SCENARIOS FOR THE FUTURE OF MOBILITY IN EUROPE: COMBINING THE SCENARIO TECHNIQUE WITH THE MULTI-ACTOR MULTI-CRITERIA ANALYSIS (MAMCA)

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Abstract

Mobility4EU is a project that aims to deliver a vision and action plan for the European transport system in 2030. It aims to identify societal trends that will influence future transport demand and supply and compile a portfolio of promising cross-modal technical and organisational solutions that address these trends. At the heart of this process lies the Multi-Actor Multi-Criteria Analysis (MAMCA) to assess the preferences of stakeholder groups across the whole transport and mobility spectrum (e.g. transport users, vehicle manufacturers, infrastructure managers, public authorities) regarding scenarios for 2030. While in previous applications of MAMCA, the scenarios were defined by the decision maker, this research proposes the combination of the intuitive logics scenario technique and the normative narrative method with MAMCA to appraise the preferences of fourteen stakeholder groups towards future scenarios for mobility in Europe by 2030 emphasizing the participative nature of the scenario building. Based on a survey of 33 stakeholders, we identified "policy & legislative framework" and "lifestyle & user behaviour" as pivotal uncertainties to steer the scenario building. They provided the basis for the development of four alternative scenarios: Data World, Digital Nomads, Slow is Beautiful, Minimum Carbon. Each narrative scenario describes future trends and technological, organisational or policy-related solutions to respond to the trends. In the next steps of the MAMCA a stakeholder analysis mapped relevant stakeholder groups and identified their objectives. The objectives were translated into criteria and each stakeholder group (224 stakeholders) weighted the importance of these criteria through an online survey. Then a panel of international experts evaluated the impact of each scenario on each criterion. Then we used the PROMETHEE method to produce a ranking of scenarios for each stakeholder group highlighting synergies and conflicts between the stakeholders. The scenarios Digital Nomads and Minimum Carbon are the highest rated for most of the stakeholder groups. This points to the importance of government intervention as both scenarios propose a pronounced role of governments in supporting innovation and interoperability. On the other hand, there is a disagreement whether the transport system should support an individualistic model of society, or a mobility system where resources are shared. These results were discussed with the stakeholders at a dedicated consensus-making workshop to come to a consensus on the consolidated scenario that best represents their objectives. This scenario has been taken forward to the Vision and Action Plan.

Keywords: scenario building, mobility, logistics, participative, multi-actor multi-criteria analysis

Introduction

Mobility4EU is a Coordination and Support Action of the European Commission working on a vision for the European transport system in 2030 and an action plan including a roadmap to implement that vision. Recommendations for tangible measures in research, innovation and implementation targeted towards various stakeholder groups are being derived. The work towards that vision and action plan is based on the identification and assessment of societal challenges that will influence future transport demand and supply, and the compilation of a

portfolio of promising cross-modal technical and organizational transport solutions. The entire process from studying trends and options for solutions, developing a vision and finally the action plan is organized within a structured participatory approach that aims to engage a broad stakeholder community into the consultation processes.

The aim of this paper is to outline how future scenarios for transport and mobility in 2030 in Europe were co-created with the stakeholders and how they were evaluated using the multi-actor multi-criteria analysis (MAMCA) method.

Methodological approach

In order to obtain a widely supported and consensus–based action plan, the Multi-Actor Multi-Criteria Analysis (MAMCA) methodology is used to consult a broad stakeholder community representing the main mobility actors in Europe. In the MAMCA, alternatives are evaluated on the criteria that are based on the objectives of the different stakeholder groups (Macharis, de Witte, & Ampe, 2009). This approach allows the involvement of a large group of stakeholders in the process of evaluating and prioritising future user needs and new transport concepts.

MAMCA has seven steps (Figure 1):

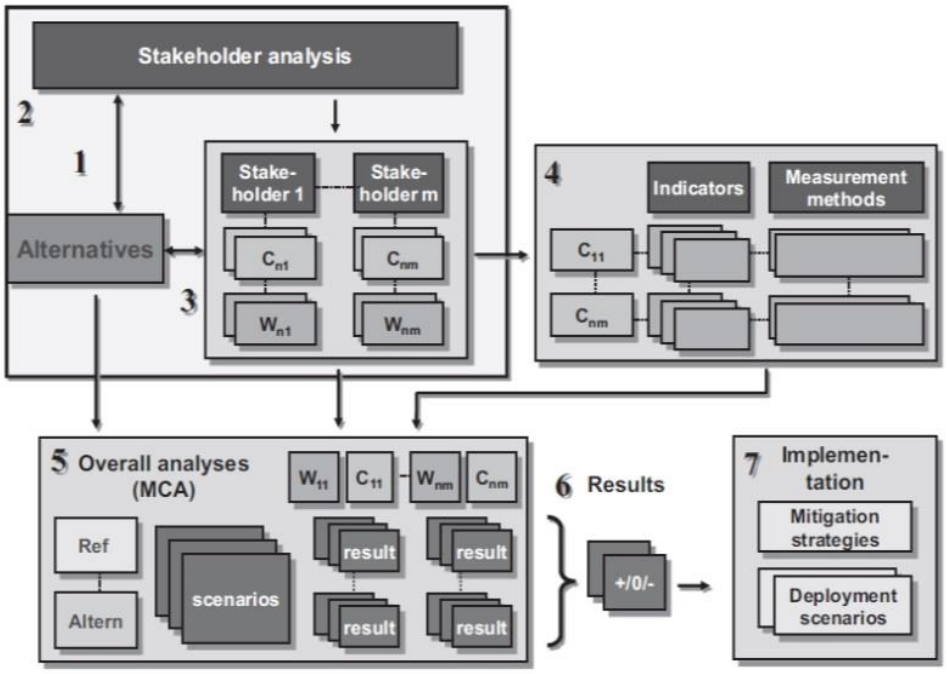

Figure 1 The steps of the MAMCA (Source: Macharis, Verbeke, & De Brucker, 2004)

Step 1 Alternatives
The process starts with the identification of alternatives or scenarios. In Moblitity4EU we consolidated dominant trends and potential future solutions into 4 scenarios that depict the future of the European transport system. These narrative scenarios were built using the intuitive logics method and further refined and validated at a stakeholder co-creation workshop.

Step 2 Stakeholder analysis
In the stakeholder analysis, all stakeholder groups that are relevant for the evaluation are mapped and their objectives are identified. Then the objectives are translated into criteria (e.g. reduction of traffic accidents = traffic safety).

Step 3 Criteria and weights
Each stakeholder group attaches weights to their criteria to express the importance of them. In this study we applied pairwise comparisons of the Analytic Hierarchy Process (AHP) (Saaty, 1994)

Step 4 Indicators
Then, indicators and measurement methods for each criterion are identified. Indicators are used to measure the performance of a scenario i.e. how a certain future scenario would impact a criterion (e.g. air quality) compared to the business as usual (current trends continue).

Step 5 Overall analysis
The scenarios are then evaluated based on qualitative (e.g. slight improvement, significant improvement, etc.) or quantitative assessment. Therefore, the impact of each scenario on each criteria is assessed to see e.g. how the scenarios affect traffic safety, greenhouse gas emissions etc. For the evaluation we applied the Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE) method (Brans & Vincke, 1985).

Step 6-7 Results (ranking) and implementation (consensus building)
The results of the evaluation are then calculated by combining the weights and the evaluations in the form of the ranking of scenarios for each stakeholder group (step 6). Since MAMCA does not produce an ultimate ranking of the scenarios, the results are then discussed with the stakeholders to come to a consensus (step 7).

In this project the above methodology has been facilitated through an online decision-making platform, i.e. the MAMCA software[1] providing an interactive method to weight stakeholder objectives, evaluate options and provide easy-to-understand visualisations of the evaluation outcomes.

Results, discussion and implications

Scenario building is the first step of MAMCA. In this study, we apply the *intuitive logics method* to create the scenarios. It is a form of creative-narrative scenario techniques based on the estimates (intuition) of experts as a reference point (Wack, 1985). Each narrative scenario is a description of future trends and technological, organisational or policy-related solutions. A long list of trends and potential solutions was compiled through desk research and dedicated stakeholder workshops (for details see Mobility4EU (2016a, 2016b)).

In October 2016, a survey was carried out among the consortium members and external stakeholders of Mobility4EU to identify which trends may have the highest degree of uncertainty and impact (pivotal uncertainties). The survey was filled in by 33 respondents representing a wide variety of organisations.

[1] www.mamca.be

Two groups of trends: policy & legislative framework and lifestyle & user behaviour emerged as pivotal uncertainties (Table 1). They define the differences between scenarios and hence provided the basis for the development of alternative scenarios.

Trend code	Trend description	Trend category
T8	**Acceleration of social life and more flexibility in spending one's time**	**Lifestyle and user behaviour**
T28	**Legislation adapts to new transport solutions and businesses**	**Policy and legislative framework**
T29	**Harmonisation of regulations at the European level to improve interoperability**	**Policy and legislative framework**
T30	**Rate of user acceptance of new technology**	**Lifestyle and user behaviour**
T32	**Increasing concern about financing transport investments**	**Policy and legislative framework**
T34	**New technologies and business models challenging legal frameworks**	**Policy and legislative framework**

Table 1 List of trends with the highest score of uncertainty and impact

Table 2 shows the two key factors (1 & 2) and their two extremes (a/b) that were used to define the four scenarios that reflect four possible combinations of these key factors.

1/a. Harmonisation of regulations and technology standards at the European level is limited. The activities of companies in the transport and mobility sector are less strictly regulated. Government support for innovation is limited, innovation mainly comes from private companies.
1/b. There is a high level of standardisation of regulations and technology standards at the European level. The activities of companies in the transport and mobility sector are more strictly regulated. Government support for innovation is strong, innovation is driven by the policy goals of the government rather than private initiatives.
2/a. Traditional and local values are regaining importance and define people's lifestyles. Burn-out from fast-paced work and social life turns people towards family values, national and local identity and cooperation within their local communities. Acceptance and adoption of new technology is slower.
2/b. There is a fast-paced transformation of lifestyles. People are becoming increasingly flexible with an accelerated pace of life. Individualisation leads to smaller household size and flexible employment. Adoption of new technology is fast.

Table 2 Possible combination of key factors that define the Mobility4EU scenarios

Four preliminary scenarios were created and discussed with the stakeholders at a scenario building workshop (for details see (Mobility4EU, 2016b).

Stakeholders evaluated the feasibility of the combinations of trends and matched potential technological and policy-related solutions with them in each scenario to complete the scenario building process. After the workshop, the input received from the stakeholders to make the

scenarios more realistic and consistent was analysed and taken into account when drafting the next version of the scenarios.

The process resulted in four scenarios: Data world (low regulation level, high level of private initiatives, flexible and individualistic lifestyles), Digital nomads (high level of government regulation and flexible and individualistic lifestyles), Slow is beautiful (protectionist markets, local sharing initiatives), Minimum carbon (healthier and active life, mobility heavily regulated to reduce carbon emissions) (Figure 2).

The scenarios are briefly described below. For the full scenario descriptions please consult Keseru et al. (2016).

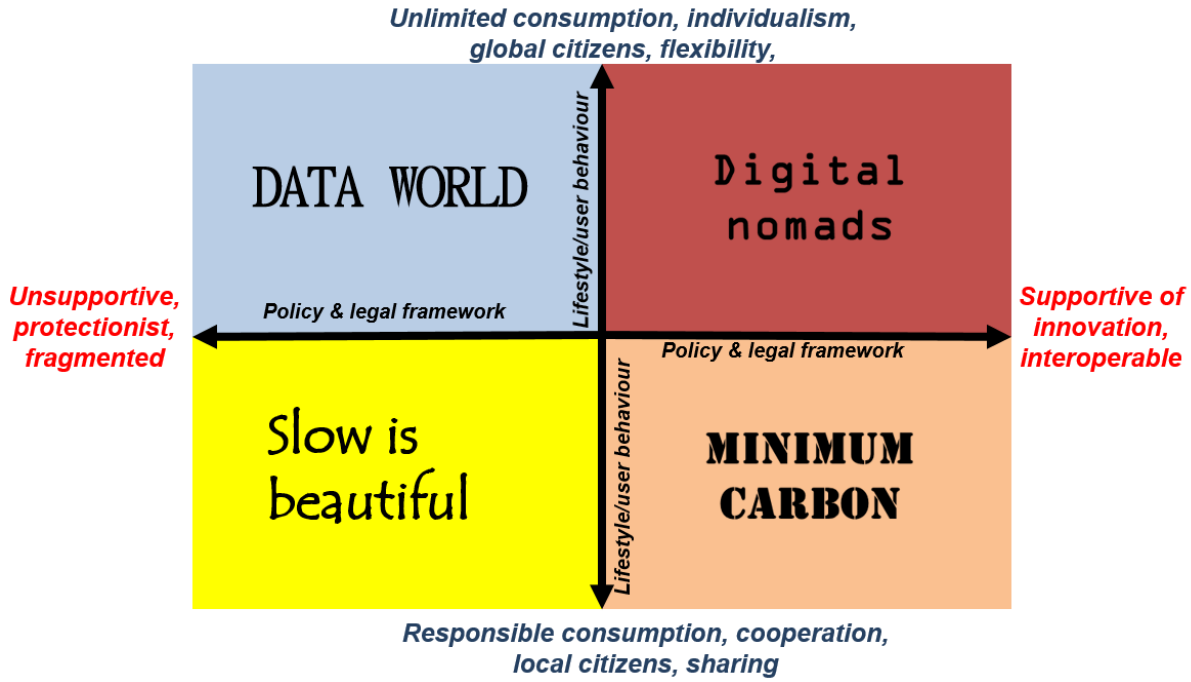

Figure 2 The four Mobility4EU scenarios

Data world

Harmonisation of regulations and technology standards at the European level is limited. The activities of companies in the transport and mobility sector are less strictly regulated. Government support for innovation is limited, innovation mainly comes from private companies, which collect, own and manage transport data. People are becoming increasingly flexible with an accelerated pace of life. Individualisation leads to smaller household size and flexible employment. This scenario mainly includes solutions that increase efficiency and profitability of private actors in transport and enable large private corporations to provide integrated mobility services.

Digital nomads

There is a high level of standardisation of regulations and technology standards at the European level. The activities of companies in the transport and mobility sector are more strictly regulated. The boundaries between private life and work disappear as people become always online and available. The solutions in this scenario enforce cooperation between private and public actors

to reduce carbon emissions and increase efficiency. Full digitalisation and automatization of the transport system is supported by government regulation and funding. Integrated mobility services are strictly regulated to provide a balanced set of transport options to users.

Slow is beautiful

European policy focuses on enabling local initiatives rather than supranational standardisation. Innovation is less supported due to scarce financial resources. People more and more turn to eco-friendly local cooperative production of food and energy, urban gardens and peer-to-peer services. Bottom-up initiatives of local communities thrive with few legal limitations on local sharing and production initiatives. The solutions in this scenario aim to restrict local road traffic and enable local initiatives to share mobility resources. The approach to digitalisation and automatization is more cautious.

Minimum carbon

Due to the severe pressure of climate change governments want to fundamentally change the behaviour of their citizens and companies to steer them to reduce carbon emissions and move them away from fossil fuels. Burn-out from fast-paced work have turned people towards healthier and active life. The solutions support strict regulation of carbon emissions both for freight and passenger transport. The focus is on reducing travel demand and provide accessibility to work and services within local self-sustaining neighbourhoods.

After creating the scenarios, 14 stakeholder groups and their objectives were identified (step 2). The groups cover all transport modes and encompass both private and public actors related to infrastructure, vehicles, services and users.

In the next step (step 3), each stakeholder group had to weight their unique set of criteria that have been derived from objectives. An online survey was carried out with the participation of 224 stakeholders from 28 European countries representing private and public companies, research organisations as well as European national, regional and local associations and local, regional and national governments. AHP pairwise comparisons were used to collect the weights, where all possible unique combinations (pairs) of criteria were presented to the stakeholders, who evaluated the importance of them on a nine-point scale (Saaty, 1994).

In the fourth step, indicators and measurement methods for each criterion were identified in collaboration with a panel of international experts. Then the scenarios were evaluated by international experts based on qualitative assessment (e.g. slight improvement, significant improvement, etc.) using the Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE) method (Macharis & Milan, 2015) (step 5).

Then in step 6, each stakeholder's preferences for the scenarios were ranked by combining the weights of each stakeholder group and the evaluation scores for each criterion and scenario using the MAMCA online decision-making software[2]. The results of the process are shown in Figure 3.

[2] www.mamca.be

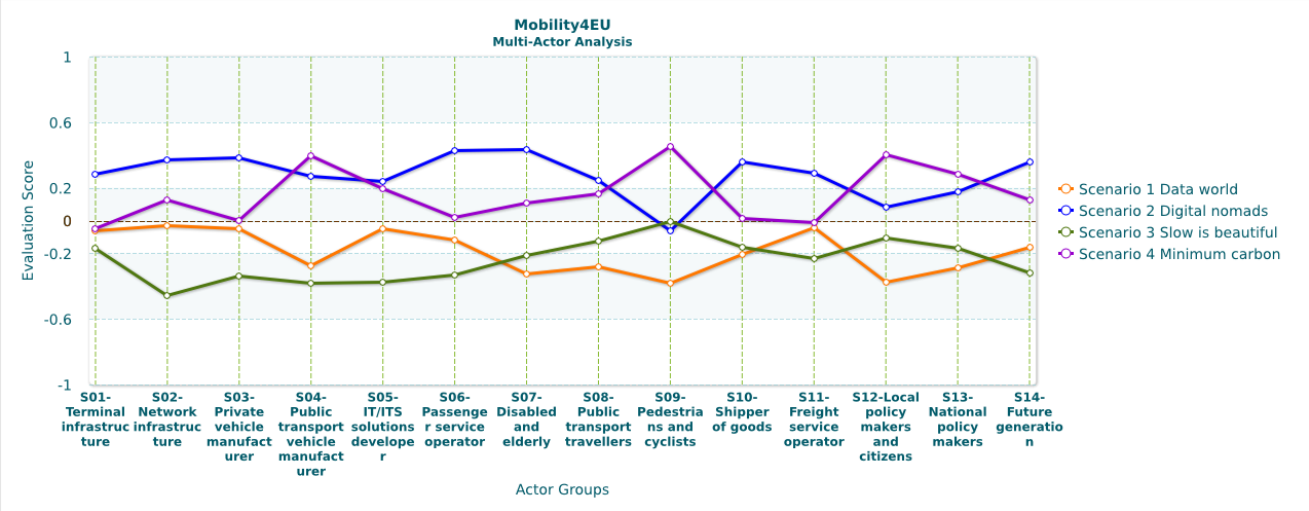

Figure 3 The results of the evaluation of the scenarios

For each stakeholder we can identify the preferred ranking of the scenarios considering their unique set of criteria. The scenarios Digital Nomads and Minimum Carbon received the highest ratings. Both scenarios support government intervention for digital innovation and interoperability (Digital Nomads) or introduce strict regulations for CO_2 emissions (Minimum Carbon). On the other hand, there is a disagreement whether the transport system should support an individualistic society or a mobility system based on shared resources in order to reduce carbon emissions.

To find the final consolidated scenario that represents the preferences of most of the stakeholders, the results of the MAMCA were discussed with the stakeholders at a consensus-making workshop (24 October 2017, Brussels) (step 7). Stakeholders agreed that the two 'winning' scenarios (Minimum Carbon and Digital Nomads) can be combined into a final consolidated scenario with some minor modifications to avoid conflicts. This preferred combined scenario is the key building block for creating a vision for transport in Europe in 2030 and then the action plan.

Conclusions

This paper has demonstrated how the multi-actor multi-criteria analysis can be used to appraise future scenarios in order to support the development of a future vision and an action plan for mobility and transport in Europe in 2030. MAMCA has enhanced the usually expert-led intuitive logics method with a broad stakeholder contribution and allowed stakeholders to participate in the creation of the scenarios and then evaluate the impact of the scenarios on their criteria. While it is often emphasized that scenarios represent different possible futures, the combination of the scenario technique with the multi-actor multi-criteria analysis can steer future policies to support a commonly supported scenario that is based on the preferences of the stakeholders that are affected by these scenarios.

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