WP1: Stakeholder involvement

Deliverable 1.4: Manual for stakeholder involvement in construction logistics

September 2019

Document change record			
Version	Date	Status	Modified by
0.1	16-JUL-2019	First draft	Nicolas Brusselaers (VUB-MOBI)
0.2	02-AUG-2019	Draft for internal review	Nicolas Brusselaers (VUB-MOBI)
0.3	14-AUG-2019	Amendments based on internal review (VUB-MOBI)	Philippe Lebeau, Cathy Macharis and Nicolas Brusselaers (VUB-MOBI)
0.4	26-AUG-2019	Draft for consortium approval	MIMIC consortium partners
0.5	15-SEP-2019	Final amendments based on consortium input	Nicolas Brusselaers (VUB-MOBI)
1.0	25-SEP-2019	Final deliverable 1.4 (Sep-2019)	Nicolas Brusselaers (VUB-MOBI)

MIMIC Deliverable 1.4

Manual for stakeholder involvement in construction logistics

Version: 1.0

Date: 25 September 2019

Responsible partner: Vrije Universiteit Brussel – Mobility, Logistics and Automotive Technology Research Centre (VUB-MOBI)

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Executive summary

Urban construction projects are essential in reducing the housing deficit of the latest urbanization trend. As such, construction projects contribute to more attractive, sustainable and economically viable urban areas once they are finished. However, construction work and construction material flow activities cause severe negative impacts on the surrounding community during the construction process. The MIMIC project focuses on the social, economic and environmental sustainability problems that arise from urban construction, and especially the logistics activities to, from, around and on urban construction sites.

This deliverable is part of MIMIC (Minimizing impact of construction material flows in cities: Innovative Co-Creation), a JPI Europe funded research project with demonstration cases in Brussels, Vienna, Oslo and Sweden. Deliverable 1.4 provides guidelines to introduce formal evaluation methods into the co-creation process. The Multi-Actor Multi-Criteria Analysis (MAMCA), designed by Macharis (2000) and further developed within the MOBI Research Centre, aims at reaching a consensus among stakeholders and stakeholder groups, hence highlighting which logistics solutions receive the largest support.

Deliverable 1.4 aims to formulate how the MAMCA methodology can be implemented within the MIMIC project and, ultimately, within the construction logistics sector. It introduces the MAMCA evaluation method, explains how this method can be applied in the co-creation process in MIMIC and in construction logistics, and provides practical guidelines to carry out the analysis with the help of the online MAMCA software.

A more descriptive first version of this deliverable is scheduled for September 2019. An updated second and final version of this deliverable, due by the end of the project in 2021, will aim to develop and implement a stakeholder involvement framework specifically for the construction logistics sector, taking into account the typical construction logistics dimensions and characteristics. Between these two milestones, this deliverable will be treated as a work-in-progress document and updated on a regular basis, hence working towards the finalized second version by the end of the project.

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1. Introduction

There is an ongoing urbanization trend, making municipalities focus on densifying cities, hence stimulating construction and renovation works in urban areas. Urban construction intrinsically strongly relies on logistics activities, and these in turn are the source of environmental nuisances. These nuisances, referred to as external costs, come in the form of i.a. air pollution, greenhouse gas emissions, noise pollution, congestion, accidents etc., and are typically not borne by the polluter himself. Despite the fact that construction sites have a positive economic impact in the long run, they thus bear a vast amount of external costs during the site duration. Improved control and coordination of logistics flows to, from and on construction sites can decrease such negative impacts.

Cities have the largest potential to reduce negative impacts through requirements on construction logistics. However, today there is a lack of knowledge within cities on how to set such demands and how to involve and manage stakeholders in these processes. The purpose of the MIMIC project is therefore to demonstrate how SMART Governance concepts can be used as an aid in the construction and city planning processes to facilitate and support construction logistics.

The MIMIC project builds further on the findings of the CIVIC (*Construction In Vicinities: Innovative Co-creation*) project (2017), and will result in increased understanding among authorities on how different types of construction logistics affect the environment and urban traffic flows. Further, the implementation of smart governance concepts will enable a supportive platform for urban development decision processes, including tools such as a stakeholder analysis using the Multi-Actor Multi-Criteria Analysis (MAMCA). This deliverable is focused on the description of this methodology, designed by Macharis (2000) and further developed within the MOBI Research Centre.

Due to the complex nature of the construction logistics sector and the many stakeholders involved, the first goal of the project and the MAMCA is to map how all these actors interact with each other, the main criteria they propose, and how important they are in their own evaluations. Based on their preferences, the Multi Actor Multi Criteria Analysis (MAMCA) will show the support of each stakeholder group for the different solutions in order to lead stakeholders towards a decision that create a consensus. Hence, MIMIC aims to create knowledge and awareness how MAMCA, optimization models and innovative dialogue tools can be implemented effectively to assess energy efficient solutions in construction logistics.

1.1 Background MIMIC

The purpose of MIMIC is to demonstrate how SMART Governance concepts can be used as an aid in the construction and city planning processes to facilitate and support logistics to, from and on urban construction sites to improve mobility and reduce congestion within cities and thereby reduce the negative impact of construction sites on the surrounding community. This is done by (1) analysis and identification of construction logistics scenarios (both on- and off-site) highlighting the relation between projects context and logistics solutions; (2) stakeholder involvement and management throughout the different project phases, through identification of

stakeholders and stakeholder objectives in a participatory MAMCA and gaming; (3) implementation of a sustainability impact assessment framework to evaluate the economic, social and environmental performance of the construction logistics scenarios; (4) enhanced data collection and optimization of construction logistics processes to evaluate and visualize the different construction logistics scenarios, using dynamic data technologies; (5) combine 1-4 into a SMART Governance Concept 2.0; (6) deployment of the SMART Governance Concept 2.0 to eliminate functional barriers for implementation and (7) transferability and scalability of construction logistics scenarios and the SMART Governance concept 2.0 across European cities.

The goal of this deliverable is to specify how the multi-actor multi-criteria analysis (MAMCA) can be implemented as a core methodology within the MIMIC-project. Within this framework, the MAMCA methodology aims to facilitate reaching consensus among the multiple and scattered stakeholders in the industry of construction logistics, hence providing a quantified overview of stakeholder support for each stakeholder's criterion and project's construction logistics scenario. Finally, the goal of MIMIC is to highlight construction logistics solutions that are both sustainable and supported by (most) stakeholders and enhance stakeholder participation.

1.2 Scope of the deliverable

The activities within the MIMIC project are divided in six work packages (WP). The overall structure is presented in the figure below.

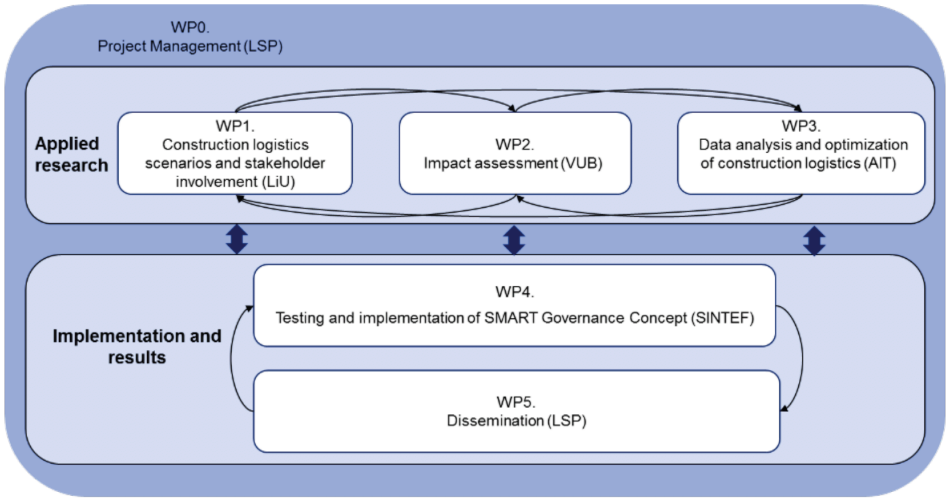

Figure 1. Structure of the different work packages within the MIMIC project

This deliverable D4.1 is part of MIMIC work package 1 *"Construction logistics scenarios and stakeholder involvement"* and is primarily targeted towards the MIMIC consortium partners involved in the national demonstration cases and who will implement the MAMCA as an instrument for participatory multi-stakeholder evaluation in this context.

The objective of Work Package 1 is twofold: (1) to develop a typology of different construction logistics solutions linking their impact on the urban environment and different types of stakeholders and thereby provide scenarios of construction logistics and (2) to develop tools

providing knowledge and understanding of construction logistics and stakeholder involvement for co-creation in the urban planning processes.

The stakeholder involvement exercise will further adapt and implement the multi-actor multi-criteria analysis (MAMCA) framework within the governance of urban construction works (building further on the findings of the CIVIC project) with specific implementation guidelines depending on the project development phase. Special attention will be paid on the identification of implementation barriers and the role of (local) government to facilitate introduction and city-wide roll-out of novel construction logistics concepts. Focus will be on the flexibility, replicability and up-scalability of the framework both from an inter- and intracity perspective (as stakeholders are numerous and varying).

Deliverable 1.4 aims to formulate how the MAMCA methodology can be implemented within the MIMIC project and, ultimately, within the construction logistics sector. A first version of this deliverable, which is more descriptive in nature, is scheduled for September 2019. An updated second and final version of this deliverable, due by the end of the project in 2021, will aim to develop and implement a stakeholder involvement framework specifically for the construction logistics sector, taking into account the typical construction logistics dimensions and characteristics.

1.3 Link with other deliverables

The MIMIC project integrates construction logistics, construction management, city logistics, sustainability and optimization of flows research, with the goal of developing the SMART Governance Concept 2.0. This concept provides the implementation partners (Cities and companies in the construction process and supply chain) with a structure of tools organized into a supportive platform for construction logistics issues in the urban development decision and procurement processes (D4.2 and D4.3). The tools help to increase the knowledge of construction logistics (D1.3), collecting stakeholder needs and criteria of construction logistics scenarios (D1.1, D1.2 and D1.4), and to evaluate the impact of construction logistics solutions on different stakeholders (D2.2, D2.3, D3.1, D3.2 and D3.3). VUB will lead the work of the impact assessment and adaptation and implementation of the MAMCA framework.

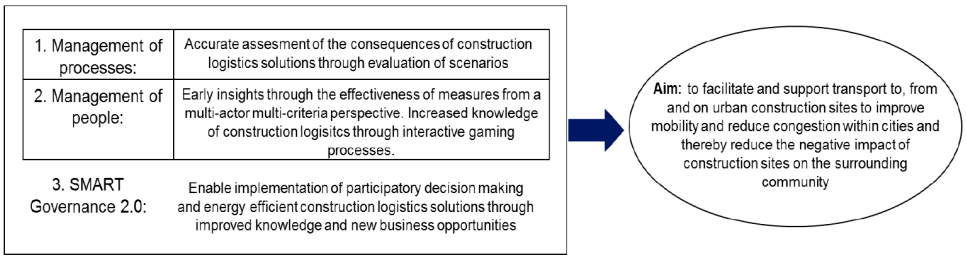

Figure 2. Competitive edge of the MIMIC project

1.4 Deliverable outline

The structure of this deliverable is as follows: first, a brief literature review is given, digging deeper into the MAMCA methodology. A next section provides the relevancy of MAMCA within

Construction Logistics and how this methodology can be implemented within the MIMIC project, presenting a practical step-by-step guide tailored towards construction logistics. A third section presents an introduction towards developing a stakeholder involvement framework for construction logistics, which will be work in progress until the end of the project. The final section provides a guide on how to use the MAMCA software application. The conclusions summarize the key highlights of this deliverable, and are followed by the appendices which serve as practical tools for consortium partners to evaluate formal methods.

1.5 Timing

Deliverable 1.4 aims to formulate how the MAMCA methodology can be implemented within the MIMIC project and, ultimately, within the construction logistics sector. A more descriptive first version of this deliverable is scheduled for September 2019. An updated second and final version of this deliverable, due by the end of the project in 2021, will aim to develop and implement a stakeholder involvement framework specifically for the construction logistics sector, taking into account the typical construction logistics dimensions and characteristics.

Between these two milestones, this deliverable will be treated as a work-in-progress document and updated on a regular basis, hence working towards the finalized second version by the end of the project. The different versions of this document are numbered in an analogical way: 0.x versions work towards a finalized 1.0 version (Sep-2019), and 1.x ones towards the final 2.0 version (2021).

1.6 Demonstration descriptions

MIMIC Demonstration projects	
Belgium	A first goal in Brussels is to gain better insight in the share of construction logistics related transport in the total transport flows per type of project, as there is currently a large gap in accurate data on these flows. The data collection on construction logistics related transport movements will be attempted by using i.e. OBU (on-board unit) data of +3,5 T trucks as well as traffic counts for a selection of (larger) construction sites, providing a better understanding on the amount and type of flows generated in practice by construction works. A second goal is to better understand the impact of these flows on urban sustainability. Therefore, VUB-MOBI will contribute to the development of tools to assess and evaluate the sustainability impact of construction logistics solutions on different stakeholders. In association with owner and city development agency CityDev and main building contractor Van Roey, the application of the sustainability impact assessment framework will be tested on the CityCampus[1] project, a 17.600 m² site bringing together light industrial activities and housing facilities. This will allow to assess the impact on economic, social and environmental sustainability (with specific focus on congestion, emissions and safety) of construction freight flows from origin to destination.

[1] For more info, please visit https://www.groepvanroey.be/nl/referentieprojecten/city-campus; https://www.citydev.brussels/nl/projects/citycampus; https://canal.brussels/nl/content/citycampus-gemengd-project-bij-ceria-en-coovi.

Norway	Omsorgsbygg Oslo KF in collaboration with Arkitema Architects will build the world's first energy-positive nursing home for elderly (Tåsenhjemmet) with low greenhouse gas emissions. The pilot building in massive wood will enable the best indoor environment for the residents and be the new meeting venue in the neighbourhood of Tåsen. A main goal is to use the most simple and passive measures that enables to meet the requirements for low emission energy-plus houses. Another high ambition for the project is to be certified as BREEAM-NOR Outstanding. To reach the political targets of CO2-emissions reduction Omsorgsbygg build zero emission buildings, and have focused on developing zero emission construction sites since 2016. Through the MIMIC project Omsorgsbygg are targeting the transportation to and from the construction site. Omsorgsbygg Oslo KF will contribute in the MIMIC by testing he applicability of the methods and solutions to reduce negative impact of construction activity.
Austria	In Vienna, MIMIC solutions will be used to evaluate how mobile phone-based movement data provided by the mobile network provider T-Mobile can be investigated to monitor the impacts of urban construction works on city traffic. Combining optimization, traffic simulation, and novel data science approaches, this will provide authorities and other stakeholders with quantitative information about the citywide mobility system for their decision processes. The SMART governance concept will be tested in cooperation with Bernard Engineers, focusing on construction projects in Vienna. Input on a large construction project will be provided by Wiener Linien GmbH.
Sweden	Two of the large development projects in Sweden are the Stockholm Royal Seaport and Väsjön projects. Together, these projects will amount to approximately 18 500 new residences and some 770 000 m2 of commercial areas. In the MIMIC project, several different construction logistics solutions will be evaluated, amongst them the construction consolidation centre of Stockholm Royal Seaport. For Väsjön, the focus will be on how construction logistics solutions can be developed in order to come to terms with coordination and planning of construction material deliveries. This will partly be achieved through the development of conceptual construction logistics solutions.

Table 1. Demonstration overview

2. Literature review

This section aims to give an overview of the Multi-Actor Multi-Criteria Analysis (MAMCA) methodology, designed by Macharis (2000) and further developed within the MOBI Research Centre, and its theoretical background. After a brief summary of MAMCA, a definition of the stakeholders within the decision-making process and the MAMCA methodology will be provided, allowing to take into consideration the stakeholders' different points of view. Subsequently, the different steps of the MAMCA methodology will be explained, and shows the relevancy of this methodology as a tool to solve complex decision-making problems and reaching a consensus amongst stakeholders.

2.1 Stakeholder concept and decision support systems

The concept of stakeholders being first introduced by Williamson (1991), the idea and need to include stakeholders in firms' decision-making process became more and more evident with the emergence of Corporate Social Responsibility (CSR) (Donaldson & Preston, 1995). A stakeholder can be a person or group of individuals, able to either directly or indirectly influence or be influenced by the objectives of a firm, thus who can affect or will be affected by the problem at hand (Freeman, 1984). It is indeed necessary to involve stakeholders as to evaluate particular decision issues, such as assessing urban logistics solutions, taking into account each stakeholder's objectives, especially because often a large variety of stakeholders are involved in public decision making.

Particularly in complex processes such as the assessment of urban or inter-urban construction logistics, the importance of involving the large number of scattered stakeholders must be stressed, as taking all these different points of view into account is proven to increase a project's rate of acceptance (Walker, 2000). In order to implement this dimension in the traditional Multi-Criteria Analysis (MCA) or Multi-Criteria Decision Analysis (MCDA) (Fandel & Spronk, 1985; Guitouni & Martel, 1998), improved socio-political aspects should be integrated in the process of decision-making (Banville et al., 1998). Although traditional MCA/MCDA evaluates multiple conflicting criteria in decision-making, they do not contain the multi-stakeholder dimension. This implementation is made possible using Group Decision Support Methods (GDSM), such as the Multi-Actor Multi-Criteria Analysis (MAMCA) developed by Macharis (2005).

As an extension of traditional MCA/MCDA, the MAMCA has proved its use in complex problem scenarios with scattered stakeholders and conflicting objectives (Milan et al., 2015; Turcksin et al., 2011; Vermote, 2014; Straightsol, 2014; Lebeau et al., 2015; Verlinde & Kin, 2018; Keseru et al., 2018).

Historically, a strong evolution is noticeable in the combination of stakeholder involvement and MCA. GDSM aims to achieve a consensus among the scattered stakeholders in the decision-making process (Leyva Lopez, 2010). However, due to the fact each stakeholder has its own unique point of view and expectations within a project, this approach knows certain pitfalls. An overview of different developments of GDSM has been presented by Alvarez-Carillo et al. (2010), the main difference between these approaches being the way information is brought

together. Generally, three main methods for GDSM can be distinguished (Ampe & Macharis, 2008). The explicit stakeholder involvement of MAMCA makes this methodology a type three GDSM, enabling stakeholders to define and allocate weights to their own criteria, hence having a unique set of criteria associated to each stakeholder group. This forms a major difference with traditional MCDA methods having a common value tree or set of criteria for all stakeholders, which is not representative of a social context with a variety of heterogenous viewpoints (Macharis et al., 2012; Munda, 2004). This enables to differentiate different stakeholder perspectives and performing a MCA/MCDA for each stakeholder group (Macharis et al., 2012).

As stakeholder input is a crucial element at core of the Multi-Actor Multi-Criteria Analysis (MAMCA) (Macharis, 2000; 2005), this methodology will be used within the MIMIC project, where stakeholder participation is of great importance.

2.2 Methodological background of the Multi-Actor Multi-Criteria Analysis (MAMCA)

Developing urban freight solutions without any disadvantages to any of the stakeholder, is not only impossible but also unnecessary (Bjerkan, Sund & Nordtømme, 2014); common ground can be reached when the perceived advantages of a particular measure are greater than its disadvantages, requiring reflective collaboration between the actors (Bjerkan et al., 2014). Improved freight partnerships, mainly characterized by a core set of interested and engaged parties, increased involvement and seeking cooperation between stakeholders from the start, often leads to greater chances of success of a project. Stakeholder consultation and taking into account their various perspectives and needs from the beginning of the project thus play a vital role in developing freight transport strategies and policy implementations with a higher acceptance rate amongst stakeholders and decreased chances of project failure (Browne, Allen & Attlassy, 2007; Quak et al., 2016; Brown et al., 2004; Lindholm & Browne, 2013).

Therefore, and as elaborated previously, the proposed stakeholder involvement methodology to be implemented within the MIMIC project is the Multi-Actor Multi-Criteria Analysis (MAMCA), an extension of the traditional Multi-criteria Analysis (MCA) (Fandel & Spronk, 1985; Guitoni & Martel, 1998) which is designed by Macharis (2000) and further developed within the MOBI Research Centre. The MAMCA allows the researcher to evaluate different alternatives (policy measures, scenario's, technologies …) with regards to the objectives of the different stakeholders that are involved in the decision-making process. This allows the MAMCA to include the stakeholders explicitly in the analysis. Their preferences are then integrated at the core of the evaluation. For illustrative purposes, Figure 3 (taken from the CITYLAB project) shows the typical output of such analysis. It depicts the support of each stakeholder group for the different solutions that were evaluated. Developed by Macharis (Macharis, 2005; 2007), the methodology has been deployed for a variety of applications, mainly in transport-related decision-making problems. An overview can be retrieved in Macharis et al., 2009.

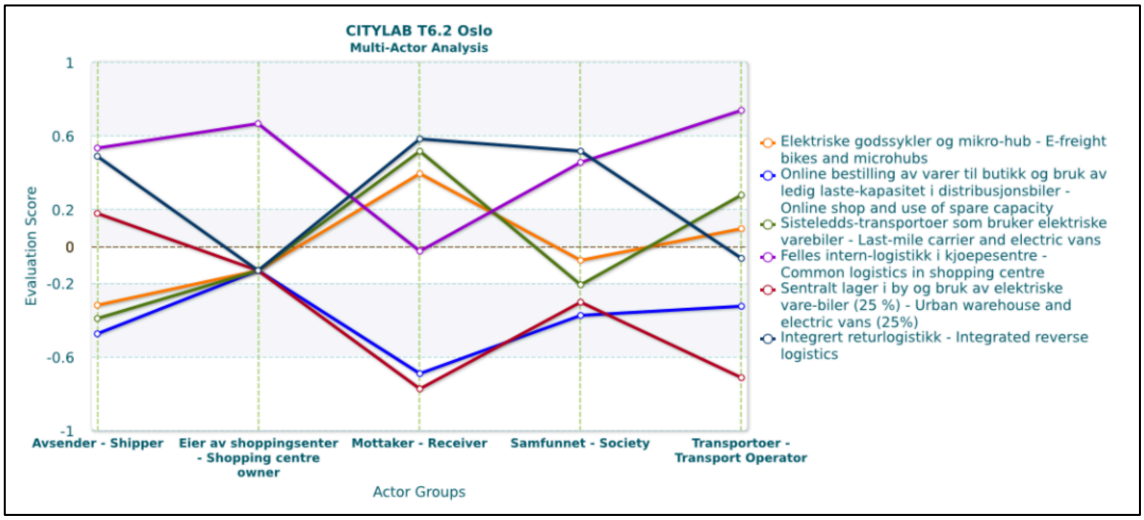

Figure 3. Typical output of a MAMCA analysis, depicting the support of each stakeholder group for the different solutions that were evaluated (taken from deliverable 6.2 of the CITYLAB project; Verlinde & Kin, 2018).

This section offers a brief overview of the different steps of the MAMCA methodology, represented in Figure 4.

The MAMCA methodology can be divided into two main phases (Macharis, 2005; Macharis et al., 2009); the first one being mainly analytical and trying to gather all the necessary information in order to conduct the analysis. The second phase is the synthetic or exploitation phase and entails the actual analysis, during which the extent to which the different alternatives contribute towards the stakeholders' objectives is evaluated. These two phases are then respectively subdivided in four and three steps (Macharis et al., 2009), as represented in Figure 4.

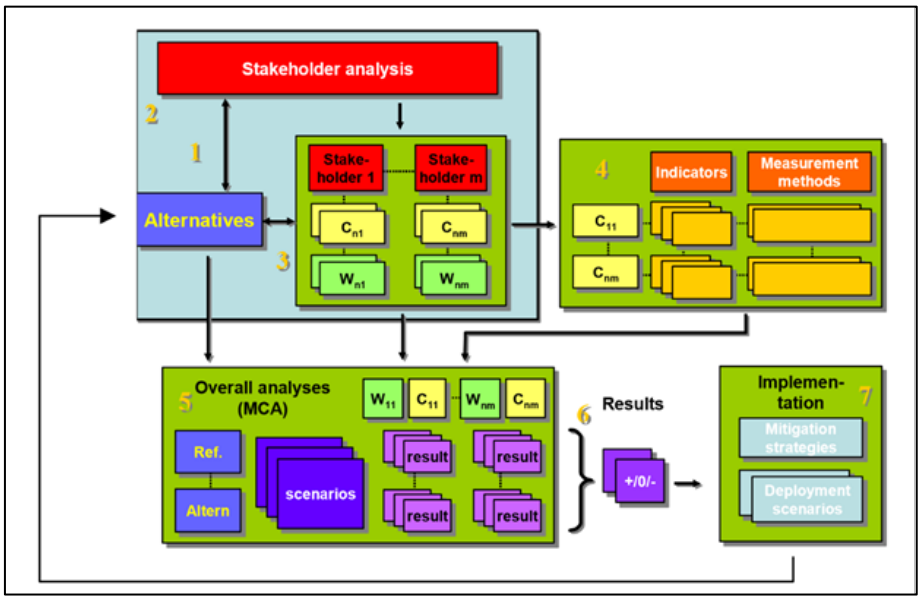

Figure 4. The steps of multi-actor multi-criteria analysis (Macharis et al., 2009)

The first step highlights a clear problem definition and formulates the alternatives to take into account. The current situation ('business as usual') is included as a benchmark. The second step provides a listing of all relevant stakeholders, including their objectives, which will later be translated into criteria during step three. The objectives or criteria can be identified through a literature study and stakeholder consultation. Once these criteria have been determined, a crucial step is to identify how important every criterion is. This is achieved by assigning weights to the different criteria and is done by the stakeholders themselves. The fourth step attempts to couple one or more measurable indicators to each criterion, hence allowing to evaluate each alternative with regards to each criterion. These indicators can either be quantitative or qualitative in nature, depending on its respective criterion. The aggregation of the information from the previous steps happens in step five, and results in an evaluation matrix. The actual results are part of step six, and are generated using a Multi Criteria Analysis (MCA), allowing the researcher to analyze the (dis)advantages associated to every alternative. The seventh and last step seeks to actually implement the results, revealing the alternatives that receive overall stakeholder support. This last step is primarily aimed at the policy maker.

The next section will discuss each step of the MAMCA methodology in more detail.

3. Manual for stakeholder involvement in construction logistics: a MAMCA guide

In order to evaluate future demonstrations from a stakeholder-oriented perspective, this chapter offers a detailed overview of the different steps related to the MAMCA. Figure 5 gives a visual overview representation of the MAMCA methodology (Macharis et al., 2009), recapitulating the steps presented briefly in the literature review part of this deliverable.

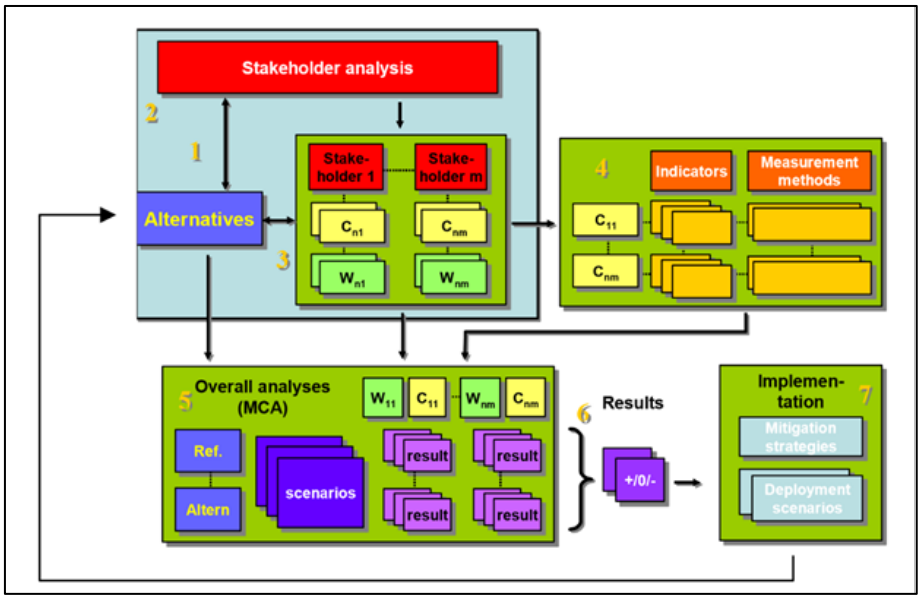

Figure 5. The steps of multi-actor multi-criteria analysis (Macharis et al., 2009)

3.1 Problem definition and formulation of alternatives (logistics solutions) (step 1)

As a starting point of the analysis, the problem statement should be clearly defined, and the relevant alternatives determined. These alternatives are determined keeping into consideration a given problem. As previously elaborated, the problem in this project concerns the (un)sustainability of urban construction logistics.

The alternatives can be policy measures, logistics scenarios, strategies or other actions that are able to solve or affect the problem at hand. Often, the current situation ('business as usual') is included as a benchmark in order to evaluate this BAU scenario against each of the logistics solutions. The alternatives should be translated into concrete scenarios that will serve as a basis for the whole analysis in the following steps.

An important aspect is who is deciding on the different alternatives or logistics scenarios. If the stakeholders are involved in (co-)creating the alternatives[2], there is clearly a link between Step

[2] This can be achieved by different means, such as the project leader proposing a list of alternatives, based on literature study, assessing the alternatives in a survey, etc.

1 and Step 2, as first the relevant stakeholders to be involved in alternative creation/identification should be assessed, hence the double arrow connecting both steps. If alternatives are identified top-down, the chronology between Step 1 and Step 2 should be considered stricter. Building further on the CIVIC project (CIVIC, 2017), this deliverable is associated with Deliverable 1.1 ("Logistics scenarios").

The Figure below shows an illustrative list of some potential alternatives in the context of urban construction logistics.

List and description of illustrative alternatives		
BAU	Business As Usual	Baseline scenario. • None or fragmented coordination • Main contractors manage logistics and induced costs • Diesel trucks as main mode of transport
Solution A	Controlling city	Construction consolidation centre as main bundling hub and incentives to stimulate the modal shift from road to inland waterways. • Construction Consolidation Center (CCC) in collaboration with port • Imposed delivery address: consolidation of goods and delivered by waterway transport near the construction site • Bundling of construction material on common delivery tours • Costs divided between city and contractors • Expected impact: higher load factor, improved air quality, potential benefits for contractors and transport operators
Solution B	Planning city	Construction consolidation centre and strong incentives for electric vehicles. • Toll scheme at construction area entrance for non-EV • Maximum number of transports & designated time slots (bundling) • Supporting services are available • Costs carried by contractors
Solution C	Night-time deliveries	Night-time delivery of materials on-site. • BAU scenario with higher temporal dispersion of material deliveries • Goods are delivered with trucks at night (before morning peak hours) • Expected impact: less congestion, higher average speed, lower emission levels but significantly higher noise levels during night time
…	…	…

Table 2. Illustrative list of alternatives to evaluate

3.2 Stakeholder identification & identifying their objectives (step 2)

Once the problem definition is set and the alternatives have been identified, the following step is to identify stakeholders. A stakeholder can be a person or group of individuals, able to either directly or indirectly influence or be influenced by the objectives of a firm, thus who can affect or will be affected by the problem at hand (Freeman, 1984). It is of high importance to explicitly include the stakeholders in the analysis, as the researcher alone might be unable to guarantee the quality of the final decision (due to for example limited access to information), but also to increase the chances of a more broadly supported alternative (Ampe & Macharis, 2008; Macharis, 2005; Macharis, 2007; Macharis et al., 2009). Within the MIMIC-project, this will be performed for the case of urban construction logistics, involving actors such as public authorities, contractors, logistics service providers and citizens.

Also the main objectives of each stakeholder (group) must be listed. These objectives or criteria can be identified through a literature study and stakeholder consultation. It is important to include their vision on the problem at hand, as new alternatives might rise up, hence enriching the overall analysis (Ampe & Macharis, 2008). Within the MIMIC project, stakeholder

identification is a crucial part, as issues related to the construction logistics sector typically involve a wide variety of parties, such as local authorities, businesses, residents, (sub)contractors, logistics service providers (LSPs) etc.

The specific stakeholders involved in construction logistics also vary depending on a number of local and regional characteristics. Due to this wide, scattered and complex nature of the stakeholders involved in construction logistics, it is possible and even favorable to cluster stakeholders with similar points of view and objectives into groups, as to minimize the number of individual actors in the analysis. Indeed, a clear stakeholder and criteria identification is necessary to arrive to more widely supported solutions. Allowing for a meaningful analysis, the number of stakeholder clusters or groups should thus be kept at a manageable and interpretable level. Previous MAMCA projects in city logistics have typically considered around 5 stakeholder groups.

Nonetheless, there are some overarching actor groups or clusters that are relevant and typically universal throughout construction logistics. This is a basic set of potentially relevant actors forming the start for a deeper exploration of the stakeholders to involve in Construction Logistics and in the national demonstration cases. The CIVIC project put forward a set of actors in the field of construction logistics (Table 3), presenting both direct and indirect stakeholders (Figure 6) (CIVIC, 2017).

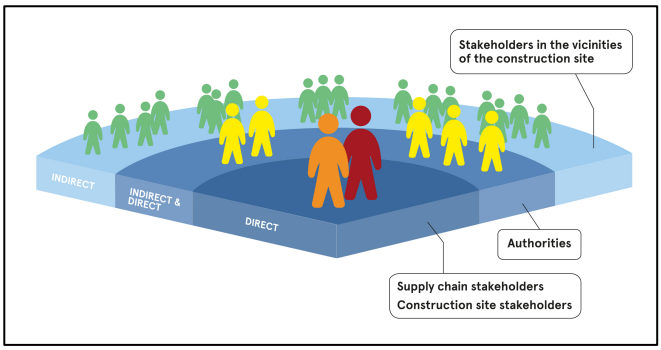

Figure 6. Direct and indirect stakeholder classification in construction logistics (CIVIC, 2017)

(In)direct	Stakeholder type
DIRECT Directly involved in the decision-making process of the project	Construction companies
	Suppliers
	Logistics Service Providers (LSPs)
	Client
INDIRECT Do not directly participate in the decision-making process	Landowners
	Infrastructure providers and operators
	Local urban planning (infrastructure)
	Authorities
	Residents and businesses in area

	Users of infrastructure (road; bikes and pedestrians; public transport)
	Visitors and customers
	General public (opinion)
	Local politicians

Table 3. Summarized list of different types of stakeholders in construction logistics (CIVIC, 2017)

3.3 Criteria definition (3a) and assigning weights (3b)

Step three envelops the definition of criteria (step 3a) and weights (step 3b).

Step 3a: Definition of criteria

For each stakeholder group, the criteria (3a) are separately determined based on the previous steps (Macharis, 2007). This implies that different stakeholder groups are not (necessarily) bound to the same set of criteria; in other words, each actor group can have its own criteria tree. For example, a local government authority might include more social and environmental criteria (emissions, noise, etc.) as opposed to a private company which will typically orient its criteria more towards economic criteria (e.g. return on investment). Examples of different criteria are presented in Table 4.

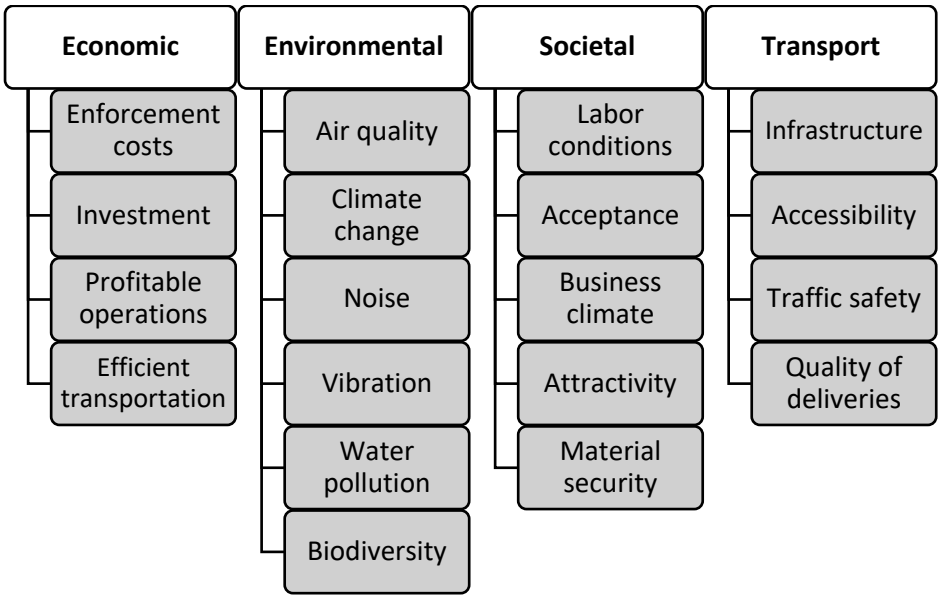

Table 4. Illustrative list of stakeholder criteria

These criteria can be identified through a series of instruments, such as interactive discussion between the academic, industrial and governmental partners, through literature review etc. The framework that will be developed will ultimately be flexible, as to cope with local variations in stakeholders and their respective criteria tree.

Table 5 presents a list of criteria that have been identified for the construction logistics sector in the CIVIC project (CIVIC, 2017), which could potentially be used as a starting point.

Criteria List		
Group	**Criterion**	**Explanation**
ECONOMIC CRITERIA	Enforcement costs	Costs to ensure other parties comply with rules in the transport system and/or legislation during the construction works
	Viability of investment	Positive return on investment. For example, the investment in mobility or safety measures should result in more (efficient) work in the long term
	Profitable operations	Objective to generate a profit by providing logistic or transport services during the construction works
	Transportation costs	The costs of transporting construction materials and/or personnel during the project
	Adaptation costs	Financial costs due to mobility impacts caused by the construction site (for example, detours, parking)
	Impact of construction works on transport infrastructure use	Impact of infrastructure works on the efficiency of a transport system, in terms of average speed level, congestion and connectivity and the impact on parking
	Quality and reliability of deliveries of construction materials	The punctuality and the percentage of damage-free delivery of goods (from shipper and recipient perspective)
ENVIRONMENTAL CRITERIA	Air pollution	Impact of construction works on local air quality. The main air pollutants considered in urban areas are sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matter (PM2.5 and PM10)
	Climate change	Impact of construction works on greenhouse gas emissions CO2 (global impact)
	Noise pollution	Sound level caused by human activities, including transport, during construction projects
	Vibration	Impact of vibrations during construction works on the surrounding built-up environment, which can cause significant damage
	Water pollution	Impact of construction projects on water quality since construction may pollute water flows and affect volume and velocity
	Biodiversity	Impact of construction works on an area of nature in the vicinity
	Landscape quality	Visual nuisance on surrounding environment
SOCIETAL CRITERIA	Labour conditions	Labour conditions for employees during construction works (from the perspective of each stakeholder)
	Social and political acceptance by citizens of impacts generated	Level of ease for stakeholders to comply with the authorities' rules and regulations during construction works
	Business climate during construction works	Attractiveness of the area in terms of business opportunities
	Attractiveness	Impact of construction works on the attractiveness of the urban environment, defined as the recreational facilities in and around the construction zone
	Social and economic revitalisation	Impact after finishing the construction site
	Security of construction material goods during construction works	Probability of construction materials being lost or stolen while being transported to, or stored on, the construction site
	Traffic safety impacts	Traffic accidents during transport of goods and people to, from and within the site, as well as accidents caused by the changes in transport infrastructure at the site
	Accessibility	Accessibility of region in vicinity of construction site by road, public transport etc.
	Diverted traffic due to construction site	Impact of diverted traffic

Table 5. Identified criteria in the CIVIC project (2017)

When the criteria for each stakeholder group have been identified, these can be represented in a stakeholder/criteria matrix.

Step 3b: Allocating weights to the defined criteria

Once criteria are determined for each stakeholder group, the second part of step three is to allocate weights to these criteria (Macharis 2005; Macharis, 2007; Macharis et al., 2009), as not every criterion is equally as important for a given stakeholder. This is thus useful in order to show the relative importance of each criterion within the stakeholder group (Macharis, Springael, De Brucker, & Verbeke, 2004; Saaty, 1988). The stakeholders allocate the weights to the criteria themselves. Stakeholders also have the opportunity to adjust the assigned weights in the MAMCA software.

Choosing and weighing the different criteria by stakeholder group can be done by means of a workshop. Multiple methods exist in order to determine the weights, as is presented in Nijkamp et al., 1990. Generally, however, the Analytical Hierarchy Process (AHP) developed by Saaty (1988) is used, as it provides a systematic way to allocate the weights (Saaty and Vargas, 2000). Applying the AHP method, the criteria are pairwise compared, matching each criterion one-on-one with the other ones using a 9-point scale (as presented in Figure 7 and Table 6) expressing the stakeholders' preferences.

Figure 7. Pairwise comparison in the MAMCA software

#	Description
1	Both criteria are equally important
2	Criterion A is barely more important than criterion B
3	Criterion A is slightly more important than criterion B
4	Criterion A is weakly more important than criterion B
5	Criterion A is moderately more important than criterion B
6	Criterion A is substantially more important than criterion B
7	Criterion A is strongly more important than criterion B
8	Criterion A is extremely more important than criterion B
9	Criterion A is distinctively more important than criterion B

Table 6. Meaning of the 1-9 scale to pairwise compare two criteria A and B.

These relative preferences are then organized into a matrix and normalized. This produces a priority vector representing the relative weights on a ratio scale. This method allows to use theoretically valid weights and is praised by users for its reliability and ease of use (Wang & Yang, 1998). It's also worth pointing out other methodologies exist and might be more appropriate, depending on the circumstances (number of stakeholder groups and criteria, time and budget constraints, etc.). Determining the criteria from a stakeholder–based perspective has one main advantage. When performing an MCA, the criteria are supposed to be independent or non–redundant. However, research has shown that there often is a certain level

of dependence (Ozturk, 2006). The MAMCA solves this issue by letting the stakeholder determine the weights of the criteria themselves (Macharis et al., 2009). In order to keep the process of weighting manageable, also here it is advisable to keep the number of criteria limited, hence complying with the methodological requirements for criteria definition being non-redundancy, minimality, homogeneity and operationality (Macharis & Baudry, 2018).

It is possible that a stakeholder consists of several members. In order to determine the weight for a given stakeholder group, a common weight can be achieved through consensus. If this appears to be too difficult to achieve, the researcher is able to calculate an overall weight by taking the geometric mean of all the individual scores (Macharis et al., 2009)[3]. If differences are too large however, members should be split into different stakeholder groups since a stakeholder group is among others defined by their homogeneous preferences.

The initial assumption is that every stakeholder is equally important. The principal goal is to support the goal of each actor and achieving a consensus among them. The researcher always has the possibility to perform a sensitivity analysis to see if the assumption of equal importance is valid (Macharis et al., 2009).

3.4 Data collection for indicator model (step 4)

The fourth step "operationalizes" the criteria using measurable indicators, thus allowing the researcher to measure and evaluate how much a certain alternative performs on a given criterion. Hence, a scale is developed by using indicators in which the contribution of an alternative can be measured (Macharis, 2007; Macharis et al., 2009). Most often, these indicators are quantitative in nature (EUR, number of decibels, kilograms of CO_2, etc.) but this does not exclude the use of qualitative indicators (such as perceived safety or visual attractiveness of a solution) (Macharis et al., 2009). It could be that several indicators are used to measure the performance of an alternative on a single criterion, and that one indicator can be associated to multiple criteria (Macharis, 2007).

Within MIMIC, the aim is to develop a common framework where the indicators within the MAMCA are also used in a social cost benefit analysis and impact assessment framework. Common key performance indicators could improve transferability across the framework.

3.5 Aggregation of information & development of evaluation matrix (step 5)

The weighed criteria and the alternatives evaluation are then combined, therefore constructing an evaluation matrix. A multitude of different multi-criteria analysis (MCA) methods are available to evaluate different alternatives, making the MCA methods of the Group Decision Support Methods (GDSM) especially useful to apply in the MAMCA methodology. The main advantage of these GDSM is that they offer a certain freedom to the stakeholders in terms of defining their own criteria, weights and preference structure and only at the end of the analysis the different points of view are being confronted (Macharis et al.,2009). These methods entail the

[3] The geometric mean of n numbers is given by multiplying these numbers and getting the nth square root of the product.

PROMETHEE methods (Brans, 1982; Macharis et al., 1998), ELECTRE (Roy & Bouyssou, 1988) and AHP (Saaty, 1988). Most often, MAMCA uses PROMETHEE and AHP (https://www.mamca.be).

Summarized, the Analytic Hierarchy Process (AHP) uses pairwise comparisons as to compare and evaluate the performance of different alternatives on criteria on a nine-point scale (as presented in Figure 8), making it user friendly and reliable (Wang & Yang, 1998), but can be time-consuming. PROMETHEE, on the other hand, scores the different alternatives on a seven-point scale (very negative, negative, slightly negative, neutral, slightly positive, positive or very positive) compared to BAU, as shown in Figure 9 and Table 7. Macharis et al. (2004) provides a complete overview of the (dis)advantages of both these methods.

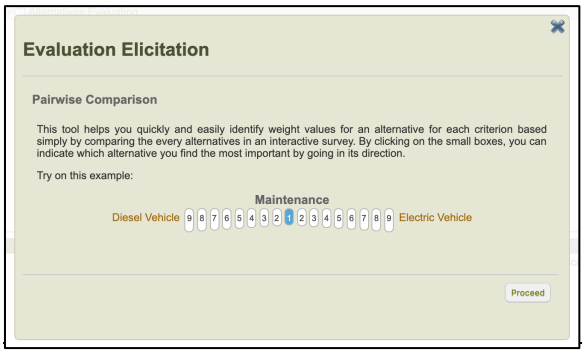

Figure 8. AHP to evaluate the performance of alternatives on criteria using pairwise comparisons in the MAMCA software

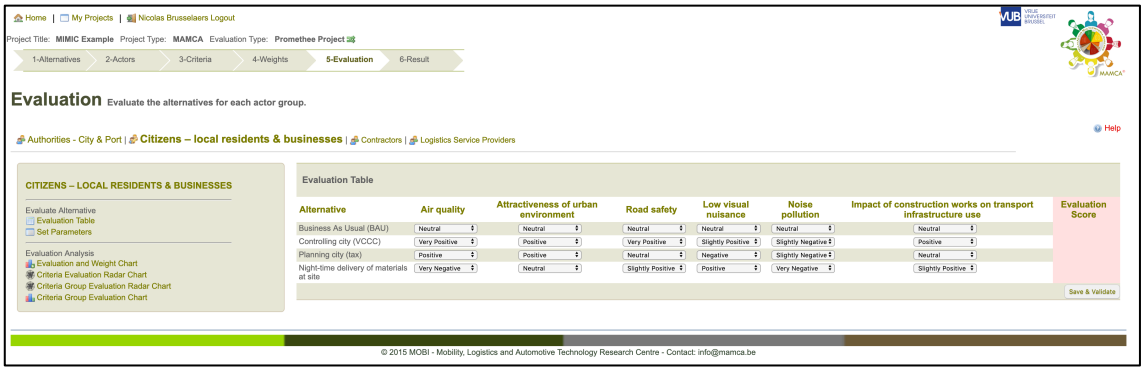

Figure 9. Evaluating alternatives using the PROMETHEE method in the MAMCA software

Evaluation steps	Explanation
Very negative	The scenario would have a very negative impact on the criterion compared to the situation today.
Negative	The scenario would have a negative impact on the criterion compared to situation today.
Slightly negative	The scenario would have a slightly negative impact on the criterion compared to situation today.
Neutral	The scenario would have no impact on the criteria compared to the situation today.
Slight positive	The scenario would have a slightly positive impact on the criterion compared to the situation today.
Positive	The scenario would have a positive impact on the criterion compared to situation today.

Very positive	The scenario would have a very positive impact on the criterion compared to situation today.

Table 7. Explanation of the evaluation scores using PROMETHEE

3.6 Results and assessment of the different strategic alternatives (step 6)

Ultimately, the outcome of the MAMCA is a classification of the alternatives put forward, revealing their strengths and weaknesses. The actual results are part of step six, and are generated using a Multi Criteria Analysis or Multi-Criteria Decision Analysis (MCA/MCDA), allowing the researcher to analyze the (dis)advantages associated to every alternative for each stakeholder group individually (uni-actor) and for all stakeholders combined (multi-actor). Hence, these highlight and justify the outcome ranking of the various options and makes it possible to specify the weak and strong points of each of them, and, ultimately, allow to see who is in favour of the implementation of a construction logistics concept and who has doubts.

In order to measure the stability or robustness of the results, a sensitivity analysis can be conducted (Macharis et al., 2009). The logic behind this analysis is that alternatives could potentially be adjusted as to minimize the bottlenecks for some stakeholders. The results could thus aid in identifying and eliminating these bottlenecks.

Often, the MAMCA is organized as an interactive process using workshop(s), thus allowing room for insight generation as to how actors are looking at a problem. This thus facilitates to capture feedback from the actors when discussing the results, and can lead to more and better insights when scoring criteria of other stakeholders. Indeed, gaining insight in the scoring of criteria by other stakeholders can enhance acceptance of particular alternatives, as stakeholders realize the impact of their preferred alternative on the criteria of others (Lebeau et al., 2018).

3.7 Interpretation and implementation of results (step 7)

The seventh and last step seeks to actually implement the results, revealing the alternatives that receive overall stakeholder support. This last step is primarily aimed at the policy maker, as to mitigate different strategies, and schemes can be created in order to deploy the chosen alternative.

4. Multi-Actor Multi-Criteria Analysis framework for construction logistics concepts

The MIMIC project builds further on the findings of the CIVIC (*Construction In Vicinities: Innovative Co-creation*) project (2017), and will result in increased understanding among authorities on how different types of construction logistics affect the environment and urban traffic flows. Further, the implementation of smart governance concepts will enable a supportive platform for urban development decision processes, including different optimization tools. First, a stakeholder analysis will be performed. Due to the complex nature of the construction logistics sector and the many stakeholders involved, the goal is to map how all these actors interact with each other, the main criteria they propose, and eventually arrive at a supported solution by means of a Multi Actor Multi Criteria Analysis (MAMCA). Hence, MIMIC aims to create knowledge and awareness how MAMCA, optimization models and innovative dialogue tools can be implemented effectively to assess energy efficient solutions in construction logistics.

Although stakeholders are getting more and more involved in choices associated to urban design, stakeholder participation related to city mobility and logistics is solely utilized in a limited and fragmented way. In order to include stakeholder perspectives and avoiding one-way communication, effective participation requires stakeholders to have a voice in the decision-making process. Figure 10 shows the main relations between stakeholders in an Urban Freight Transport (UFT) context (Mommens, Kin & Macharis, 2014; Behrends, 2011).

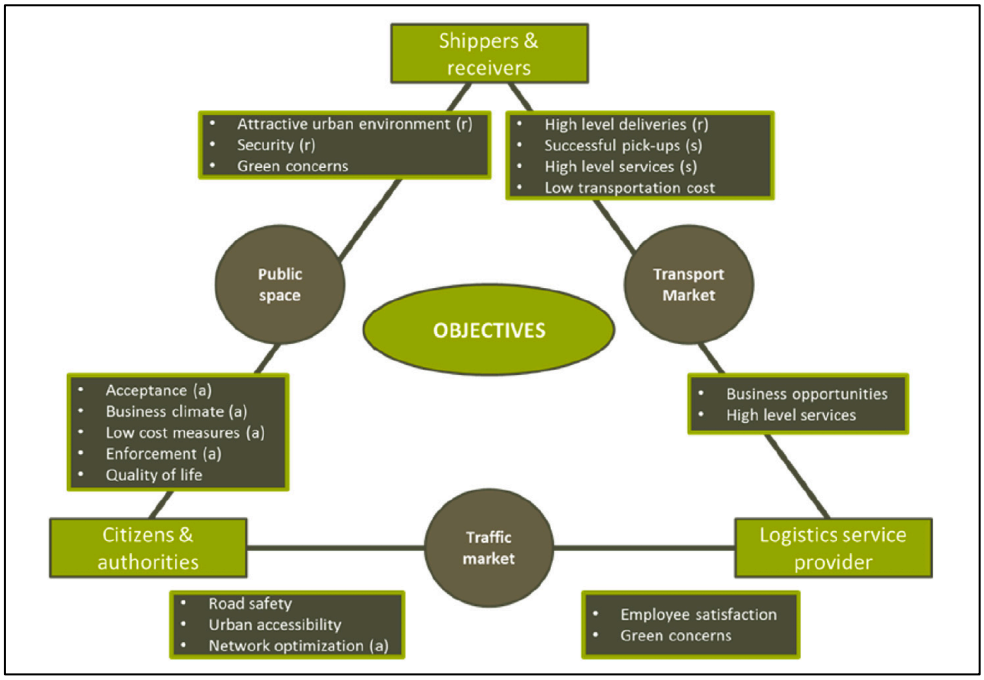

Figure 10. Main relations between stakeholders in the urban freight transport (UFT) context (Mommens, Kin & Macharis, 2014; Behrends, 2011)

Effective participation requires understanding and the feeling of having a voice among stakeholders. With this vision, MIMIC makes use of the MAMCA methodology which allows to

take into account all stakeholders' issues at an early stage. This enables stakeholders to make better informed selections and supports them to have interaction in defining options that are both more power efficient and have a broader acceptance base. Such a method can create win-win conditions for all stakeholders, as by means of simultaneously alleviates burdens for local neighborhood contributors and optimizing effectivity in operations for contractors, logistics carrier providers (LSP's) and transport companies. Smart records and transport options shape enter for participatory decision making. Planning, predicting, optimization and assessment fashions are fundamental to extend the understanding among stakeholders on the impact of logistics and mobility measures for efficiencies and externalities in an accurate way.

The potential impact for the livability of cities is large, considering that construction related transport takes a large share of the total truck and van movements in cities. The goal of this deliverable is to provide an adaptation and implementation of the MAMCA framework (building further on the findings of the CIVIC project), hence providing the necessary tools to build a generic model implementable across the national demonstration cases and potentially going beyond the scope of the project in construction logistics globally.

Inherently, both the construction logistics sector and the different characteristics of the implementation cities make the development of a standard stakeholder assessment framework challenging. Indeed, several dimensions might need to be taken into consideration when developing the stakeholder involvement framework, such as time (construction sites' logistics planning), the identification of local and regional implementation barriers, the identification of actors and their activities and the up-scalability of solutions (geographically, location, construction site type etc.).

The stakeholder framework should thus be built in a flexible fashion as to cope with local conditions, while simultaneously remaining generic enough to allow implementation across national demonstration cases, cities and the industry. In order to allow adjustments to the MAMCA methodology and the stakeholder assessment framework to local differences and characteristics, input from the different consortium partners will be asked.

Special attention will thus be paid on the identification of implementation barriers and the role of (local) government to facilitate introduction and city-wide roll-out of novel construction logistics concepts. Focus will be on the flexibility, replicability and up-scalability of the framework both from an inter- and intracity perspective (as stakeholders are numerous and varying).

Conclusively, the adaptation, development and implementation of the stakeholder involvement framework will ultimately allow to cope with local differences and characteristics. In order to take these into account, the list of stakeholders and criteria is then adapted consequently. That will allow to come to a decision support system that is generic enough as to be implemented in different cities, but can be adapted for preferences (weighting) locally, hence reflecting the characteristics and specific preferences of these local stakeholders.

5. MAMCA software user guide

This MAMCA software user guide is written for the MIMIC national demonstration coordinators that will perform the analysis. The coordinators will receive their login details for the evaluation software from the VUB.

The evaluation of co-created alternatives starts by adding the alternatives to the online MAMCA software by clicking ‘Create a Project’. MIMIC coordinators should add a name, a description, and a goal. The project type should be ‘MAMCA’ and the evaluation type can either be ‘AHP’ or ‘Promethee’, as shown in Figure 11. Click ‘Create Project’ to finish setting up the project. Users can access the project anytime under ‘My Projects’ in the top-left corner of the window.

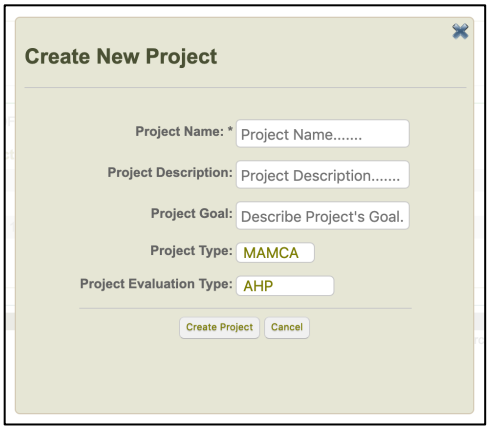

Figure 11. Creating a new project within the MAMCA software

The navigation bar at the top of the screen shows in which MAMCA stage the user is (see Figure 12).

Figure 12. The navigation bar in the MAMCA software

5.1 Alternatives

After having set up a project in the MAMCA software, users can add the co-created alternatives by clicking ‘Add Alternatives’ in the box on the left-hand side of the window. A box will pop up in which a name and description of the alternative can be filled in (see Figure 13). Repeat this step for every alternative. A ‘do-nothing’ alternative should also be added (business as usual scenario). This alternative represents the status quo, meaning the current situation. Tick the box under ‘select baseline’ in the list of alternatives for the alternative that is represents the current situation (see status quo Figure 14). Every alternative can be edited by clicking the icon and deleted by clicking the icon.

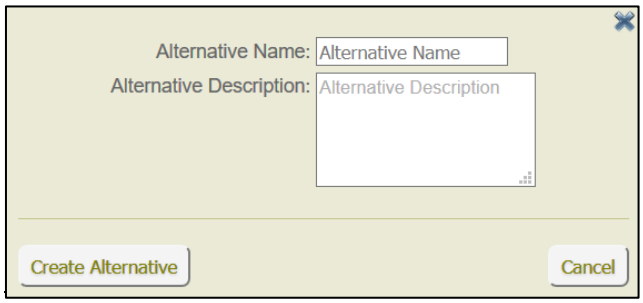

Figure 13. Adding an alternative

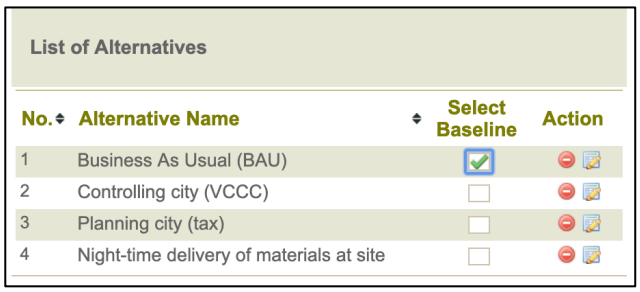

Figure 14. List of alternatives

Click on '2-Actors' in the navigation bar to proceed to the next step: the stakeholder analysis.

5.2 Actors

Stakeholders can be added to the MAMCA software by going to the Actor page and clicking on 'Add Actor Group' under 'Actors' (see Figure 15). Information about the stakeholders needs to be added in the textbox that pops up. Per stakeholder group, select who is defining the criteria, and who is entering the evaluations (see Figure 16). For MIMIC, the coordinators define the criteria and provide input for the evaluation. 'Group Weight' should be left blank as all stakeholders are considered equal. Click 'Save and Add Another Group' until all stakeholders have been entered. Once all stakeholders have been entered, click 'Save and Finish'. An example is given in Figure 17. Every stakeholder group can be edited by clicking on the icon and deleted by clicking on the icon.

Figure 15. Adding stakeholders

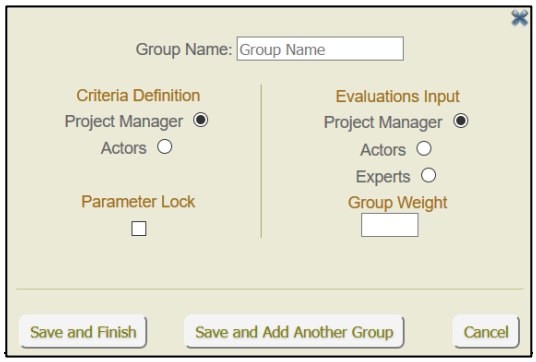

Figure 16. Defining stakeholders

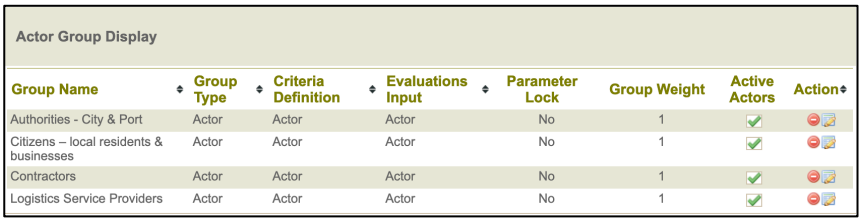

Figure 17. Example of actor group display for construction logistics

Users can proceed to the next step by clicking on '3-Criteria' in the navigation bar at the top of the window.

5.3 Criteria

In the MAMCA software, criteria can be added for each stakeholder group by clicking 'Add Criterion'. A textbox pops up in which the criteria can be named and grouped (see Figure 18). Fill in the name of the criteria but leave blank 'Group Name'. Click on the names of the stakeholder groups to navigate between them.

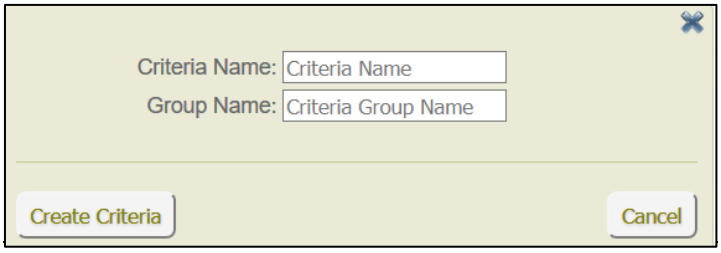

Figure 18. Adding criteria

5.4 Weights

Once all the criteria of all the stakeholders have been added, click on '4-Weights' in order to assign weights. For each stakeholder, click on 'Pairwise Comparison' under 'Weigh Criteria' in the left-hand textbox (see Figure 19). This allows stakeholders to identify weights for their criteria by indicating which of the two shown criteria they find more important and to what extent. If weights have been collected using pen and paper AHP pairwise comparison sheets,

the average weight per criterium can be calculated using the AHP Calculator spreadsheet, which you can find on ProjectPlace along with its instructions.

Figure 19. Weighing of criteria

In the MAMCA evaluation software, pairwise comparison is done by indicating which criterion is the more important one by adjusting a slider (see Figure 20). If a stakeholder has a very strong preference for one criterion (air quality) over another (safety), they would adjust the slider to the 9 that is closest to their preferred criteria (air quality). If a stakeholder prefers the two criteria equally, the slider remains in the middle. Repeat this step for all the criteria per stakeholder.

Figure 20. Pairwise comparison

#	Description
1	Both criteria are equally important
2	Criterion A is barely more important than criterion B
3	Criterion A is slightly more important than criterion B
4	Criterion A is weakly more important than criterion B
5	Criterion A is moderately more important than criterion B
6	Criterion A is substantially more important than criterion B
7	Criterion A is strongly more important than criterion B
8	Criterion A is extremely more important than criterion B
9	Criterion A is distinctively more important than criterion B

Table 8. Meaning of the 1-9 scale to pairwise compare two criteria A and B

Users can proceed to the next step by clicking on '5-Evaluation' in the navigation bar at the top of the window.

5.5 Evaluation

The evaluation of the impact of the alternatives on the criteria is done under '5-Evaluation' in the navigation bar. The MIMIC coordinators are responsible for filling in the evaluation table (see Figure 21) in the MAMCA software, but the evaluation of the impact is done by experts who are

specialized in a certain field (e.g. traffic safety or noise pollution). Since stakeholders may be biased towards one or another alternative, they do not take part in the evaluation of the impact each alternative has on the criteria.

There are seven possible answers in the evaluation table: very negative; negative; slightly negative; neutral; slightly positive; positive; very positive (as presented in Table 9). Please note that for criteria such as air quality, a decrease in emissions is a positive impact. Click 'Save & Validate' once an evaluation table has been filled in. Different visualizations of the evaluation can be found under 'Evaluation Analysis' in the left-hand textbox.

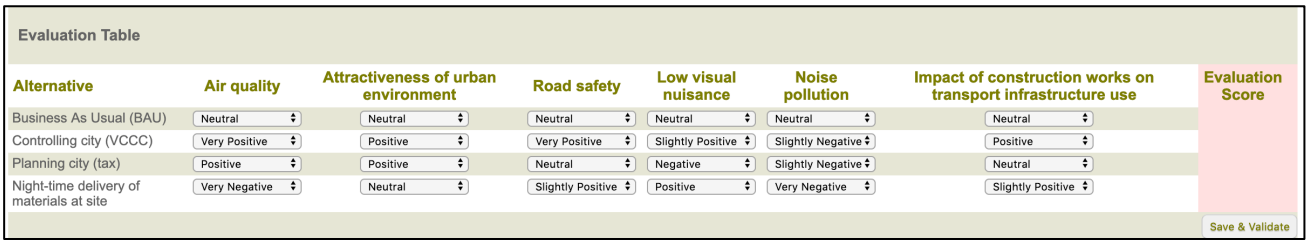

Figure 21. Evaluation table

Evaluation steps	Explanation
Very negative	The scenario would have a very negative impact on the criterion compared to the situation today.
Negative	The scenario would have a negative impact on the criterion compared to situation today.
Slightly negative	The scenario would have a slightly negative impact on the criterion compared to situation today.
Neutral	The scenario would have no impact on the criteria compared to the situation today.
Slight positive	The scenario would have a slightly positive impact on the criterion compared to the situation today.
Positive	The scenario would have a positive impact on the criterion compared to situation today.
Very positive	The scenario would have a very positive impact on the criterion compared to situation today.

Table 9. Explanation of the evaluation scores

5.6 Multi-Actors and results

Click on '6-Multi Actors/6-Result' in order to view the stakeholder preferences. Different visualizations of stakeholder preferences can be found under 'Multi-Actor Chart' in the left-hand textbox (see Figure 22). All the charts show the preferences of each stakeholder group for each alternative, based on their criteria and weights. For example, the multi-actor line chart in Figure 23 shows the evaluation score (preference) of each stakeholder group for the business as usual scenario and for four alternatives. The stakeholders are on the x-axis, their scores for each alternative are on the y-axis.

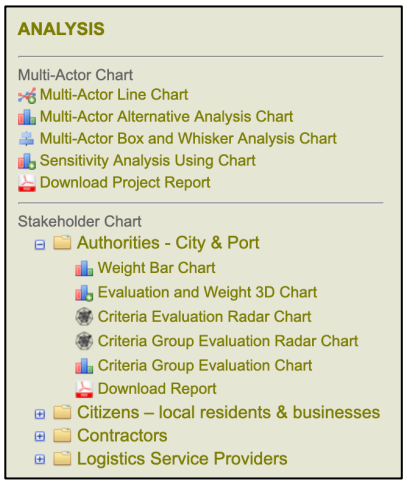

Figure 22. Different visualizations of stakeholder preferences

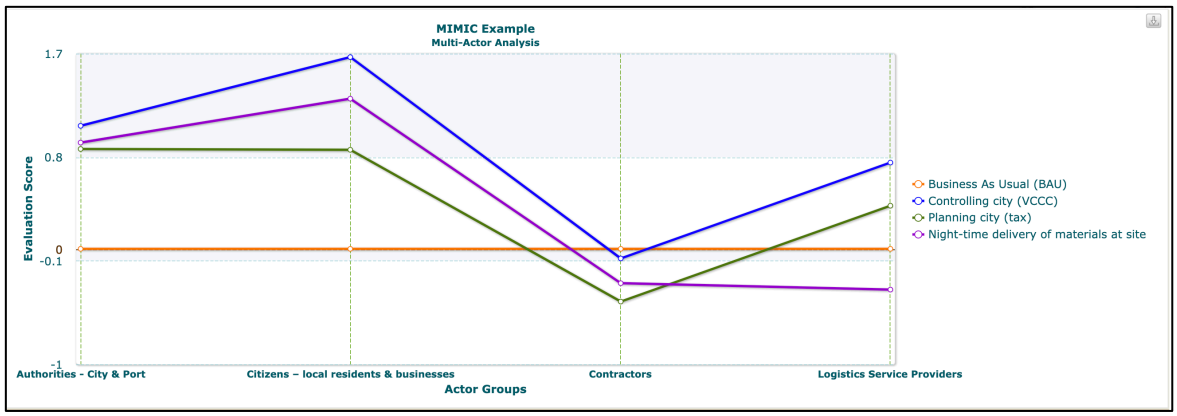

Figure 23. A multi-actor line chart example for construction logistics

The function 'Evaluation and Weight 3D chart' under 'Stakeholder Chart' in the menu on the left of the page visualises the criteria weights and evaluation scores per stakeholder, as shown in Figure 24. Comparing the evaluation and weight chart of each stakeholder gives an insight in what criterium/criteria causes a stakeholder to (not) support an alternative.

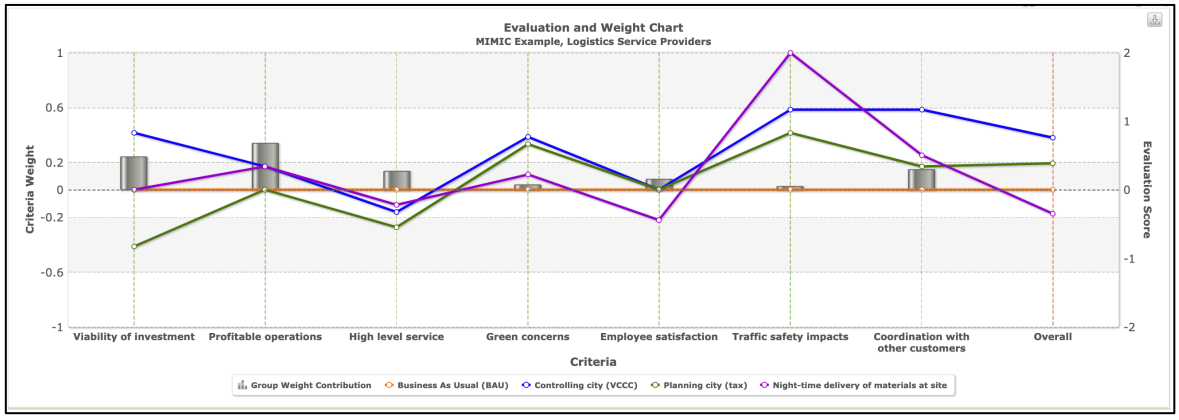

Figure 24. Evaluation and weight chart

The MAMCA software also allows users to perform a sensitivity analysis which shows the effect a change in the weight of a criterium has on the chart that shows the preferences of each stakeholder groups. This can be done by clicking 'Sensitivity Analysis Using Chart' under 'Analysis'. Tick the box of the stakeholder group whose criteria you wish to change. The sensitivity analysis allows users to easily show if the result changes when the weights are changed.

A complete report with all the visualizations can be downloaded as a PDF-file by clicking on 'Download Project Report' under 'Multi-Actor Chart' in the left-hand textbox. Visualizations of the criteria and weights per stakeholder can be found under 'Stakeholder Chart'. Individual visualizations can be downloaded by clicking the  icon in the top-right corner of an image. A PDF-file with all the visualizations can be download as a PDF-file by clicking on 'Download Report' in the same textbox.

5.7 Organizing a MAMCA workshop

The idea behind organizing a MAMCA workshop is that representatives of each construction logistics stakeholder group are present. During the workshop, each participant is then guided in expressing how important certain (decision) criteria are to him/her when choosing or evaluating a certain logistics solution, as well as to challenge the perceptions of local stakeholders by discussing the results. MAMCA thus aims and aids to achieve consensus amongst different stakeholders by including them all in the decision-making process.

Figure 25 provides an example of how the planning of a MAMCA workshop could look like, and how much time should be allocated to gather the necessary pieces of information. Since a workshop can easily take 2-3 hours, it is advisable to hold half a day to account for any delays or unforeseen circumstances. However, the entire analysis should not be conducted on the day of the workshop itself: many preparatory steps can be handled before actually gathering the stakeholders for this workshop. Figure 25 brings together the MAMCA steps and presents which ones of these could already be validated before the actual workshop.

14h00: Welcome participants
→ *Best to ask them to sit with their stakeholder group.*
14h15: Present the workshop
→ *Take time to explain clearly the scenarios.*
→ *Explain why we are doing a MAMCA.*
→ *Explain how the workshop will be organized.*
14h45: Discussion in stakeholder group around the weight collection
→ *Groups are going much faster than others (approx. 15 minutes + break).*
15h00: Presentation of the step 4 and showing the multi-actor view
→ *Explain how to read the figure with an example.*
15h15: Discuss the results of the MAMCA in a plenary session
→ *Preferably with two people to moderate the debate.*
→ *Don't talk too much, ask questions.*
16h00: Closing the workshop
→ *Recap the lessons learned thanks to the MAMCA.*

Figure 25. Example of a MAMCA workshop agenda

Time	Planning elements
Before the workshop	Step 1: scenario definition
	Step 2: stakeholder identification
	Step 3: criteria selection (but no weights yet)
	Develop a survey to invite stakeholders to the workshop, with the aim to: (1) pin/save a date; (2) validate your stakeholder groups; (3) validate your criteria and; (4) start step 4 before the workshop.
During the workshop	Step 3: Allocate weights to the criteria
	Step 5: Run the analysis
	Step 6: Discuss the results
After the workshop	Report
	Dissemination
	Feedback
	…

Table 10. Outline of preparatory work and MAMCA steps in light of the MAMCA workshop

6. Conclusions

This deliverable looks at different evaluation possibilities in order to assess alternatives on criteria of varying stakeholders. The analysis ultimately leads to an overview of (dis)advantages associated to construction logistics measures or concepts, taking into account a uni-actor or multi-actor points of view. Therefore, the Multi-Actor Multi-Criteria Analysis (MAMCA) methodology developed by Macharis (2000) is well-suited to be implemented in complex decision-making processes, as is often the case in the fields of mobility policies and urban transport where a multitude of stakeholders from varying backgrounds are involved.

The MAMCA software, made accessible through https://www.mamca.be, allows the user to follow the different steps of the methodology and generates multiple visualization schemes for the uni-actor or multi-actor results. From a multi-actor point of view, often not a single scenario scores highest for all stakeholders. Although one particular solution might lead to a preferential scenario for most stakeholders, it might still score very low for others, where these actors could then even prefer opting for the business as usual (BAU) scenario to the proposed scenario. However, the MAMCA aims at reaching a consensus among stakeholders and stakeholder groups, hence highlighting which alternatives receives the largest support. Sometimes compromises to some alternatives might be in order for them to be fully acceptable and implementable. On the stakeholder level, the MAMCA highlights how a particular alternative is scoring on the selected criteria of an actor group.

7. Sources for further reading

The list below gives an overview of further advanced reading. These papers have also been uploaded on ProjectPlace.

- Technical paper on PROMETHEE approach (outranking method): *BRANS, J.P, VINCKE, P., 1985, A Preference Ranking Organisation Method: The PROMETHEE Method for Multiple Criteria Decision-Making, Management Science, 31(6), 647-656*.
- Additional technical paper on the PROMETHEE procedure: *MACHARIS, C., BRANS, J.P. and B. MARESCHAL, 1998, The GDSS Promethee procedure, Journal of Decision Systems, Vol. 7, pp. 283-307.*
- Classification scheme and comprehensive literature review in order to uncover, classify, and interpret the state of research on PROMETHEE methodologies and applications in 2010: *BEHZADIAN, M., KAZEMZADEH, R.B., ALBADVI, A., AGHDASI, M. (2010) PROMETHEE: A comprehensive literature review on methodologies and applications, European Journal of Operational Research, 210, 198-215.*
- Analysis of applications of PROMETHEE-GDSS and further developments for enhancement of its applicability: *MACHARIS, C., MARESCHAL, B., WAUB, J-P., MILAN, L., 2015, PROMETHEE-GDSS revisited: applications so far and new developments, Int. J. Multicriteria Decision Making, 5(1/2), 129-151.*
- Short introduction to the basic principles of AHP: *COYLE, G. (2004) The analytical hierarchy process. Introduction, Practical Strategy. Open Access Material. Pearson Education Limited.*
- Introduction of the MAMCA methodology by an overview of other evaluation methods for transport projects in the past and illustration by means of two practical cases: *MACHARIS, C., DE WITTE, A. and J. AMPE, 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.*
- Policy related paper describing the MAMCA methodology and how it was applied in the "Flanders in Action Process": *MACHARIS, C., DE WITTE, A. and L. TURCKSIN, 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.*
- Theoretical foundation of the MAMCA, together with several applications in the field of transport appraisal: *MACHARIS, C., TURCKSIN, L. and K. LEBEAU, 2012, Multi Actor Multi Criteria Analysis (MAMCA) as a tool to support sustainable decisions: state of use, Decision Support Systems, 54(1), 610–620.*
- Overview of the use of Multi-Criteria Decision Analysis (MCDA) for transport project appraisal: *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, 177-186.*
- Use of MAMCA methodology complemented with an electronic group decision support system (GDSS) through a workshop in Leuven, Belgium: *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.*

8. Acknowledgements

This project has received funding from the European Union's H2020 research and innovation programme and is part of the research programme JPI Urban Europe with project number 438.15.403 (MIMIC). This project is subsidised by the Brussels Capital Region - Innoviris and the European Union and receives funding from the Swedish Governmental Agency for Innovation Systems (Vinnova), the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT) in the framework of the research programme "Stadt der Zukunft" and the Austrian Federal Ministry of Science, Research and Economy (BMWFW) and The Research Council of Norway.

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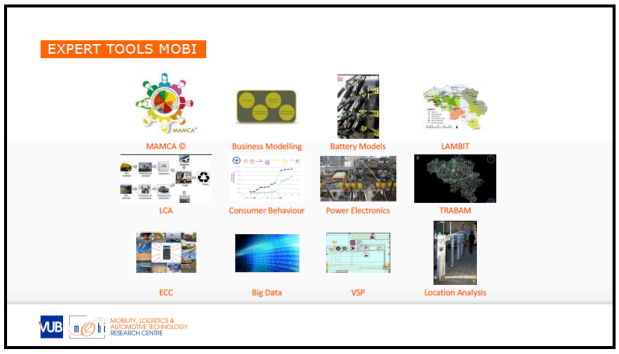
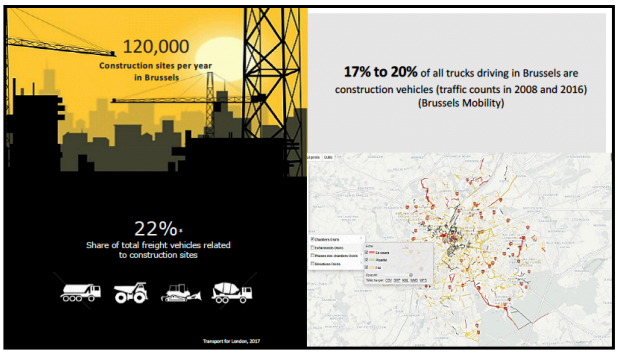
Annex 1: Slides & Instructions Vienna MAMCA workshop 16/01/2019

This presentation was given during Consortium Meeting 1 in Vienna, and can also be retrieved on ProjectPlace.





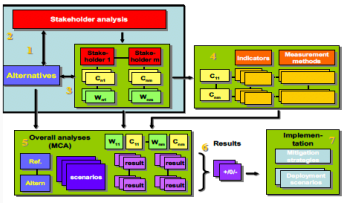
DIFFERENT ACTORS HAVE DIFFERENT INTERESTS

NEED FOR SUPPORT FROM ALL ACTORS!

AIM OF THIS WORKSHOP

To gain insight in the extent to which different alternatives for transport to, from and within construction sites contribute to the interests of the different stakeholders involved

MULTI-ACTOR MULTI-CRITERIA ANALYSIS

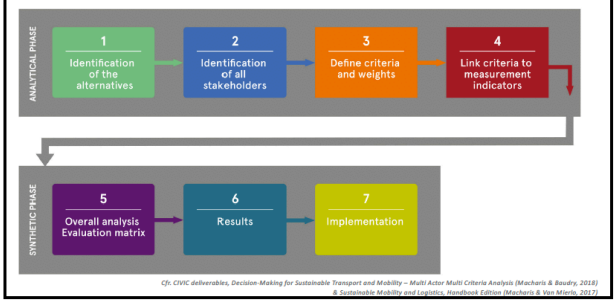


MULTI-ACTOR MULTI-CRITERIA ANALYSIS

multi-actor, multi-criteria analysis

Straightsol project

MAMCA methodology (Macharis, 2005)

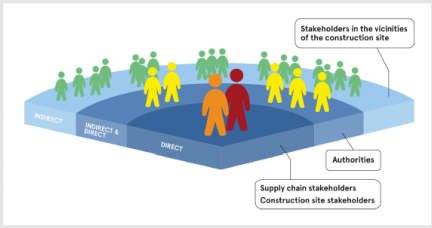


Cfr. CIVIC deliverables, Decision-Making for Sustainable Transport and Mobility – Multi Actor Multi Criteria Analysis (Macharis & Baudry, 2018) & Sustainable Mobility and Logistics, Handbook Edition (Macharis & Van Mierlo, 2017)

1. Alternatives

- **Business As Usual (BAU)**
  - None or fragmented coordination
  - Main contractors manage logistics and induced costs
  - Diesel trucks as main mode of transport
- **Controlling city (VCCC): bundling hub + waterway**
  - Vienna Construction Consolidation Center (VCCC) in collaboration with Hafen Wien
  - Imposed delivery address: consolidation of goods and delivered by waterway transport near the construction site
  - Bundling of construction material on common delivery tours
  - Costs divided between city and contractors
  - Expected impact: higher load factor, improved air quality, potential benefits for contractors and transport operators
- **Planning city (tax): bundling hub + electric vehicles (EV)**
  - Toll scheme at construction area entrance for non-EV
  - Maximum number of transports & designated time slots (bundling)
  - Supporting services are available
  - Costs carried by contractors
- **Night-time delivery of materials on site**
  - BAU scenario with higher temporal dispersion of material deliveries
  - Goods are delivered with trucks at night (before morning peak hours)
  - Expected impact: less congestion, higher average speed, lower emission levels but significantly higher noise levels during night time

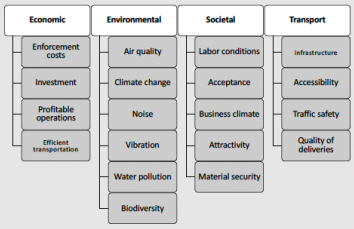
2. Stakeholders



2. Stakeholders

- **Authorities - City of Vienna (Vienna Mobility & Port of Vienna)**
  - Administration of the Vienna Region responsible for equipment, infrastructure and mobility issues, hence facilitating economic development and the growing need for mobility solutions while improving quality of life and sustainable development
  - Coordinating construction sites in Vienna
  - Have strong + correlation with citizen interests, such as keeping noise levels down, desiring high urban environment attractiveness etc.
- **Contractors**
  - Largest construction sites in Vienna
  - Currently operating the traditional way (diesel trucks) but desire to shift if economically viable / higher efficiency rates (less damaged materials, on-time deliveries, shorter site period…)
  - In need of timely (ideally JIT) deliveries
- **Logistics Service Providers**
  - Increasing demand from contractors to minimize share of transport-related costs in construction projects
  - Multimodal logistics company with its own fleet of inland barges operating (enabling inland barges to be independent of shore-based facilities by equipping them with a crane, hence stimulating modal shift)
- **Citizens – local residents & businesses**
  - Residents in vicinity of construction sites, businesses in area, users of infrastructure: car drivers, cyclists, pedestrians, public transport users etc.
  - Fear among local residents: willingness to reduce emission and congestion levels, noise nuisance etc.

3. Criteria



3. Criteria – Authorities (Vienna Mobility & Port of Vienna)

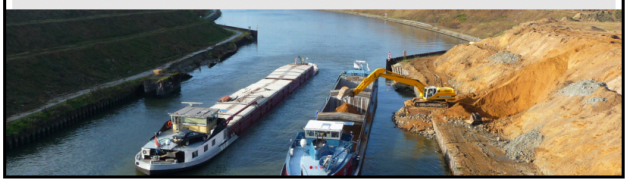
Criterion	Definition
1. Traffic Safety impacts	Traffic accidents during transport of goods and people to, from and within the site, as well as accidents caused by the changes in transport infrastructure at the site
2. Network optimization (efficiency of the transport infrastructure)	Optimal use of existing infrastructure
3. Positive business climate & attractiveness of the urban environment	Attractiveness of the area in terms of business opportunities and impact of construction works on the attractiveness of the recreational facilities in and around the construction zone
4. Construction time	Duration of site
5. Adaptation costs	Financial costs due to mobility impacts caused by the construction site or transportation flows to and from the Port of Vienna (Ex. Shared parking, detours…)
6. Social and political acceptance by citizens of impacts generated	Level of ease to comply with authorities' rules and regulations during construction works

3. Criteria – Contractors (recipients)

Criterion	Definition
1. Viability on investment	A positive return on investment (Ex. the investment in higher LSP costs should result in more efficient work in the long term)
2. Quality and reliability of deliveries of construction materials	The punctuality and the percentage of damage-free delivery of goods
3. Labour conditions	Labour conditions for employees during construction works
4. Transportation costs	The cost of transporting construction materials and/or personnel during the project
5. Climate change & green concerns	Impact of construction works on greenhouse gas emissions CO_2 - positive attitude towards environmental impact

3. Criteria - Logistics Service Providers

Criterion	Definition
1. Viability of investment	A positive return on investment
2. Profitable operations	Making profit by providing logistics services
3. High level service	High transport satisfaction rates and close collaboration with Port of Vienna
4. Green concerns	Positive attitude towards environmental impact
5. Employee satisfaction	Employees are satisfied with their work and working environment
6. Traffic safety impacts	Traffic accidents during transport of goods as well as accidents caused by the changes in transport infrastructure

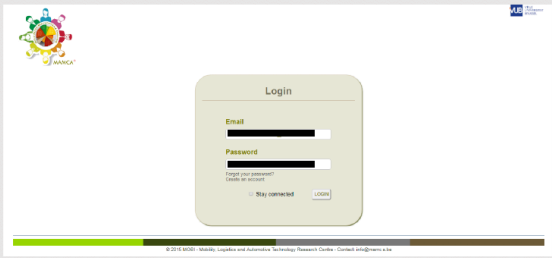


3. Criteria – Citizens (local residents and businesses)

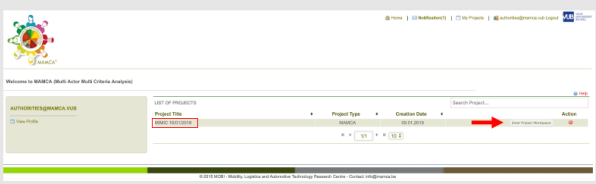
Criterion	Definition
1. Air quality	Reduce emissions of CO_2, NO_x, $PM_{2.5}$ and PM_{10}
2. Attractiveness of urban environment	Attractive environment for local residents and businesses
3. Road safety	Positive impact on road safety
4. Low visual nuisance	Less space occupancy by trucks
5. Noise pollution	Sound level caused by human activities, including transport, during construction activities
6. Impact of construction works on transport infrastructure use (urban accessibility)	Impact of infrastructure works on the efficiency (reduction of freight transport) of a transport system, in terms of average speed level, congestion and connectivity and the impact on parking

Let's MAMCA !

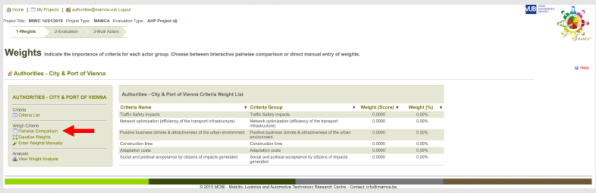
Login on the MAMCA software with the userID and password (www.mamca.be)



Click 'Enter Project Workspace' for 'MIMIC 16/01/2019'



Click on 'Pairwise comparison' to allocate weights to the criteria

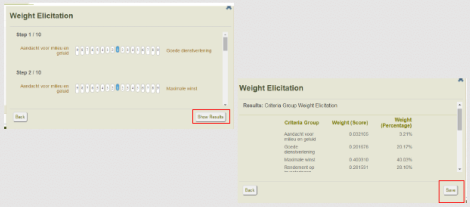


The first page shows an explanation on how the pairwise comparison works. When you are ready, click on 'Proceed' to start the comparisons of your criteria.

What does the 1-9 scale mean?

1	Both criteria are equally important
2	Criterion A is barely more important than criterion B
3	Criterion A is slightly more important than criterion B
4	Criterion A is weakly more important than criterion B
5	Criterion A is moderately more important than criterion B
6	Criterion A is substantially more important than criterion B
7	Criterion A is strongly more important than criterion B
8	Criterion A is extremely more important than criterion B
9	Criterion A is distinctively more important than criterion B

Compare the criteria pairwise and scroll down. Once you are finished, click on 'show results'. Check the results and click on 'save'.



Stakeholder criteria recap

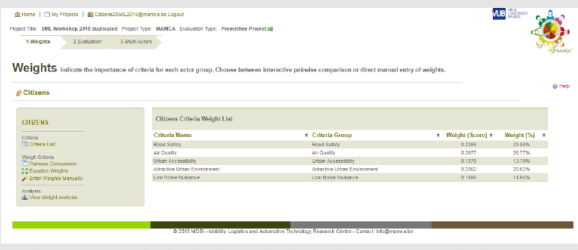
Authorities

Contractors

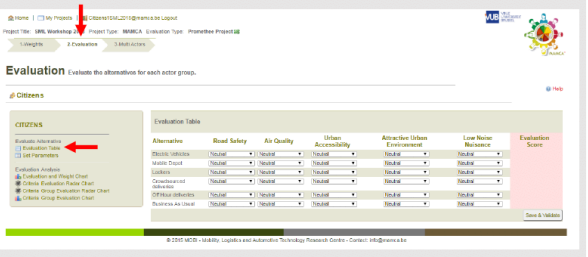
LSPs

Citizens

Here you can see the weights per criterion.

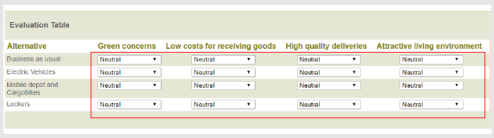


Click on '2-Evaluation' and 'Evaluation Table'

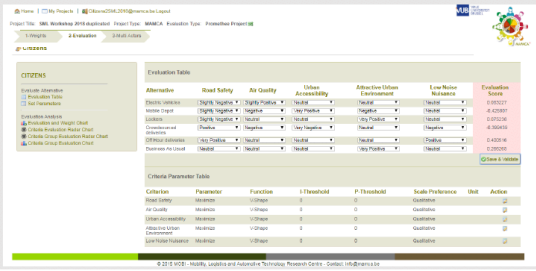


Evaluate the alternatives with regard to the different criteria

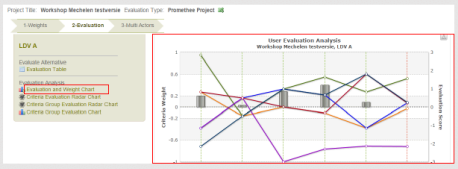
You have to evaluate whether the proposed alternative is negative, similar or positive compared to the business as usual situation.



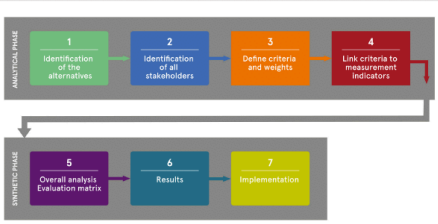
Don't forget to "save & validate"



Then you can click on 'Evaluation and Weight Chart to see your own results graphically. We will discuss the overall results at the end of the workshop.

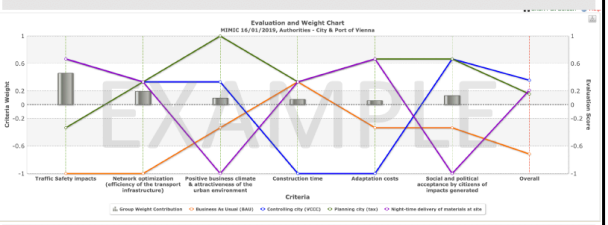


5. Results and discussion

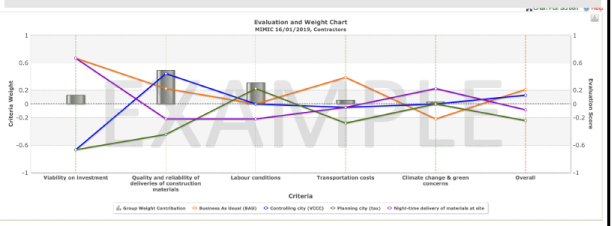


Results multi-actor

Results Authorities

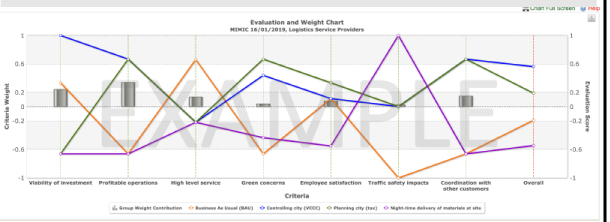


Results Contractors



MOBILITY, LOGISTICS & AUTOMOTIVE TECHNOLOGY RESEARCH CENTRE

Results Logistics Service Providers



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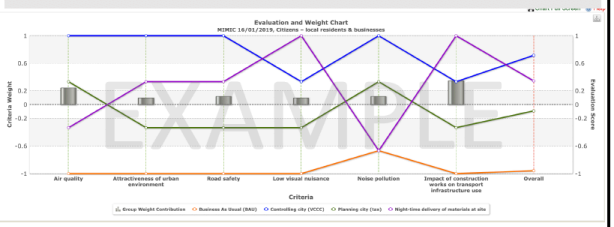
Results Citizens



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Conclusions

- Identification of stakeholders, criteria and weights to evaluate alternatives
- Gradual development MAMCA methodology
- Conflicting results
- Important role for demonstrating sustainability of solutions (economical, societal and environmental effects)

Johann Schnitt / YouTube

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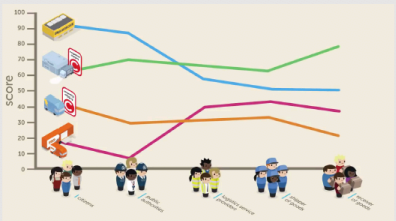
Thanks for your participation !



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KEEP IN TOUCH

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