As such, the evaluation conducted in the early strategic phase of projects should not prematurely conclude the discussion, but rather enhance it (te Boveldt et al., 2022).

By enabling the analyst to interpret the negative and positive impact scores separately, SIS is particularly appropriate in complex transport projects, which are often altered and defined throughout their course of planning or implementation. For instance, the Boveldt et al. (2022) applied the SIS to appraise the alternatives to the redevelopment of an overpass in Brussels. The technique was applied in this project because the uncertainty on central aspects such as costs and the development of supra-regional infrastructure impeded high-precision appraisal. Furthermore, as this was a politically sensitive project, most stakeholders had a pre-defined preferred alternative. It was therefore convenient to highlight the impacts, to nurture and support the debate, instead of ranking alternatives and prescribing a decision.

2.5 Combination of MCA and MAMCA

Combining evaluation methods such as MCA and MAMCA with co-creation has been done in previous research. This deliverable builds on two projects in which an appraisal tool that combines two of the methods presented in Sections 2.2 and 2.3 was combined: the New Integrated Smart Transport Options (NISTO) project (Keseru et al., 2015) and the Looper – Learning Loops in the Public Realm[1] project (Pappers et al., 2018).

The NISTO research project (Keseru et al., 2015) developed a set of tools to appraise the sustainability and the stakeholder preferences on small-scale transport projects. These tools, sustainability MCA and MAMCA, were tested in five urban transport projects in Belgium, France, Germany, the Netherlands, and the UK. The cases studied included real-time travel information for buses, an integrated transport tourist ticket; investments in bicycle infrastructure; a mobile app to collect travel behaviour data; and a bike rental scheme. The results of the stakeholder assessment, obtained through MAMCA, and the outcome of the sustainability appraisal, obtained through MCA, was used by the researchers to identify solutions that were more sustainable and supported by the majority of the stakeholders.

[1] www.looperproject.eu

The Looper project (Pappers et al., 2018) addressed the whole co-creation process to improve traffic safety. Citizens and stakeholders debated on topical issues, then the problem was framed by citizens and relevant data was collected. Through a platform, the Looper project visualized the data and enabled the co-design of solutions which were evaluated, and the best were put into practice and monitored. The evaluation of the co-designed solutions included a sustainability and stakeholder assessment, and to this end, a set of guidelines was developed. These guidelines presented how to integrate MCA and MAMCA into a co-creation process. The sustainability MCA and MAMCA were tested together in three locations: Brussels, Manchester, and Verona.

3 The SmartHubs Appraisal tool

The SmartHubs Appraisal tool is part of the SmartHubs co-creation process to know the impacts of co-designed mobility hubs on sustainability as well as on stakeholder preferences. From previous research (Bulckaen et al., 2016; Keseru et al., 2015, 2016), we find that using evaluation techniques makes stakeholder preferences more explicit, which can facilitate detecting where stakeholder preferences converge. This, in turn, can positively impact reaching consensus on an alternative and could lead to implementation. However, sustainability MCA and MAMCA, or SIS, have not yet been deployed as appraisal tools that contribute to the co-design process of mobility hubs. This section therefore presents these three appraisal methods.

3.1 Sustainability impacts of smart mobility hubs

The sustainability appraisal tool is an MCA conducted through the use of several criteria, each one with a specific weight, to appraise the sustainability of a mobility hub. The criteria refer to the three pillars of sustainability: economy, environment, and society. In this sustainability MCA, each pillar is given equal relevance (i.e., one-third) and contains a set of criteria.

The criteria used in the sustainability MCA need to be specific to mobility hubs. This was done via two surveys (n=17 and n=21) distributed among members of the SmartHubs consortium; an international panel of experts, academics and professional working in the domain of transportation and shared mobility services. The first questionnaire survey aimed to identify criteria that were considered relevant to apprise sustainability (see Appendix 1). The second questionnaire survey aimed to weight the relevance of the criteria (see Appendix 2).

The list of 26 possible useful criteria that was considered in the first survey was obtained from the literature and previous research, such as the NISTO project(Keseru et al., 2015). The NISTO project developed a tool to evaluate the sustainability on small-scale mobility projects and tested it in five urban transport projects in the UK, Germany, Belgium, the Netherlands, and France:

1. **Economic sustainability**

    a. **Economic activity** – Economic (and business) change due to the realization of the mobility hub.
    Indicators: commercial activity, employment and hospitality.
    b. **Cost-effectiveness** – Cost-Benefit Analysis: comparison of costs and revenues.
    Indicators: Investment costs, operating costs and revenues.

c. **Reliability** – Functioning of transport modes and travel time.
   Indicators: Delays, cancellation and duration of the trip.
d. **Public funding** – Efficient public spending on transport.
   Indicators: Level of transport subsidies for investments and operating costs.
e. **Adaptability** – Ability to adapt to socio-economic and technological changes.
   Indicators: Adaptable planning and provision of resources for unexpected needs.

2. Environmental sustainability

a. **Land consumption** – The proportion of land which is occupied by transport infrastructure in the city contributing to the loss of green areas and habitats, and causing visual impact.
   Indicator: Extent of new land consumption by project implementation concerning existing land occupied by transport infrastructure within a city.
b. **Greenhouse gas emissions** – Contribution of the mobility hub to greenhouse gas emissions.
   Indicator: Project CO2.
c. **Air quality** – Level of air pollution in the mobility hub.
   Indicator: Emission of air pollutants, such as NOx and PM2.5, and perception of air quality.
d. **Resource use** – Source of energy used in the facilities and infrastructure of the mobility hub.
   Indicator: Proportion of alternative energy sources used in the facilities of the hub and its permanent infrastructure.
e. **Noise** – Noise emission within the mobility hub.
   Indicator: Noise produced by all types of elements of the hub, perception of noise and exposure to noise
f. **Material use** – Choice of materials used for the construction of the mobility hub and use of circularity.
   Indicators: Proportion of sustainable and reused materials, and consideration of their life cycle
g. **Climate adaptation measures** – Measures to adapt the mobility hub to the impact of climate change.
   Indicator: inclusion of measures directed to tackling climate change, such as natural cooling and water saving.
h. **Flexibility** – Flexible design of facilities allowing adaptation.
   Indicators: capacity to host different uses over time and adapt to spatial transformations.
i. **Resilience** – Ability of a mobility hub to keep operating in the face of one or more major obstacles to normal function, such as extreme weather or accidents.
   Indicators: (1) Qualitative indicator: based on experience or expert opinion (Serdar et al., 2022) ; (2) GIS bases: Network resilience indicator proposed by UNIBO; (3) Performance-based indicator: reflect performance over time in different stages (Serdar et al., 2022).

3. Social sustainability

a. **Safety** – Perceived safety of all users of the mobility hub.
   Indicator: Number of accidents and perception of safety.
b. **Security** – Experienced security of all users of the mobility hub.
   Indicator: Reported crime and perception of crime and security.
c. **Access to opportunities** – Provision of access to jobs and basic services for all citizens and visitors, irrespective of social and economic background.

Indicator: Location of the hub regarding population density, and the accessibility that it provides to employment, healthcare and essential services, considering the distance, time and frequency.

d. **Universal accessibility** – Physical and digital accessibility of transport for the disabled, people with reduced mobility, children and people with small children.
   Indicators: Proportion of fully accessible services, facilities and information.
e. **Social inclusion** – Use of the mobility hub by disadvantaged groups.
   Indicators: Proportion of people belonging to disadvantaged groups within users compared to the local population.
f. **Gender equality** – Presence of women in the mobility hub, as users or workers.
   Indicator: proportion of women in the different transport options and working categories within the hub.
g. **Affordability** – Affordability of transport for all individuals, regardless of their socio-economic characteristics.
   Indicator: Cost of transport services available at the hub compared to the average income of local residents.
h. **Active mobility** – Use of active modes of transport in the mobility hub.
   Indicators: Part of mobility done by foot, cycling or by other active modes of transport, measured in per cent of the total distance.
i. **Liveability** – Social use of the mobility hub and how well citizens and visitors feel in it and the immediate surroundings.
   Indicators: Quality of urban space, walkability and pedestrian friendliness.
j. **Socio-political acceptance** – Support of the mobility hub by citizens.
   Indicator: Citizen's approval or satisfaction with the project.
k. **Policy integration** – Integration in local, regional and national policies.
   Indicators: (1) integration between policy instruments involving different modes; (2) integration between policy instruments involving infrastructure provision, management, and pricing; (3) integration between transport and land use measures; and (4) integration with other policy areas such as health and education.
l. **Satisfaction of workers** – Satisfaction of all people working at the hub full-time or part-time.
   Indicator: Rating from employees.

Through a first questionnaire (n=17) (see Appendix 1), these 26 criteria were reviewed by experts from the SmartHubs consortium. For each criterion, respondents could indicate whether they wanted to include it in the SmartHubs Appraisal Tool, or if they did not know.

The acceptance rate of criteria was calculated only with the 'Yes' and 'No' votes; the 'I don't know' responses were excluded from the analysis. The criteria that received a 'Yes' in more than 60% of the valid responses were selected. This threshold was chosen by the authors as it entails that the criterion is validated by a majority of the valid responses. The results of the questionnaire concerning the acceptance of the proposed criteria for the economic, environmental, and social sustainability are respectively shown in Table 1, Table 2 and Table 3. Two criteria were removed because their acceptance rate was lower than 60% (highlighted in red), obtaining a list of 24 accepted criteria.

Table 1. Review of criteria to appraise the economic sustainability of mobility hubs

Economic sustainability	Yes	No	I don't know	Acceptance
Economic activity	9	4	4	69%
Cost-effectiveness	15	2	0	88%

Reliability of transport modes and travel time	15	2	0	88%
Public funding	10	1	6	91%
Adaptability	12	1	4	92%

Table 2. Review of criteria to appraise the environmental sustainability of mobility hubs

Environmental sustainability	**Yes**	**No**	**I don't know**	**Acceptance**
Land consumption	7	6	4	54%
Greenhouse gas emissions	15	1	1	94%
Air quality	13	3	1	81%
Resource use	11	3	2	79%
Noise	13	2	2	87%
Material use	11	4	2	73%
Climate adaptation measures	10	2	5	83%
Flexibility	12	3	2	80%
Resilience	14	2	0	88%

Table 3. Review of criteria to appraise the social sustainability of mobility hubs

Social sustainability	**Yes**	**No**	**I don't know**	**Acceptance**
Safety	12	3	2	80%
Security	9	4	4	69%
Access to opportunities	14	0	3	100%
Universal accessibility	17	0	0	100%
Social inclusion	17	0	0	100%
Gender equality	14	1	2	93%
Affordability	16	0	1	100%
Active mobility	10	2	5	83%
Liveability	15	1	1	94%
Socio-political acceptance	13	2	3	87%
Policy integration	10	2	5	83%
Satisfaction of workers	7	6	3	54%

In a second questionnaire (n=21) (see Appendix 2), the same group of experts was asked to rate the relevance of each criterion for appraising the sustainability of mobility hubs. Each participant distributed 100 points among the criteria of each category. As a result, the average rating of each criterion was used to establish its weight in the sustainability MCA (see Table 4). The weights add up to 100 per pillar of sustainability.

Table 4. The weighting of criteria to appraise the sustainability of mobility hubs

	Criterion	**Weight**
Economic sustainability	Economic activity	18,5
	Cost-effectiveness	22,1
	Reliability	23,8

	Public funding	17,1
	Adaptability	18,6
Environmental sustainability	Greenhouse gas emissions	14,4
	Air quality	8,4
	Resource use	15,3
	Noise	10,4
	Material use	8,2
	Climate adaptation measures	10,7
	Flexibility	13,3
	Resilience	19,3
Social sustainability	Safety	8,3
	Security	7,8
	Access to opportunities	12,6
	Universal accessibility	15,6
	Social inclusion	10,2
	Gender equality	6,7
	Affordability	12,9
	Active mobility	7,8
	Liveability	6,3
	Socio-political acceptance	6,3
	Policy integration	5,5

3.2 Stakeholder support for smart mobility hubs

The goal of the stakeholder assessment is to find an alternative that has support from most or all stakeholders. Within SmartHubs, the alternatives are defined by citizens through the co-design process. The co-design phase should result in two or more alternatives whose impact on stakeholder preferences can be evaluated. A do-nothing alternative should also be evaluated in order to see how the impact of the alternatives compares to the current situation. This alternative is sometimes also called the status quo or baseline alternative.

The stakeholder assessment can be done with two methods: MAMCA or SIS. The choice of the method depends on the number of alternatives and the availability of data. While SIS can be conducted with two alternatives, the baseline alternative and a co-designed option, MAMCA requires at least two alternatives next to the baseline alternative. Moreover, unlike in SIS, the alternatives evaluated using MAMCA must be mutually exclusive, meaning they cannot co-exist.

Both MAMCA and SIS require criteria and weights. However, the criteria must be context-related and be chosen by the stakeholders. Then, once the stakeholders have selected their criteria, they must attach weights to their criteria. Interviews with stakeholder representatives are recommended to collect criteria and weights. For stakeholders that are a group of individuals (such as citizens), it is recommended to collect criteria in a co-design workshop and to weigh the criteria using a questionnaire survey.

4 Practical guidelines[2]

The practical guidelines of this deliverable are structured according to the steps of MCA, MAMCA and SIS. These guidelines are written for Living Lab coordinators that will guide the evaluation process of the co-designed SmartHubs alternatives. The living lab coordinators are the person or team in charge of the deployment and development of each living lab. As such, they will identify the local stakeholders and invite them to the sustainability and stakeholder assessment process. To complete the assessment process, a minimum of two meetings with stakeholders is recommended: (1) to weight the criteria of stakeholders, and (2) to discuss the results of the assessment tool. However, having an additional meeting or exchange with stakeholders (e.g., by mail or phone) is necessary before the two meetings, to acknowledge the relevant criteria to consider in the process.

Furthermore, living lab coordinators must decide whether MAMCA or SIS is more convenient in regard to the evaluation of their co-designed mobility hub alternatives. Both methods are explained in sections 2.2 and 2.3 of this document. It is recommended to use MAMCA if the appraisal process aims to rank the co-designed options. SIS can be used in more complex cases in which data might not be available and the aim is to evaluate the positive and negative impacts of the co-designed options.

The content of these guidelines should enable the understanding of the appraisal process in SmartHubs. See the MAMCA Software User Guide in the next section for instructions on how to use the evaluation software. The text below gives instructions for each step of the MCA, MAMCA, and SIS.

4.1 Alternatives

The first step when conducting an MCA, MAMCA or SIS is to define alternatives. The goal of the evaluation procedure is to find an alternative that improves the current situation regarding sustainability and that has support from most or all stakeholders. Within the SmartHubs project, the alternatives are defined by citizens through a co-design process. The co-design phase should result in several alternatives that can be evaluated on their sustainability (MCA) and stakeholder preferences (MAMCA and SIS). A do-nothing alternative should also be evaluated in order to see how the impact of the alternatives compares to the current situation. In this regard, MAMCA and SIS differ in the required number of alternatives. While SIS can be conducted with two alternatives, the baseline alternative and a co-designed option, MAMCA requires several at least two alternatives next to the baseline alternative. Moreover, unlike in the SIS, in the MAMCA alternatives must be mutually exclusive so they cannot co-exist.

Guiding citizens through a co-design that results in alternatives that can be evaluated is the responsibility of the Living Lab coordinators. Problem analysis is the first stage of the SmartHub co-creation process. SmartHubs deliverable 3.2 ‘Needs of users and digitally excluded citizens’ can provide relevant input for the problem analysis.

[2] This section is partly based on the D3.3 - Linking co-design with evaluation from the Looper project (Pappers et al., 2018).

4.2 Stakeholders

During the stakeholder analysis, the stakeholders that are affected by or can affect the implementation of alternatives are defined. Including these stakeholders in the evaluation process improves the chance of implementation of (one of) the co-created alternatives. The identification of stakeholders is only relevant to do the stakeholder assessment, which is uses the MAMCA and SIS tools. In the case of the the sustainability MCA, no separate evaluation per stakeholder is done

Stakeholder groups are distinguished based on their objectives. If stakeholders have a different set of objectives, they should belong to a separate stakeholder group. An objective for a local government could be "to decrease car traffic". Moreover, different and/or conflicting objectives may exist within a stakeholder group. For example, initially, you may identify citizens as a distinct stakeholder group. Nevertheless, citizens that use public transport as their primary mode of transport may have a different objective than those that mainly use shared mobility services.

All stakeholders are assumed to be equal, regardless of the size of a stakeholder group. This means that even though the stakeholder group 'public transport users' has a larger population than the stakeholder group 'shared mobility users,' the weights of these stakeholder groups are equal. Assigning different weights to different stakeholder groups is difficult if not impossible: who would decide which stakeholder group is more important and which is less important?

The analysis of stakeholders is carried out by the Living Lab coordinators. Throughout the stages of the SmartHubs co-design process, citizens can suggest stakeholders that they think could affect or be affected by the implementation of the alternatives. During the problem identification stage, for example, citizens may already think ahead about which stakeholders may not agree with the alternative they think would solve the problem. It is recommended that Living Lab coordinators register such suggestions.

The input of citizens can then be combined with the thoughts and ideas of the Living Lab coordinators, who may have a better overview of the stakeholders that should be involved. Suggestions for stakeholders can also be found in academic literature. Moreover, new stakeholders might emerge during the following steps, in which case those new stakeholders need to be contacted and interviewed to determine their criteria and the importance they attach to these criteria.

Below is a list of stakeholder groups that have been identified from previous research on MAMCA within the realm of transport and mobility. Living Lab coordinators are free to define stakeholders that are not on this list.

- Government (local, regional or national)
- Public transport operators
- Police
- Transport authority
- Businesses (e.g., shared mobility service, local commerce, employers)
- Citizens
- Mobility associations

Living Lab coordinators will report the outcome of the identification of the stakeholders in a document with a list of stakeholders, their definitions and contact details (e.g., name of the organisation that represents s the stakeholders). A template can be found in Appendix 3, and it

should be reported in Tasks 4.2, 4.3, 4.4 and 4.5 concerning the implementation of the living labs in Anderlecht, Eastern Austria, Munich, and Rotterdam-The Hague.

4.3 Stakeholders' objectives, criteria and indicators

In MAMCA, SIS and MCA criteria are necessary to evaluate the impact of alternatives. The 24 criteria for the sustainability MCA are predefined and can be found in section 3.13.2 of this document.

The criteria for MAMCA and SIS allow us to evaluate the impact of each alternative on a stakeholder. In this evaluation, each stakeholder defines their criteria. Unlike in the sustainability MCA where there is only one set of criteria, each stakeholder group can have a different set of criteria in MAMCA and SIS.

Criteria are defined based on the objectives of stakeholders. The objective of a stakeholder can be defined by asking what they would like to see changed through the implementation of a mobility hub. Once the objective of a stakeholder is clear, it can be translated into criteria. For example, the objective of a government could be "to improve the air quality in an area".

In order to determine the impact of the alternatives on the criteria, indicators and measurement methods need to be selected. For example, an indicator for the criterion 'air quality' can be NO_x emissions, while for the criterion 'traffic safety' the number of accidents is an indicator. Living Lab coordinators can reuse the criteria and indicators from the sustainability MCA explained in section 3.1

For the MAMCA and SIS, the Living Lab coordinators are responsible for collecting and defining most of the stakeholder objectives, criteria, indicators, and weights by interviewing stakeholder representatives. In the SmartHubs project, criteria of some stakeholders have been collected through interviews in the task 2.4 "Review of the state of the practice". Living Lab coordinators should contact stakeholders to define objectives and criteria. If this is done in-person, the meeting usually starts with an introduction to the project and a description of the MAMCA or SIS methodology. The stakeholder is then asked to define their objectives and formulate possible criteria. The Living Lab coordinator can assist the stakeholder in defining their criteria and converting the criteria into indicators: asking stakeholders what is most relevant for them, explaining the use if the criteria in the process, and showing example of possible criteria. In the next step, the stakeholders might need to weigh all possible combinations of criteria, it is recommended to limit the number of criteria per stakeholder. Should an in-person meeting not be possible, defining stakeholders' objectives and criteria can also be done via e-mail, phone

In case a stakeholder group is large (e.g., citizens, a group that has many 'members'), Living Lab coordinators will collect the objectives and criteria via a questionnaire in which respondents can validate a pre-defined set of objectives/criteria and can add missing ones. This step can be skipped in case the objective(s) of this group are very clear and can be defined by the Living Lab coordinators. Living Lab coordinators are responsible for promoting the survey, for example via emails, social media, or connections with citizen or community organisations. Objectives and criteria can also be defined and collected during co-design workshops. Another way to collect the objectives and criteria of citizens is to interview citizens or community representatives. In the SmartHubs Living Lab in Anderlecht, citizens could state their preferences regarding mobility hubs during semi-structured interviews conducted for task 3.2 'Needs of users and digitally excluded citizens'.

4.4 Criteria weights

Assigning weights to criteria allows us to understand the importance of each criterion compared to other criteria. Whereas stakeholders will assign weights to their criteria for the MAMCA and SIS, the weights of the criteria in the sustainability MCA are predefined. These weights are based on answers of 21 experts from Belgium, Germany, Italy, and the Netherlands as described in section 3.1.

Regarding MAMCA, different methods can be used to assign weights to the criteria. Within SmartHubs, Saaty's (1988) Analytical Hierarchy Process (AHP) and SMART (Simple Multi-Attribute Rating Technique) (Von Winterfeldt & Edwards, 1986) are the preferred method with which stakeholders can assign weights to their criteria. AHP uses a pairwise comparison mechanism, which allows stakeholders to indicate which criterion of two is the more important one by adjusting a slider. If a stakeholder has a very strong preference for one criterion (e.g., air quality) over another (e.g., safety), they will adjust the slider closest to their preferred criteria (air quality). If a stakeholder prefers the two criteria equally, the slider remains in the middle. SMART is based on a linear additive model and allows stakeholders to indicate the relevance of criteria by distributing 100 points across all available criteria.

Living Lab coordinators have to set up a meeting with all stakeholder to assign weights to the criteria. Instructions on how to assign weights in the MAMCA software can be found in section 5.1.4 Assigning weights to the criteria of the stakeholder group(s) of citizens can be done by sending out a survey to citizens in which they can do the pairwise comparison. Another option is to have a citizen organisation representative assign the weights, or use a pen-and-paper version of the AHP pairwise comparison mechanism during a workshop (see Appendix 4 – Pen and Paper AHP Pairwise Comparison for a template).

4.5 Evaluation

In this step, the impact of alternatives on the stakeholders and the MCA criteria are evaluated. The question that evaluators need to answer is: "What impact will an alternative have on a criterion compared to the do-nothing alternative?". To carry out an independent evaluation, the evaluation should be carried out by experts (who can be part of SmartHubs) or by an external person with expertise in a specific area (e.g., traffic safety or noise pollution). Since stakeholders may be biased towards one or another alternative, they do not take part in the direct evaluation.

Various MCA methods can be used to evaluate the alternatives, but AHP (Saaty, 1988) or SMART (Von Winterfeldt & Edwards, 1986) are the preferred methods within SmartHubs. The AHP method assesses the impact of each alternative on each criterion employing a nine-point scale in a qualitative evaluation table (see Table 5). The method also makes it possible to enter actual indicator values (e.g., number of accidents) in the evaluation table whenever quantitative data is available for a certain criterion. It should be noted that although in the SmartHubs project stakeholder objectives are defined by asking what stakeholders would like to see changed within a year, the longer-term impacts of an alternative on a criterion can be taken into account during the evaluation. The SMART method assesses the performance of each alternative concerning each criterion using a rating between 0 and 10.

Table 5. Evaluation of alternatives – explanation of scores

Evaluation score	Explanation
Very negative	The co-designed option would have a very negative impact on the criterion compared to the situation today.
Negative	The co-designed option would have a negative impact on the criterion compared to the situation today.
Slightly negative	The co-designed option would have a slightly negative impact on the criterion compared to the situation today.
Neutral	The co-designed option would have no impact on the criteria compared to the situation today.
Slight positive	The co-designed option would have a slightly positive impact on the criterion compared to the situation today.
Positive	The co-designed option would have a positive impact on the criterion compared to the situation today.
Very positive	The co-designed option would have a very positive impact on the criterion compared to the situation today.

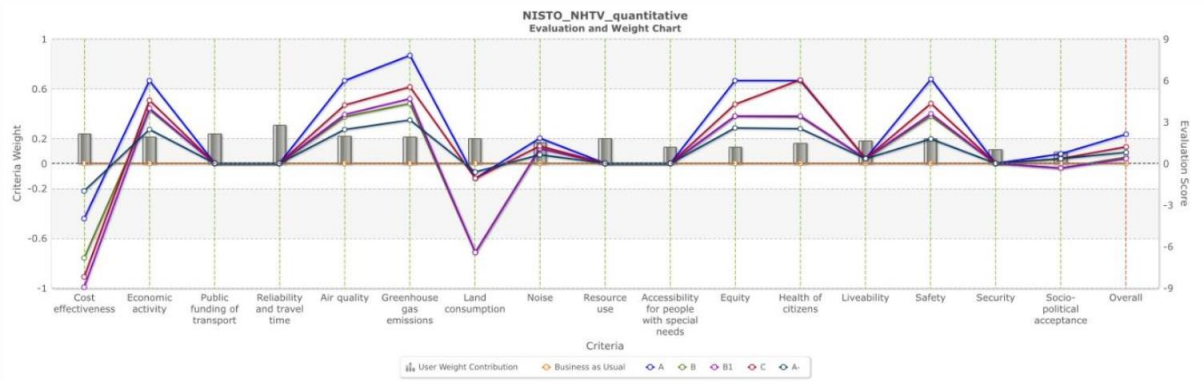
Appendix 5 – Evaluation Table, shows the evaluation table that can be used for the evaluation of the impact of the alternatives on a criterion. This table should be filled in for each criterion. It is important that the experts also provide a justification and sources for this justification (e.g., studies, reports, statistics). Therefore, the assessment must be supported by empirical evidence.

4.6 Results

Once the weights of the stakeholders' criteria and the evaluation scores have been determined, the MAMCA software calculates the evaluation scores for each alternative and stakeholder as well as for the sustainability assessment. This step, therefore, allows the Living Lab coordinators to rank the alternatives on sustainability (MCA) and see the preferred alternative of each stakeholder (MAMCA). If the chosen evaluation method is SIS instead of MAMCA, the impact scores are calculated manually as explained in section 5.2. The result of SIS will not be a ranking of alternatives, but the identification of the alternatives' positive and negative impacts on stakeholders.

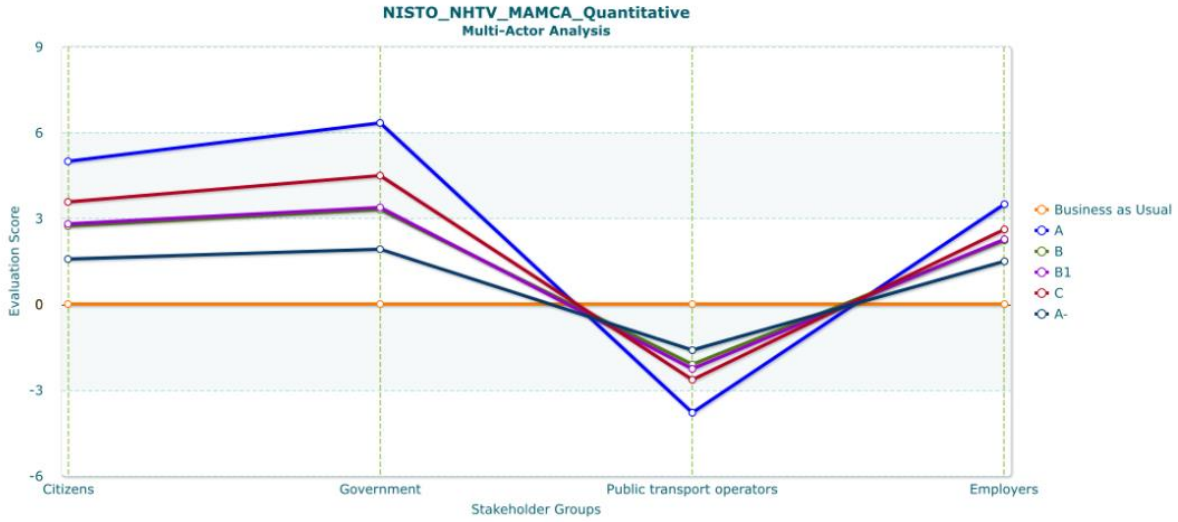
The results of the sustainability MCA rank the alternatives on their sustainability scores. This allows the Living Lab coordinators and stakeholders to see which alternative is the most or least sustainable. For example, Figure 3 shows the sustainability scores of different alternatives for a new bicycle highway in the Netherlands (A; B; B1; C; A-). Here, alternative A has the highest sustainability score, whereas alternative B1 has the lowest score.

Figure 3. Results sustainability MCA in NISTO



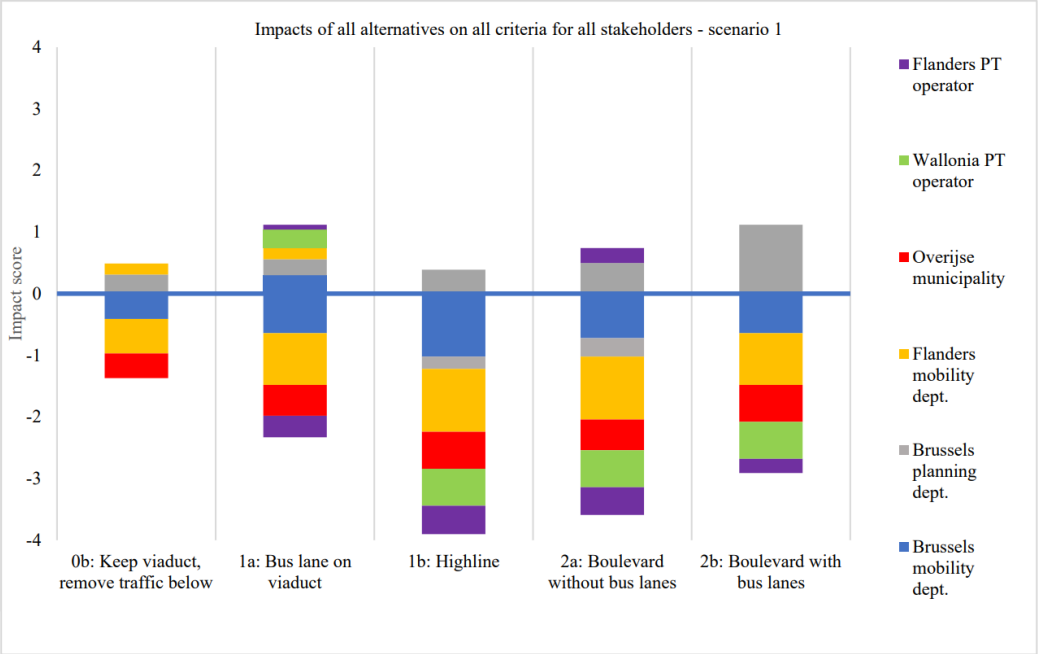
The results of MAMCA show the ranking of alternatives for each stakeholder. Figure 4 shows the stakeholder preferences for the alternatives for a new bicycle highway. Here, alternative A has the highest evaluation score for three out of four stakeholder groups (citizens, government, employers). In this example, public transport operators might prefer business as usual because a new bicycle highway could attract current bus passengers, thereby decreasing the revenue of the bus operator.

Figure 4. Results MAMCA in NISTO



The results of SIS can be graphically obtained by using an Excel template. As shown in Figure 5, five options to redevelop an overpass in Brussels are evaluated and the positive and negative impacts of each alternative on each stakeholder are aggregated. Thus, stakeholders can see the overall scoring of each alternative and make an informed decision about their preference. These results might be useful to guide the discussion during the second meeting with stakeholders, enhancing debate and consensus-making.

Figure 5. Results SIS for the redevelopment of an overpass in Brussels (te Boveldt et al., 2022)



The output of both the MCA, and MAMCA or SIS should be used as a blueprint to reach consensus among stakeholders. This can be done by ranking the alternatives based on their sustainability as well as stakeholder preferences. The coordinators should analyse each alternative and see how and why stakeholder support for the alternatives differs. Highlight criteria that cause (a lack of) stakeholder support for an alternative and use this as input for a discussion between stakeholders. The MAMCA software can visualise stakeholder preferences and evaluation scores. The visualisations that can be used for consensus-making are described in section 5. Likewise, the output of SIS also provides visualizations that are useful to reach consensus. The analysis of alternatives should include possible ways to reach a consensus on one (or more) alternative scenario(s).

To proceed to the third and last stage of co-design – implementation and monitoring – the Living Lab coordinator should organise a consensus-making meeting (second meeting) Here, the task of the Living Lab coordinators is to facilitate the consensus-making process. During this meeting, stakeholders will determine which alternative(s) is favoured. The Living Lab coordinators will present the results of the sustainability MCA and MAMCA or SIS as well as suggested way forwards. Participants can express their opinion about it and debate about preferences and impacts. In this regard, the facilitator should enhance debate and encourage interaction among participants. As a result, ca decision could be made and the Living Lab coordinators should formalise the pathway to implementation of the alternative(s) with input from the stakeholders. New options can also be identified during this process, which requires the Living Lab coordinators to repeat the evaluation for the new alternative.

4.7 Stages of the co-evaluation process

This section shows the structure of the evaluation process in a Living Lab. Coordinators are of course free to plan the evaluation phase as they see fit.

1. Living Lab coordinators: prepare a shortlist of co-designed alternatives of a mobility hub. These are likely to be uncoordinated, at different scales, have different feasibilities, and can vary between bottom-up and top-down approaches.

2. First meeting of stakeholders: discuss the shortlist of co-designed options; identify stakeholders affected; define stakeholder criteria; identify possible sources of expertise for the evaluation of the impact of alternatives on criteria. Further co-design is possible at this stage, i.e., turning loose ideas into practical proposals.

3. Living Lab coordinators: put the information together in the MCA and MAMCA/SIS format, with summaries of each alternative. Try to get further comments and responses from the community, in particular from those lacking technical knowledge or digital skills, or not present at workshops.

4. Second meeting of stakeholders: present and discuss the sustainability scores and the stakeholder support for the different co-designed options. Also discuss the feasibility, time to implementation, and costs of the alternatives. Then decide on the next steps for interventions.

5. Living Lab coordinators: set up the implementation in consultation with key stakeholders. Internal discussion and report on how the process worked or not, with evaluation lessons for the future.

5 Software user guide

It is recommended to use the MAMCA software (www.mamca.eu) to conduct the sustainability MCA and MAMCA. The SIS is done using a template in Microsoft Excel. Although the following guidelines show as an example the appraisal process of a project about logistics, the functioning and steps remain the same to appraise the co-designed alternatives of a mobility hub. The guidelines in section 5.1 are applicable to both the sustainability MCA and MAMCA; the guidelines in section 5.2 are applicable to SIS.

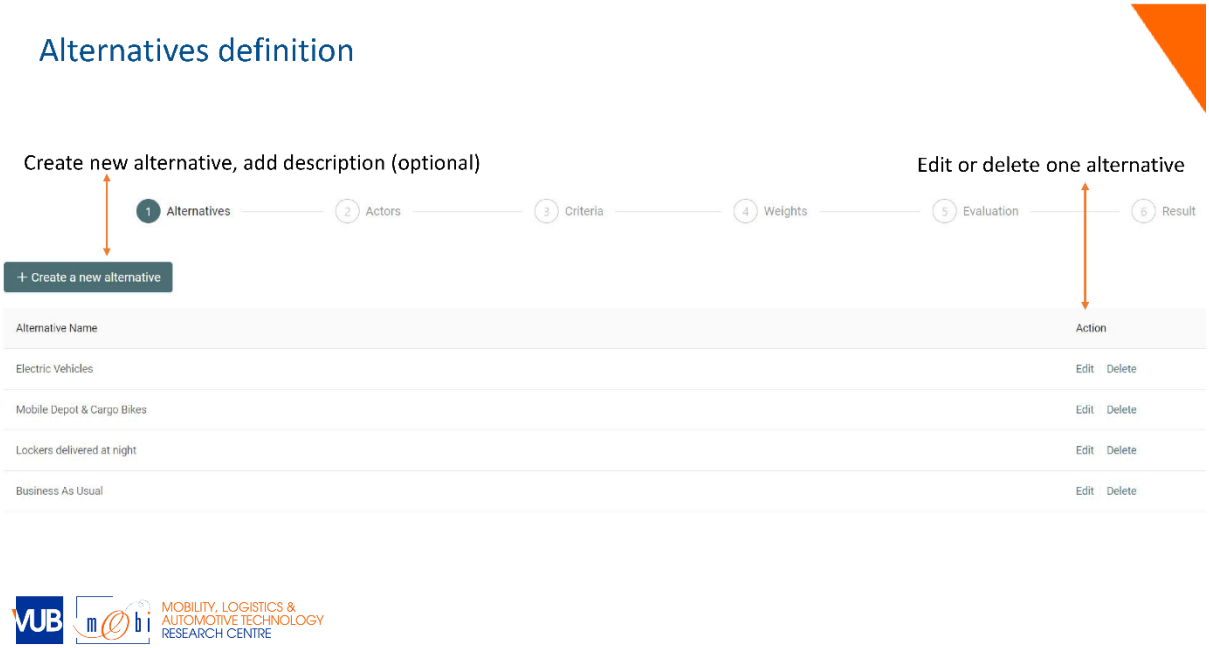
5.1 Sustainability MCA & MAMCA

The following pictures show the screenshots of every step of a sustainability MCA and MAMCA using the MAMCA software.

5.1.1 Definition of alternatives

The first step in evaluation is defining the alternatives. Figure 6 shows how alternatives can be added and edited in the software.

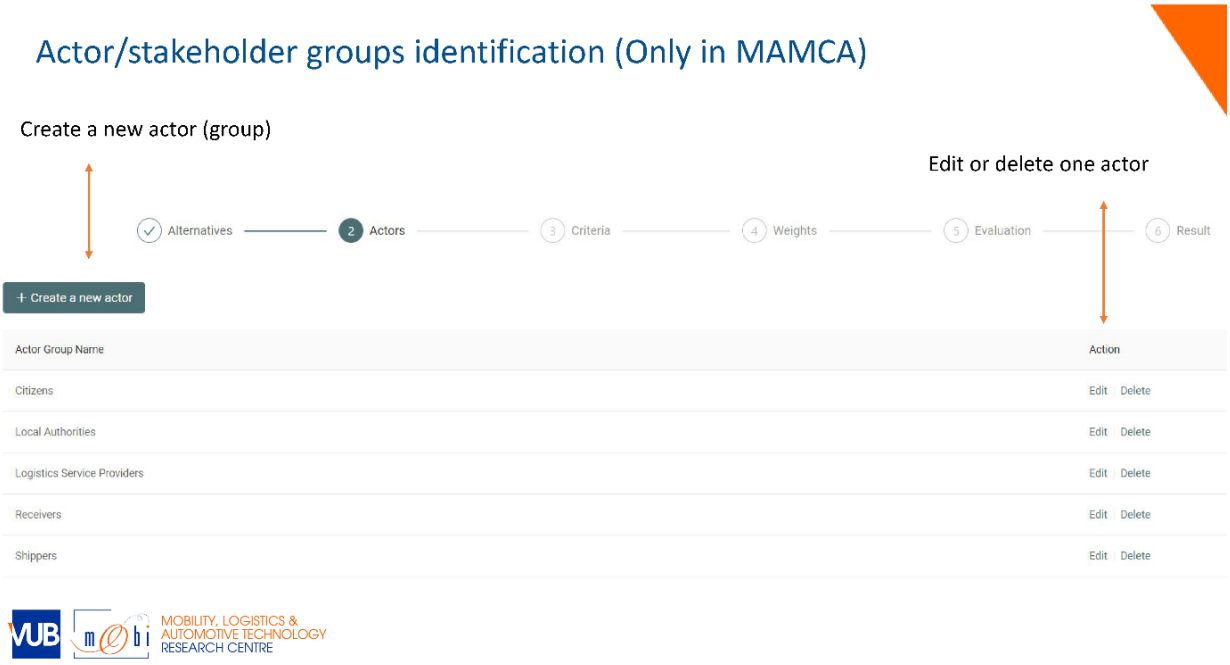
Figure 6. MA/MCA – Definition of alternatives



5.1.2 Definition of stakeholders (only applies to MAMCA)

Then, add the stakeholders to the program as explained in Figure 7. This step only applies to MAMCA, not to MCA.

Figure 7. MAMCA – Definition of stakeholders



5.1.3 Definition of criteria

Add the criteria and weights following the steps shown in Figure 8, Figure 9. For the sustainability MCA, first create three criteria representing the pillars of sustainability (i.e., economy, social, and environment), and then assign the 24 sustainability criteria from Table 4 in section 3.1 as sub-criteria. For MAMCA, add criteria per stakeholder group (called 'actors' in the software).

Figure 8. MA/MCA – Definition of criteria

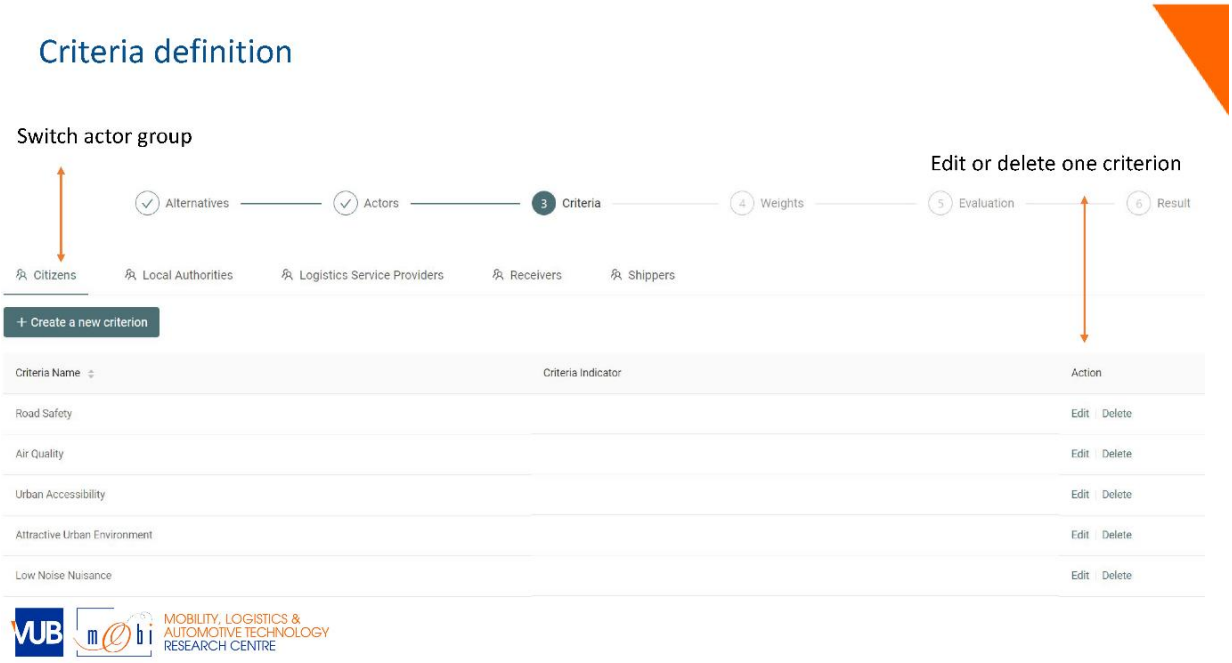
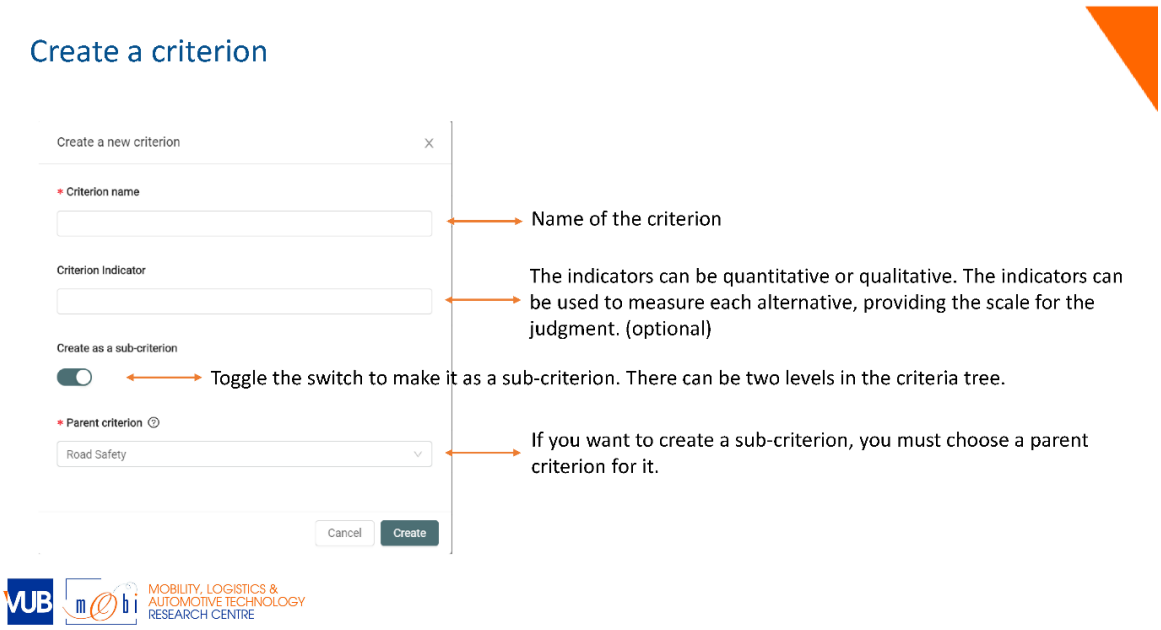


Figure 9. MA/MCA – Creation of criteria



5.1.4 Definition of weights

There are three methods to allocate weights to criteria. Pairwise comparison allows stakeholders to indicate their preference between pairs of criteria on a 17-point scale from 9 to 1 to 9 (see Figure 11). Second, there is the 100-scale. The most important criterion will be given the highest number (1-100). Then, all other criteria are rated in comparison to the most important one (see Figure 12). The values are normalised. Third, weights can be entered manually for each criterion, and the values are normalised (see Figure 13). This latter method is used to add the weights of the sustainability criteria from Table 4 in section 3.1.

Figure 10. MA/MCA – Weight allocation

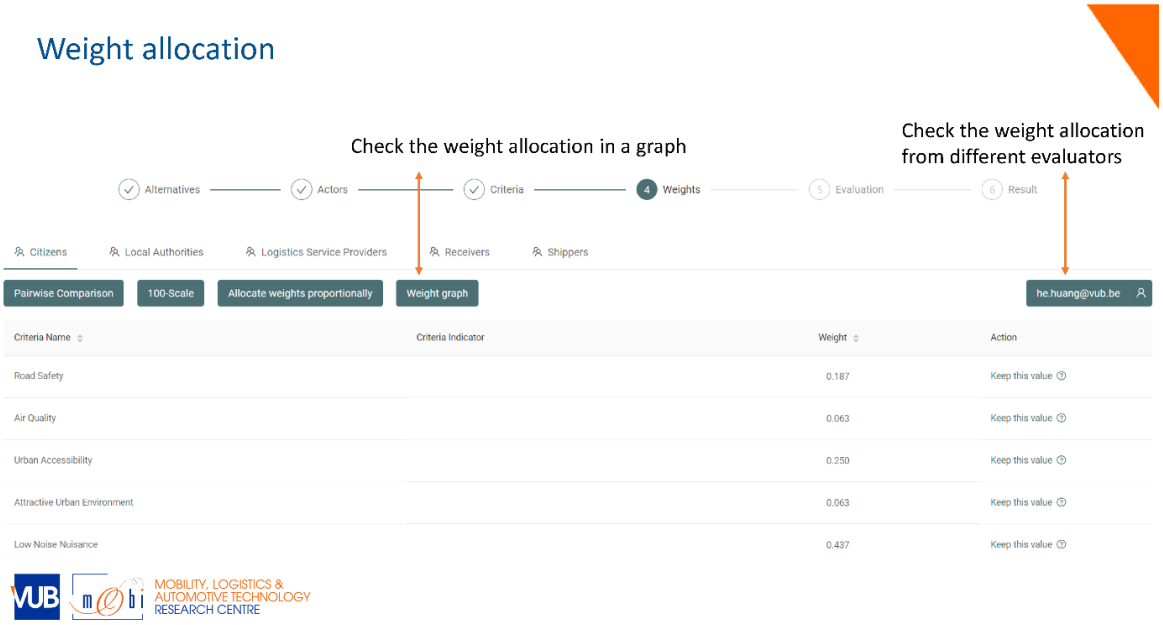


Figure 11. MA/MCA – Weight allocation – Pairwise comparison

Pairwise comparison

Each criterion should compare with all the other criteria (the sub-criteria in one group will also compared within the group).

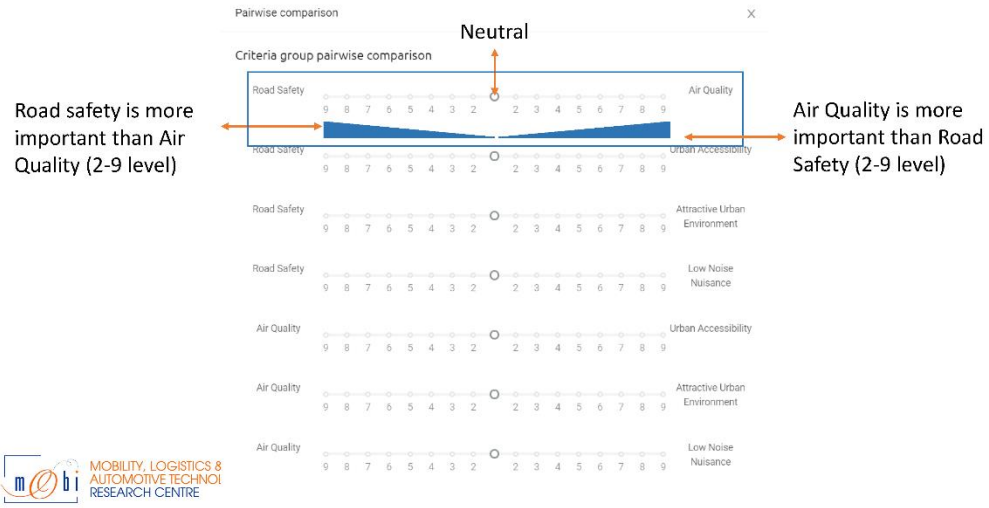


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Figure 12. MA/MCA – Weight allocation – 100-Scale method

100-Scale

The most important criterion is not necessary to give 100 points, the final result will be normalized at the end.

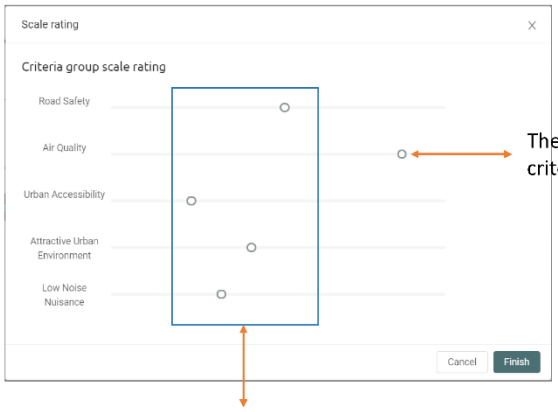

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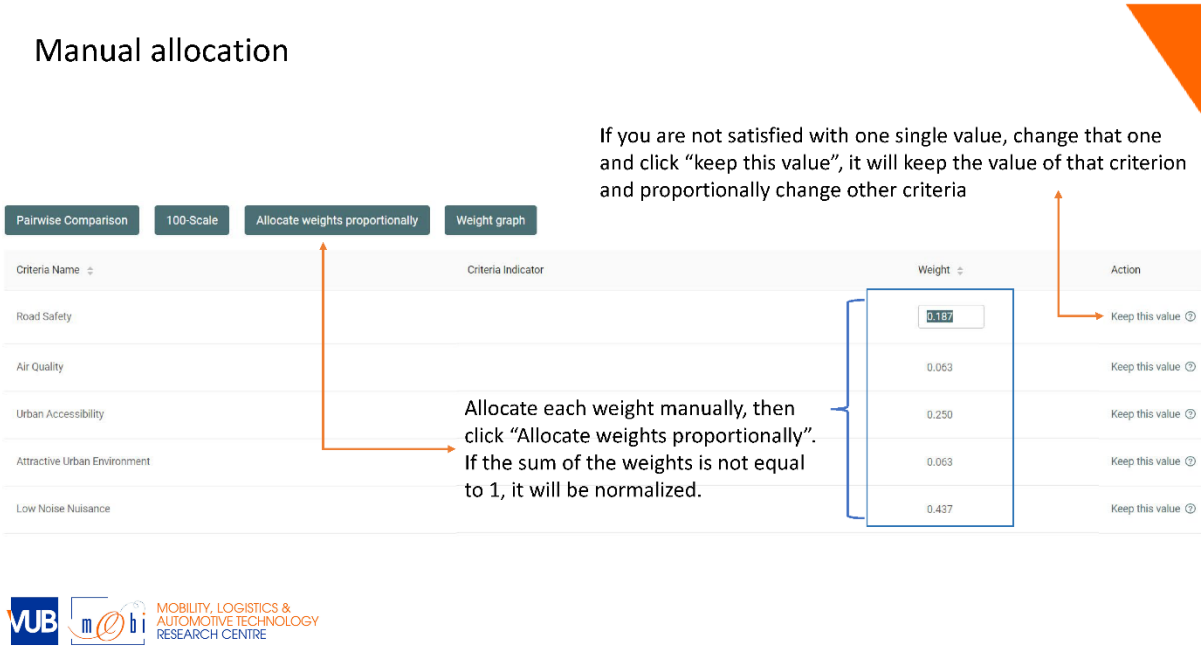
Figure 13. MA/MCA – Weight allocation – Manual entry



5.1.5 Evaluation of alternatives

In this step, the impact of the alternatives on the criteria is evaluated.

Figure 14. MA/MCA – Evaluation of impact alternatives on criteria.

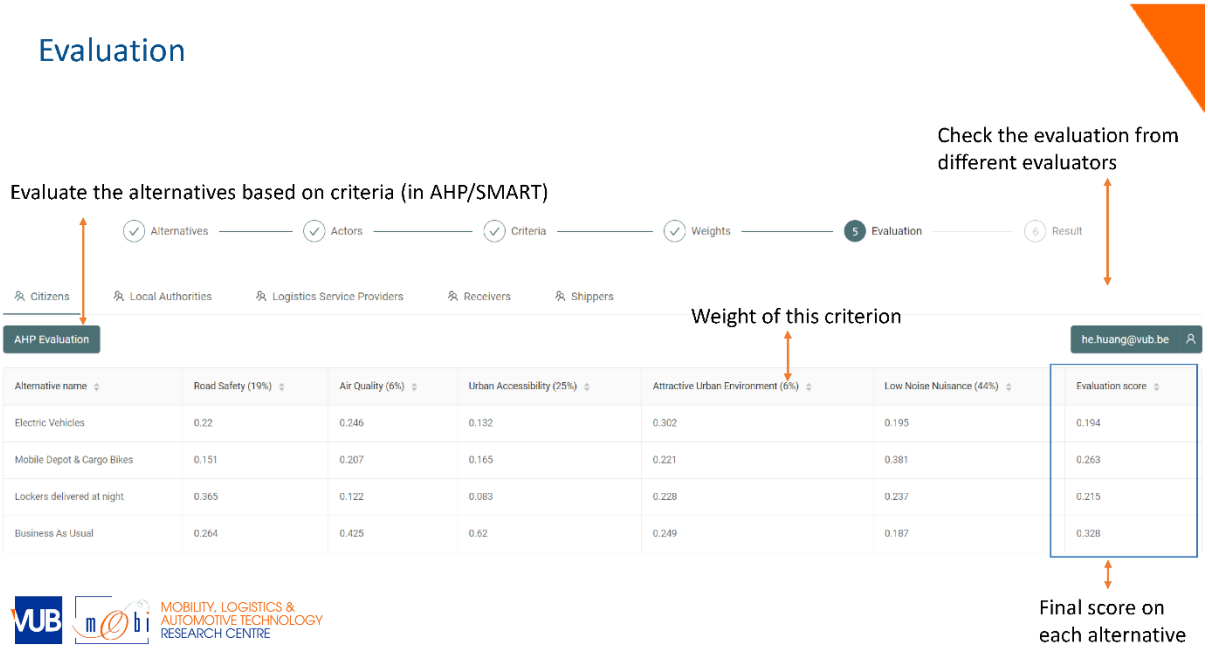


Figure 15. MA/MCA – Evaluation – AHP

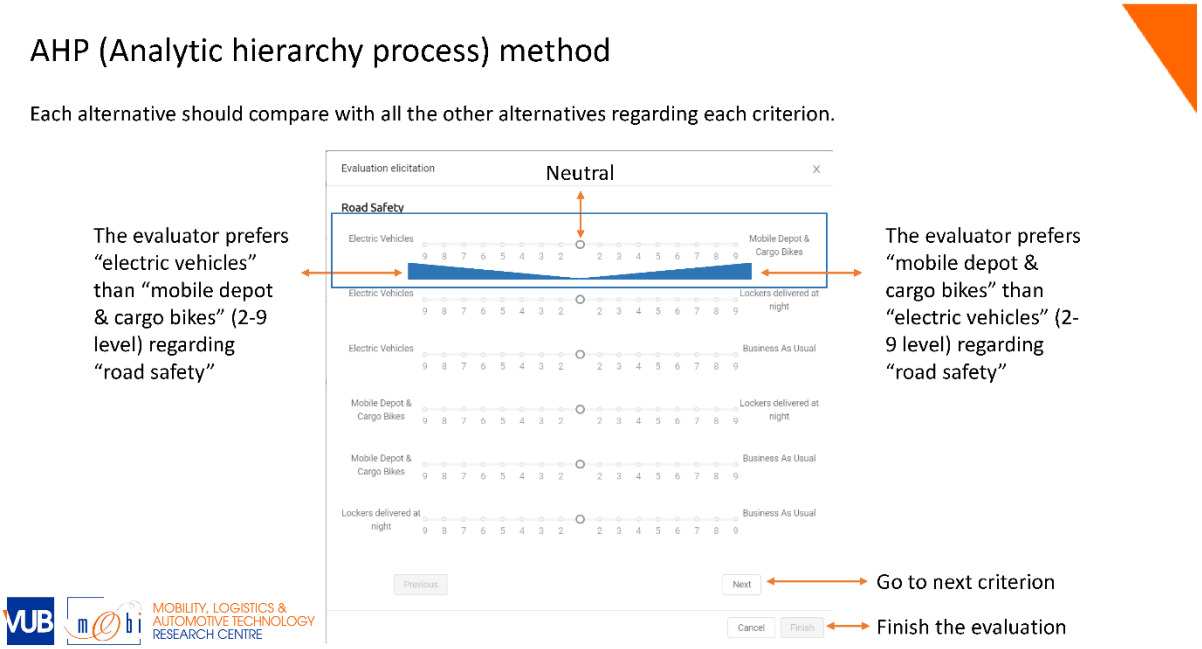
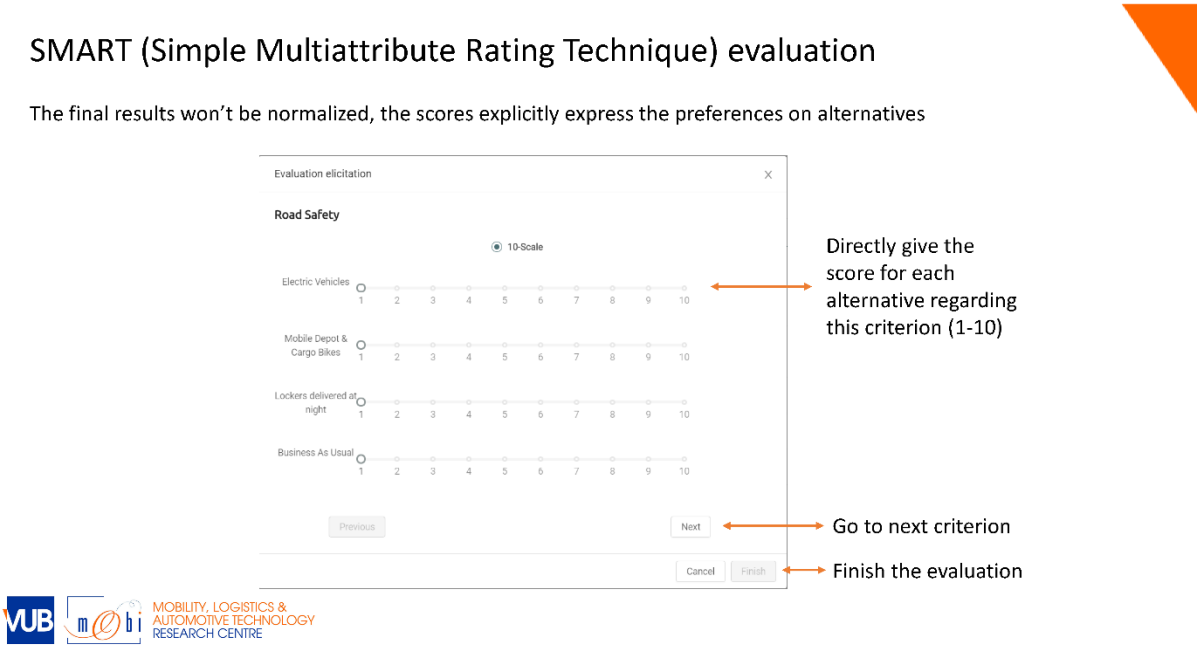


Figure 16. MA/MCA – Evaluation – SMART

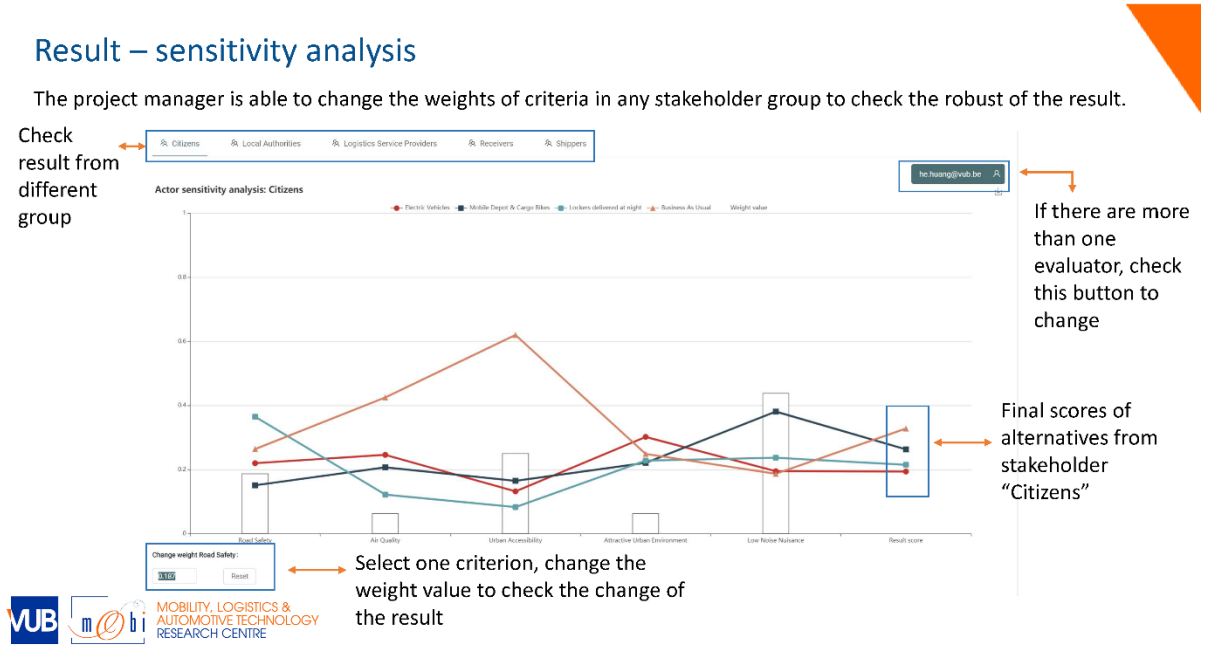


5.1.6 Results

The outcome of (MA)MCA visualises the impact of alternatives on criteria. Figure 17 shows the sensitivity analysis for the impact of three alternatives and one baseline scenario on the criteria

of the stakeholder group 'citizens.' The 'results score' show how the alternatives rank for this stakeholder group: business as usual (orange) has the most positive impact.

Figure 17. MA/MCA – Result – sensitivity analysis



5.2 SIS

The procedure of SIS is explained by te Boveldt et al. (2022) and is summarised in this section. We recommend consulting the original paper for the details of the calculation. In short, the steps of SIS are:

a. Formulate the problem, alternatives and the reference (baseline) alternative. SIS minimally requires only one alternative and a baseline alternative.
b. Identify the stakeholders.
c. Formulate the criteria that represent the interests of the stakeholders concerning the decision problem and the alternatives.
d. Compare the effects of the alternatives with the reference scenario and give a score to the performance of each alternative on each criterion, which can range anywhere between extremely negative and extremely positive.
e. Stakeholders attribute their weights to each of the criteria.
f. Analyse the output. SIS calculates a negative and a positive impact score for each alternative that can be analysed in several ways:
    a. Compare alternatives to each other and see which has the highest positive impact and the lowest negative impact.
    b. If you have a favourite alternative (or if you have just one), you can see what and how strong the negative impacts are and which stakeholders are affected, so you can improve the alternative with that information.

The SIS Excel template provides an interface you can automatically calculating and visualising results. The following instructions guide you step by step through the different tabs of the interface The instructions below are provided in the interface itself (tab 0).

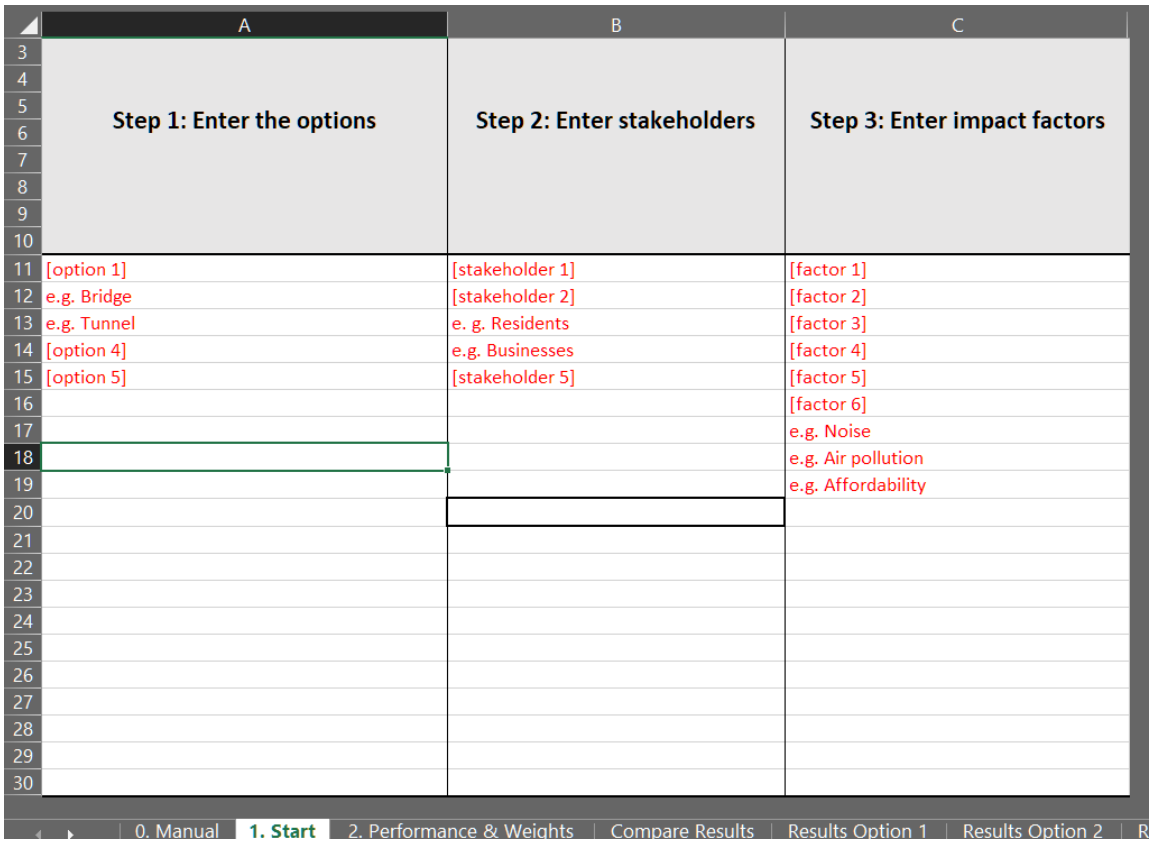
5.2.1 Tab 1: Start

1. Options. Enter the names of your decision options in column A (see Figure 18). Only enter the options that are not the 'business-as-usual' or 'do-nothing' scenarios. The output of SIS also makes sense if you have only one option or if the options are combinable and do not exclude one another (contrary to alternatives in (MAMCA).

2. Stakeholders. Enter the names of the stakeholders in column B (min. 1).

3. Impact factors. Enter all factors on which the alternatives might have relevant impact on the stakeholders. It is possible that not all factors are relevant for all stakeholders. In that case they receive a weight score of 0 on tab 2. Ensure minimum ambiguity and overlap.

Figure 18 SIS – options, stakeholders, and impact factors



5.2.2 Tab 2: Performance & Weights

1. Performance descriptions. In the designated cells (see Figure 19), describe the performance of each alternative on each factor. How will the alternative make a difference compared with doing nothing? Be as factual as you can, using quantitative data if possible, otherwise qualitative descriptions. This step is optional and not necessary for further calculations, but it provides a base for justifying the qualitative, subjective input of the later steps. It is easiest that the descriptions are provided by centrally appointed 'experts' but recommended to be shared and agreed upon by all stakeholders.

2. Performance scores. Indicate the extent to which the effect is negative or positive, choosing from the dropdown menus. It is easiest to have the centrally appointed experts do the scoring.

But as it has a subjective character, in some cases it might be appropriate to let the stakeholder do the scoring. In that case you will need to distribute different copies of the scoring table among the stakeholders.

3. Weights. Show the descriptions and scores to the stakeholders. Based on this information, they give a score to each of the factors that reflects their importance, for their respective situation. Give a score between 10 (maximum importance) and 0 (no importance). In most cases it is easiest to start with the most important factor and rate the other factors in relation to the most important one. It is possible for several factors to have the same weight. It is also possible that no factor has maximum importance. For calculating the impact scores, the labels (negative-positive) are converted into numerical values from -1 to +1.

Figure 19. SIS – performance and weights

Step 1: Describe the performance of the option for each factor (optional)	Step 2: Enter perfomance score of the option for each factor									Step 3: Enter the weights of each stakeholder for each factor between 10 (most important) and 0 (not important) Replace with your own numbers							
[option 1]		e.g. Bridge		e.g. Tunnel		[option 4]		[option 5]		[stakeholder 1]	[stakeholder 2]	e. g. Residents	e.g. Businesses	[stakeholder 5]	0	0	0
Description (difference with doing nothing)	Score (compared to doing nothing)	Description	Score	Description	Score	Description	Score	Description	Score								
[perfomance option 1 on factor 1]	Most negative (-1)	[perfomance op	Most positive (1)	[perfomance option 3	Slightly negative (-0.33)		Neutral (0)		Neutral (0)	10.0	10.0	1.0	10.0	10.0			
[perfomance option 1 on factor 2]	Most positive (1)	[perfomance op	Slightly negative (-0.33)	[perfomance option 3	Slightly negative (-0.33)		Neutral (0)		Neutral (0)	10.0	7.0	10.0	0.0	7.0			
[perfomance option 1 on factor 3]	Strongly Negative (-0.67)	[perfomance op	Most positive (1)	[perfomance option 3	Slightly negative (-0.33)		Neutral (0)		Neutral (0)	10.0	4.0	2.0	8.0	5.0			
[perfomance option 1 on factor 4]	Slightly negative (-0.33)	[perfomance op	Most positive (1)	[perfomance option 3	Slightly positive (0.33)		Neutral (0)		Neutral (0)	2.0	10.0	10.0	0.0	5.0			
[perfomance option 1 on factor 5]	Positive (0.67)	[perfomance op	Most positive (1)	[perfomance option 3	Most positive (1)		Neutral (0)		Neutral (0)	8.0	5.0	8.0	10.0	10.0			
[perfomance option 1 on factor 6]	Most negative (-1)	[perfomance op	Most positive (1)	[perfomance option 3	Most positive (1)		Neutral (0)		Neutral (0)	10.0	4.0	5.0	5.0	10.0			
[perfomance option 1 on factor 7]	Most positive (1)	[perfomance op	Strongly Negative (-0.67)	[perfomance option 3	Most negative (-1)		Neutral (0)		Neutral (0)	4.0	8.0	5.0	5.0	5.0			
[perfomance option 1 on factor 8]	Positive (0.67)	[perfomance op	Strongly Negative (-0.67)	[perfomance option 3	Slightly positive (0.33)		Neutral (0)		Neutral (0)	1.0	9.0	1.0	10.0	1.0			
[perfomance option 1 on factor 9]	Slightly positive (0.33)	[perfomance op	Strongly Negative (-0.67)	[perfomance option 3	Slightly positive (0.33)		Neutral (0)		Neutral (0)	10.0	7.0	10.0	1.0	5.0			
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								
	Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)		Neutral (0)								

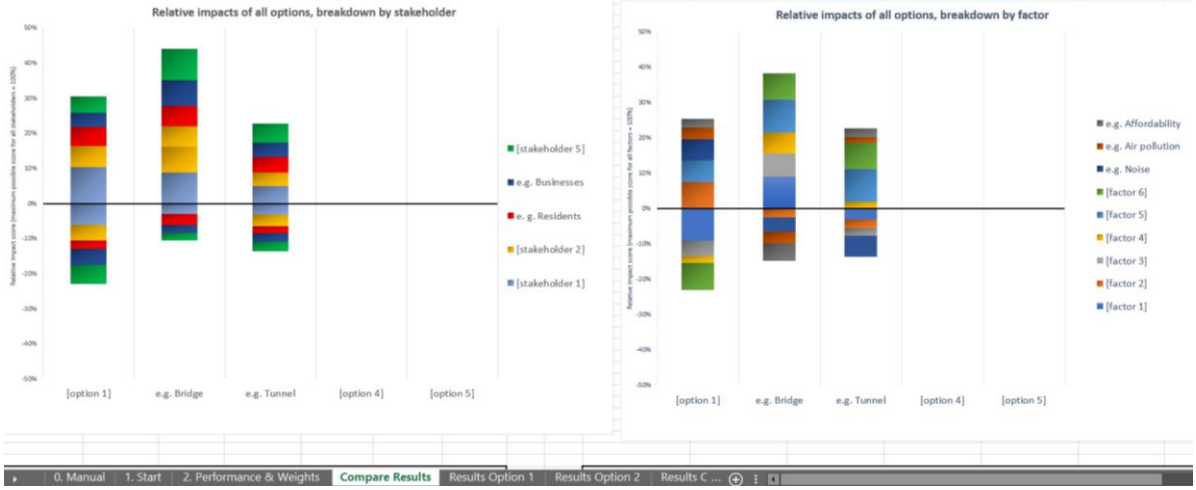
5.2.3 Tab: Compare Results

Based on your input, this tab shows two charts that allow you to compare the options:

Relative impacts of all options, breakdown by stakeholder. This show you the extent to which the stakeholders are negatively or positively affected by each of the options. For instance, in Figure 20, the left chart shows how the three options have more positive impacts than negative impacts for all stakeholders. And in the case of option 1, stakeholder 5 obtains a score of 30 concerning positive impacts, and a score of -20 concerning negative ones.

Relative impacts of all options, breakdown by factor. This shows you the extent to which each of the factors contributes negatively or positively to the total impacts. In both charts, 100% represents the maximum possible (negative or positive) impact an option can have for all factors and all stakeholders combined. The layout of the charts can be modified to your liking. For clarity, it is recommended to use one colour to represent each stakeholder, no matter whether the impacts are negative or positive.

Figure 20. SIS – relative impacts of all options by stakeholder (left) and by factor (right)



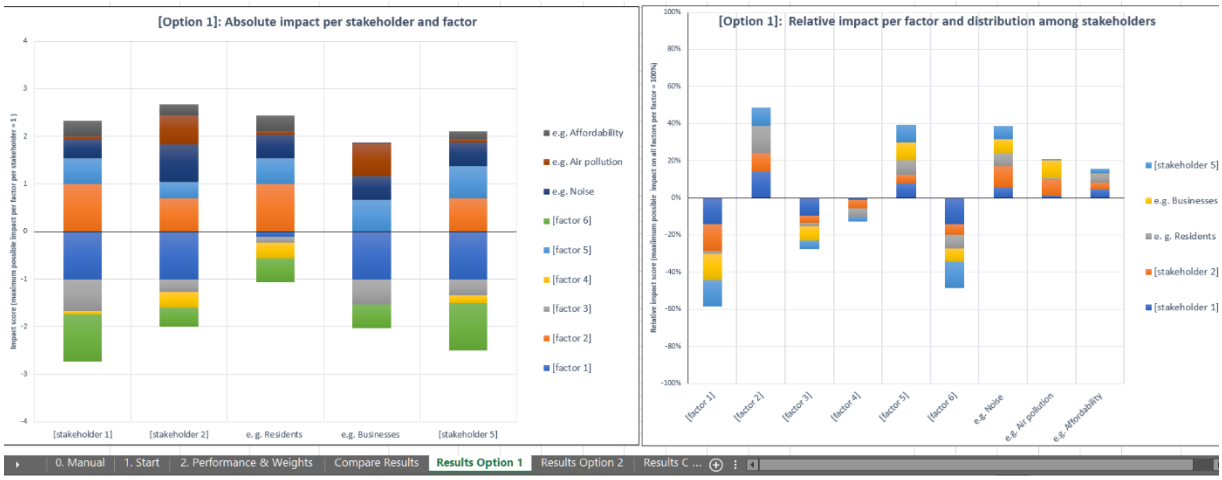
5.2.4 Tabs: Results Option 1, 2, 3

Each of the tabs allows a deeper analysis of the individual options through two charts, showing how your favourite decision can be improved to meet stakeholders' demands.

Absolute impact per stakeholder and factor. This shows you the option's impact on each of the factors, while also displaying the stakeholders for whom the impacts are relevant. Here, 1 unit represent the maximum (negative or positive) impact for 1 stakeholder on factor. So, the higher number of factors relevant for a stakeholder, the higher impact score can be.

Relative impact per factor and distribution among stakeholders. This shows you the option's impact on each of the factors, while also displaying the stakeholders for whom the impacts are relevant. 100% represents the maximum possible impact with regard to the respective factor. Here too, the layout of the charts can be modified to your liking, but it is recommended to use one colour per stakeholder.

Figure 21. SIS – Absolute impact per stakeholder and factor (left) and relative impact per factor and distribution among stakeholders (right)



6 Conclusions

Combining evaluation methods such as MCA and MAMCA or SIS as part of a co-design process is recommended and has proven effective previously. This deliverable presents guidelines on how to integrate a sustainability analysis and a stakeholder support assessment into the SmartHubs co-design process. This is because one of the aims of the projects is to assess if a co-designed development enables mobility hubs to act as a game changer toward inclusive sustainable urban mobility and accessibility. Moreover, the inclusion of stakeholders, as the consideration of their support, is a central element of the democratic integration of a SmartHub (Geurs & Münzel, 2022).

The proposed methods are multi-criteria analysis (MCA) for the sustainability analysis and multi-actor multi-criteria analysis (MAMCA) or stakeholder-based impact scoring (SIS) for the assessment of stakeholder support. The goal of these methods is to show how sustainable and how much stakeholder support each co-designed SmartHub alternative has. Together, these methodologies can facilitate reaching consensus between the different stakeholders on a co-designed alternative that is both sustainable and has support from (most) stakeholders.

By developing the SmartHubs Appraisal Tool, this document has presented the methodology that will allow us to investigate to what extent the co-creation process of a mobility hub can be supported by a sustainability and stakeholder assessment tool. The impact of the SmartHubs Appraisal Tool will be measured by its application in the SmartHubs Living Labs. Further research could investigate if the relevance of each stakeholder in the assessment of the co-designed options should be reconsidered, since currently all stakeholders count equally. Such research could investigate what stakeholder should have more relevance in the tool and why, as how to measure and justify such choices.

7 References

Anderson, K., Blanchard, S. D., Cheah, D., & Levitt, D. (2017). Incorporating Equity and Resiliency in Municipal Transportation Planning: Case Study of Mobility Hubs in Oakland, California. *Transportation Research Record*, *2653*(1), 65–74. https://doi.org/10.3141/2653-08

Aydin, N., Seker, S., & Özkan, B. (2022). Planning Location of Mobility Hub for Sustainable Urban Mobility. *Sustainable Cities and Society*, *81*, 103843. https://doi.org/10.1016/j.scs.2022.103843

Bell, D. (2019). Intermodal Mobility Hubs and User Needs. *Social Sciences*, *8*(2), Article 2. https://doi.org/10.3390/socsci8020065

Blomkamp, E. (2018). The Promise of Co-Design for Public Policy. *Australian Journal of Public Administration*, *77*(4), 729–743. https://doi.org/10.1111/1467-8500.12310

Bradwell, P., & Marr, S. (2017). Making the most of collaboration an international survey of public service co-design. *Annual Review of Policy Design*, *5*(1), Article 1.

Browne, D., & Ryan, L. (2011). Comparative analysis of evaluation techniques for transport policies. *Environmental Impact Assessment Review*, *31*(3), 226–233. https://doi.org/10.1016/j.eiar.2010.11.001

Brucker, K. D., Verbeke, A., & Macharis, C. (2004). THE APPLICABILITY OF MULTICRITERIA-ANALYSIS TO THE EVALUATION OF INTELLIGENT TRANSPORT SYSTEMS (ITS). *Research in Transportation Economics*, *8*, 151–179. https://doi.org/10.1016/S0739-8859(04)08008-4

Bulckaen, J., Keseru, I., & Macharis, C. (2016). Sustainability versus stakeholder preferences: Searching for synergies in urban and regional mobility measures. *Research in Transportation Economics*, *55*, 40–49. https://doi.org/10.1016/j.retrec.2016.04.009

Edwards, B. (2011). *Sustainability and the Design of Transport Interchanges*. Routledge. https://doi.org/10.4324/9780203839652

Geurs, K., & Münzel, K. (2022). *A multidimensional mobility hub typology and inventory*. https://www.smartmobilityhubs.eu/_files/ugd/c54b12_819c85702a6442c6bebb18538fb93516.pdf

Grimble, R., & Wellard, K. (1997). Stakeholder methodologies in natural resource management: A review of principles, contexts, experiences and opportunities. *Agricultural Systems*, *55*(2), 173–193. https://doi.org/10.1016/S0308-521X(97)00006-1

Hernandez, S., Monzon, A., & de Oña, R. (2016). Urban transport interchanges: A methodology for evaluating perceived quality. *Transportation Research Part A: Policy and Practice*, *84*, 31–43. https://doi.org/10.1016/j.tra.2015.08.008

Keseru, I., Bulckaen, J., & Macharis, C. (2016). The multi-actor multi-criteria analysis in action for sustainable urban mobility decisions: The case of Leuven. *International Journal of*

Multicriteria Decision Making, *6*(3), 211–236. https://doi.org/10.1504/IJMCDM.2016.079713

Keseru, I., Bulckaen, J., Macharis, C., Hadavi, S., & Mommens, K. (2015). *NISTO Case Study Evaluation Report* (p. 62). Vrije Universiteit Brussel. http://nistotoolkit.eu/apps/docs/CaseStudyEvaluationReport.pdf

Macharis, C. (2000). *Strategische modellering voor intermodale terminals. Socio-economische evaluatie van de locatie van binnenvaart/weg terminals in Vlaanderen.* [PhD Dissertation]. Vrije Universiteit Brussel.

Macharis, C. (2004). The optimal location of an intermodal bargeterminal. In M. Beuthe, D. V. Himanen, P. A. Reggiani, & D. L. Zamparini (Eds.), *Transport Developments and Innovations in an Evolving World* (pp. 211–234). Springer.

Macharis, C., & Bernardini, A. (2015). Reviewing the use of Multi-Criteria Decision Analysis for the evaluation of transport projects: Time for a multi-actor approach. *Transport Policy*, *37*(0), 177–186. https://doi.org/10.1016/j.tranpol.2014.11.002

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. https://doi.org/10.1002/atr.5670430206

Macharis, C., De Witte, A., & Turcksin, L. (2010). The Multi-Actor Multi-Criteria Analysis (MAMCA) application in the Flemish long-term decision making process on mobility and logistics. *Transport Policy*, *17*(5), 303–311. https://doi.org/10.1016/j.tranpol.2010.02.004

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. https://doi.org/10.1016/j.dss.2012.08.008

Martinez, C., & Rakha, T. (2017). *A design framework for sustainable mobility hub networks in mid-sized cities*. *3*, 4860–4867. Scopus.

Nordström, E.-M., Eriksson, L. O., & Öhman, K. (2010). Integrating multiple criteria decision analysis in participatory forest planning: Experience from a case study in northern Sweden. *Forest Policy and Economics*, *12*(8), 562–574. https://doi.org/10.1016/j.forpol.2010.07.006

Pappers, J., Keserü, I., & Macharis, C. (2021). Participatory evaluation in transport planning: The application of Multi-Actor Multi-Criteria Analysis in co-creation to solve mobility problems in Brussels. *Transport in Human Scale Cities*. https://doi.org/10.4337/9781800370517.00028

Pappers, J., Keserü, I., & Macharis, J. (2018). *Report on the specifications for integrating evaluation tools in the LOOPER platform* (1.0). Zenodo. https://doi.org/10.5281/zenodo.3822373

Serdar, M. Z., Koç, M., & Al-Ghamdi, S. G. (2022). Urban Transportation Networks Resilience: Indicators, Disturbances, and Assessment Methods. *Sustainable Cities and Society*, *76*, 103452. https://doi.org/10.1016/j.scs.2021.103452

te Boveldt, G., Keseru, I., & Macharis, C. (2022). When monetarisation and ranking are not appropriate. A novel stakeholder-based appraisal method. *Transportation Research Part A: Policy and Practice*, *156*, 192–205. https://doi.org/10.1016/j.tra.2021.12.004

Vermote, L., Macharis, C., Hollevoet, J., & Putman, K. (2014). Participatory evaluation of regional light rail scenarios: A Flemish case on sustainable mobility and land-use. *Environmental Science & Policy*, *37*, 101–120. https://doi.org/10.1016/j.envsci.2013.08.013

Wang, J.-J., Jing, Y.-Y., Zhang, C.-F., & Zhao, J.-H. (2009). Review on multi-criteria decision analysis aid in sustainable energy decision-making. *Renewable and Sustainable Energy Reviews*, *13*(9), 2263–2278. https://doi.org/10.1016/j.rser.2009.06.021

World Commission on Environment and Development. (1987). *Our Common Future*. Oxford University Press. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

8 Appendices

8.1 Appendix 1 – Questionnaire survey 1

SmartHubs Sustainability appraisal

Start of Block: Introduction

Title T3.5 - SmartHubs sustainability appraisal tool

Introduction **Selection of criteria to appraise sustainability**

The result of this survey will be used to decide which criteria must be included in the SmartHubs sustainability appraisal tool. This survey is divided into three parts, and each one refers to one pillars of sustainability: economic sustainability, environmental sustainability and social sustainability.

During the following questions, you will be asked if you agree or disagree on including each pre-selected criteria. At the end of each block, you will be able to add indicators or comment on those that are listed through an open question.

Please, feel free to make remarks or to ask for additional indicators.

Thank you for your support.

Page Break

Q0 Could you please indicate your field of expertise and the name of your organization?

_____

End of Block: Introduction

Start of Block: Economic sustainability

Q1 **Economic sustainability**

From the following criteria, which ones do you think should be used to appraise the economic sustainability of mobility hubs?

	Yes (1)	No (2)	I don't know (3)
Economic activity - Economic (and business) change due to the realisation of the project. *Indicators: commercial activity, employment and hospitality.* (1)	○	○	○
Cost effectiveness - Cost-Benefit Analysis. *Indicators: Investment costs, operating costs and revenues.* (2)	○	○	○
Reliability of transport modes and travel time *Indicators: Delays, cancellation and duration of trips.* (3)	○	○	○
Public funding - Efficient public spending on transport. *Indicators: Level of transport subsidies for investments and for operating costs* (4)	○	○	○
Adaptability - Ability to adapt to socio-economic and technological changes. *Indicators: Adaptable planning and provision of resources for unexpected needs.* (5)	○	○	○

Q2 Would you add any other criteria for appraising the economic sustainability of a mobility hub? If yes, can you name it, describe it and explain why it is relevant?

End of Block: Economic sustainability

Start of Block: Environmental sustainability

Q3 **Environmental sustainability**

From the following criteria, which ones do you think should be used to appraise the environmental sustainability of mobility hubs?

	Yes (1)	No (2)	I don't know (3)
Land consumption - The proportion of land which is occupied by transport infrastructure in the city contributing to the loss of green areas and habitats, and causing visual impact. *Indicator: Extent of new land consumption by project implementation in relation to existing land occupied by transport infrastructure within a city.* (1)	○	○	○
Greenhouse gas emissions - Contribution of the project to greenhouse gas emissions. *Indicator: Project CO2.* (2)	○	○	○
Air quality - Level of air pollution in the mobility hub. *Indicator: Emission of air pollutants, such as NOx and PM2.5, and perception of air quality.* (3)	○	○	○
Resource use - Use of energy resources. *Indicator: Proportion of alternative energy sources used in the facilities of the hub and its permanent infrastructure.* (4)	○	○	○
Noise - Noise emission within the hub. *Indicator: Noise produced by all type of elements of the hub, perception of noise and exposure to noise.* (5)	○	○	○
Material use - Choice of materials and circularity. *Indicators: Proportion of sustainable and reused materials, and consideration of their life cycle.* (6)	○	○	○
Climate adaptation measures - Measures adopted to fight climate change *Indicator: inclusion of measures directed to tackling climate change, such as natural cooling and water saving.* (7)	○	○	○
Flexibility - Flexible design of facilities allowing adaptation. *Indicators: capacity to host different uses over time and adapt to spatial transformations.* (8)	○	○	○
Resilience - Ability of a mobility hub to keep operational in the face of one or more major obstacles to normal function, such as extreme weather or accidents. *Indicator: to decide in task 5.4.* (9)	○	○	○

Q4 Would you add any other criteria for appraising the environmental sustainability of a mobility hub? If yes, can you name it, describe it and explain why it is relevant?

_____

_____

_____

_____

_____

End of Block: Environmental sustainability

Start of Block: Social sustainability

Q5 **Social sustainability**

From the following criteria, which ones do you think should be used to appraise the social sustainability of mobility hubs?

	Yes (1)	No (2)	I don't know (3)
Safety - Safety of all transport users. *Indicator: number of accidents and perception of safety.* (1)	○	○	○
Security - Security of all transport users. *Indicator: Reported crime and perception of crime and security.* (2)	○	○	○
Access to opportunities - Provision of access to jobs and basic services for all citizens and visitors, irrespective of social and economic background. *Indicator: Location of the hub in regard of population density, and the accessibility that it provides to employment, healthcare and essential services, considering distance, time and frequency.* (3)	○	○	○
Universal accessibility - Physical and digital accessibility of transport for the disabled, people with reduced mobility, children and people with small children. *Indicators: Proportion of fully accessible services, facilities and information.* (4)	○	○	○
Social inclusion - Use of transport by disadvantaged groups. *Indicators: Proportion of people belonging to disadvantaged groups within users compared to the local population.* (5)	○	○	○
Gender equality - Presence of women in the mobility hub, as users or workers *Indicator: proportion of women in the different transport options and working categories within the hub.* (6)	○	○	○
Affordability - Affordability of transport for all individuals, regardless of their socio-economic characteristics. *Indicator: Cost of transport services available at the hub compared to the average income of local residents.* (7)	○	○	○
Active mobility - Level of use of active modes of transport. *Indicators: Part of mobility done by foot, cycling or by other active modes of transport, measured in percent of total distance.* (8)	○	○	○
Liveability - How well citizens and visitors feel in the mobility hub and the immediate surroundings. *Indicators: Quality of urban space, walkability and pedestrian friendliness.* (9)	○	○	○
Socio-political acceptance - Support of the project by citizens. *Indicator: Citizen's approval of/satisfaction with the project.* (10)	○	○	○

Policy integration - Integration in local, regional and national policies. *Indicator: Proportion of related policies in which the project and mobility hub(s) are considered.* (11)	○	○	○
Satisfaction of workers - Satisfaction of all people working at the hub full-time or part-time. *Indicator: Rating from employees.* (12)	○	○	○

Q6 Would you add any other criteria for appraising the social sustainability of a mobility hub? If yes, can you name it, describe it and explain why it is relevant?

_____

_____

_____

_____

_____

End of Block: Social sustainability

Start of Block: Additional criteria

Q7 To conclude this survey, would you add any other criteria for appraising the sustainability of a mobility hub? If yes, can you name it, describe it and explain why it is relevant?

_____

_____

_____

_____

_____

Q8 Do you have any comment or suggestion concerning this survey?

_____

_____

_____

_____

_____

End of Block: Additional criteria

8.2 Appendix 2 – Questionnaire survey 2

SmartHubs Sustainability appraisal - 2

Start of Block: Introduction

Title T3.5 - SmartHubs sustainability appraisal tool

Introduction **Weighting of criteria to appraise sustainability**

This survey will be used to decide how important each criterion is in the SmartHubs sustainability appraisal tool (T3.5). This survey is divided into three parts, each one refers to one pillar of sustainability:

Economic sustainability
Environmental sustainability
Social sustainability

The three pillars are considered equally relevant in the SmartHubs Sustainability Appraisal tool and each pillar has a different number of criteria.

During the following questions, you will indicate how relevant each criterion is for you. **For each pillar of sustainability, you are asked to distribute 100 points among all criteria.** In total, you will be distributing 300 points in three separate sections of this survey.

At the end of the survey you will be able to write a comment concerning the criteria and the survey.

Thank you for your support!

Lluis Martinez
Jesse Pappers
Prof. Dr. Imre Keserü

Page Break

Q1 What is your field of expertise?

_____

Q2 Which institution do you work for?

- ACUR: TU Wien - Artifact-based Computing & User Research
- AML/IVS: Aspern Mobility Lab/TU Wien
- Aspern.mobil LAB
- BOKU: University of Natural Resources and Life Sciences
- Federal Government of Lower Austria
- ITS Vienna Region
- IVS: TU Wien - Transport System Planning
- Mobility Lab Graz
- Mopoint
- SUM: Stadt-Umland-Management Wien-Niederösterreich
- Wien 3420 Aspern Development AG
- AND: Anderlecht Municipality
- Brussels Mobility
- Mpact
- VUB: Vrije Universiteit Brussel
- City of Munich
- MVV: Munich Public Transport Association
- TUM: Technical University of Munich
- UPS
- WWU: University of Münster
- UNIBO: University of Bologna
- CROW

- ○ HTM Personenvervoer
- ○ MRDH: Metropolitan Region Rotterdam The Hague
- ○ NS Stations
- ○ RET
- ○ Rotterdam Municipality
- ○ The Hague Municipality
- ○ UT: University of Twente
- ○ IMM: Istanbul Metropolitan Municipality
- ○ LFL: Lojika Field Labs
- ○ Other: _____

End of Block: Introduction

Start of Block: Economic sustainability

Q3 **Economic sustainability**

Distribute **100 points** among the following **5 criteria** to appraise the economic sustainability of mobility hubs.
You can give 0 points if you consider a criterion irrelevant.

Economic activity *Economic (and business) change due to the realisation of the mobility hub*
Cost effectiveness *Cost-Benefit Analysis: Investment costs, operating costs and revenues*
Reliability of transport modes and travel time *Delays, cancellation and duration of trips.*
Public funding *Efficient public spending on transport*
Adaptability *Ability to adapt to socio-economic and technological changes*

End of Block: Economic sustainability

Start of Block: Environmental sustainability

Q4 **Environmental sustainability**

Distribute **100 points** among the following **8 criteria** to appraise the environmental sustainability of mobility hubs.
You can give 0 points if you consider a criterion irrelevant.

Greenhouse gas emissions *Contribution of the mobility hub to greenhouse gas emissions*
Air quality *Level of air pollution in the mobility hub* (9)
Resource use *Source of energy used in the facilities and infrastrucutre of the mobility hub*
Noise *Noise emission within the mobility hub* (3)
Material use *Choice of materials used for the construction of the mobility hub and use of circularity* (4)
Climate adaptation measures *Measures to adapt the mobility hub to the impacts of climate change* (10)
Flexibility *Flexible design of facilities allowing adaptation*
Resilience *Ability of a mobility hub to keep operational in the face of one or more major obstacles to normal function, such as extreme weather or accidents*

End of Block: Environmental sustainability

Start of Block: Social sustainability

Q5 **Social sustainability**

Distribute **100 points** among the following **11 criteria** to appraise the social sustainability of mobility hubs.
You can give 0 points if you consider a criterion irrelevant.

Safety *Perceived safety of all users of the mobility hub*
Security *Experienced security of all users of the mobility hub*
Access to opportunities *Provision of access to jobs and basic services for all citizens and visitors, irrespective of social and economic background*

Universal accessibility *Physical and digital accessibility of the mobility hub for the disabled, people with reduced mobility, children and people with small children*

Social inclusion *Use of the mobility hub by disadvantaged groups*
Gender equality *Presence of women in the mobility hub, as users or workers*
Affordability *Affordability of transport for all individuals, regardless of their socio-economic characteristics*
Active mobility *Use of active modes of transport in the mobility hub*
Liveability *Social use of the mobility hub and how well citizens and visitors feel in it and the immediate surroundings*
Socio-political acceptance *Support of the mobility hub by citizens*
Policy integration *Integration of the mobility hub in local, regional and national policies*

End of Block: Social sustainability

Start of Block: Additional criteria

Q6 To conclude this survey, would you like to comment on the selected criteria or the weightings that you have done?

_____

_____

Q7 Do you have any other comment or suggestion concerning this survey?

_____

_____

8.3 Appendix 3 – Stakeholder identification form

Living Lab coordinators will report the outcome of the identification of the stakeholders in a document with a list of stakeholders, their definitions and contact details.

Stakeholder group	Definition	Representative	Contact details
Name of the stakeholder group (e.g., government)	*Description of the stakeholder group. In the example of the stakeholder group government: which level of government? What are their competences and responsibilities?*	*Name of person(s) that will be interviewed to collect the criteria and weights for the sustainability MCA and MAMCA.*	*Name, position, e-mail address, and phone number of the representative(s) that will be interviewed.*

8.4 Appendix 4 – Pen and paper AHP pairwise comparison

Dear participant,

Your opinion matters in the SmartHub project. By filling in the table below, we can define the **preferences of participants**. A similar analysis will be made for other stakeholders, such as the municipality and businesses. We will use this data to find out **which co-designed mobility hub is preferred by (most of) the stakeholders**.

You fill in the table by indicating per line which of the two criteria is more important to you.

Example:

Equal importance	Crit. A ☐☐☐☐ x ☐☐☐☐ Crit. B
Criterium A is very important, Criterium B is not important	Crit. A x ☐☐☐☐☐☐☐ Crit. B
Criterium A is slightly more important than criterium B	Crit. A ☐☐ x ☐☐☐☐☐ Crit. B

Please fill in the table below

	Much more important	More important	Fairly more important	Slightly more important	Neutral	Slightly more important	Fairly more important	More important	Much more important	
Criterion 1										Criterion 2
Criterion 1										Criterion 3
Criterion 1										Criterion 4
Criterion 1										Criterion 5
Criterion 2										Criterion 3
Criterion 2										Criterion 4
Criterion 2										Criterion 5
Criterion 3										Criterion 4
Criterion 3										Criterion 5
Criterion 4										Criterion 5

8.5 Appendix 5 – Evaluation table

Evaluator	*Please fill in name*		
Stakeholder group		**Criterion**	**Indicator**
Alternative	**Evaluation score**	**Justification**	**Sources**
Alternative 1	*Choose an item.*		
Alternative 2	*Choose an item.*		
Alternative 3	*Choose an item.*		
Alternative 4	*Choose an item.*		