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Societal Drivers for the Future Transport System in Europe: the Mobility4EU Project

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Short Abstract

Global socio-economic and environmental megatrends ask for a paradigm shift in mobility and transport in which multimodal solutions and ***electrification*** are key. An action plan for the implementation of innovative transport and mobility in Europe is needed. The MOBILITY4EU project develops such a plan considering all modes of transport and a multitude of societal drivers. It uses a Multi-Actor-Multi-Criteria Analysis (MAMCA) methodology for consulting a broad societal stakeholder community. This paper will present objectives and methodology of the project and results on the interaction between societal trends and formulation of (future) societal requirements on transport.

Keywords: deployment, EU, prediction, policy, consumers

1 Introduction

Global socio-economic and environmental megatrends are urging for a paradigm shift in mobility and transport that involves disruptive technologies and multimodal solutions in which electrification plays a key role. The individual transport sectors face diverse technical and non-technical requirements and rather individual, sometimes contradicting challenges. An action plan for the coherent implementation of innovative transport and mobility solutions in Europe is thus urgently needed. Within this context, the challenges of transport and mobility in Europe have been discussed from a multitude of perspectives in the past. Technical and non-technical roadmaps have been defined for all modes and from the point of view of many different stakeholders e.g. within European Technology Platforms and associations. Furthermore, the European Commission has presented a comprehensive framework for transport in 2050 reflecting many of these assessments and aligning them to overall political goals [1]. Nonetheless, the goals and actions remain fragmented. Sometimes, even artificial boundaries are created, where new societal factors and key technological enablers (i.e. the ageing of population and its impact on transportation services offer and demand, Internet of Things, Automation, electrification technologies, etc.) are considered in a concatenated and secluded way thus loading either to cross-modal and inter-stakeholder antagonisms or to suboptimal sectorial solutions. The MOBILITY4EU project in contrast, will develop an action plan, built on a comprehensive vision of the transport and mobility system in 2030, jointly developed, discussed, and agreed in a structured, transparent and democratic process involving stakeholders that represent all societal drivers and all transport modes, and that will be in line with the targets for the European transport area, set out by the European Commission. Therefore the MOBILITY4EU project considers a multitude of societal drivers encompassing health, environment and climate protection, public safety and security, demographic

change, urbanisation and globalisation, economic development, digitalisation and smart system integration. The successful implementation of the vision for the future transport and mobility system of Europe requires a continuous cross-modal and inter-stakeholder dialogue and collaboration. For this purpose the developed action plan will not only contain a roadmap indicating what needs to be carried out in research, innovation, organisation and implementation in technical and non-technical domains, but will also contain the blueprint for the implementation of a sustainable and continuous European Transport and Mobility Forum beyond the duration of the project. Moreover, in order to obtain a widely supported and consensus–based action plan, a Multi-Actor Multi-Criteria Analysis (MAMCA) methodology is used for consulting a broad stakeholder community representing the main societal actors. This stepwise and scientifically sound approach allows the consortium of the MOBILITY4EU project to involve a large group of stakeholders in the process of identifying, evaluating and prioritising future user needs, new transport concepts, implications and potential societal resistance and adoption. The involved stakeholder community includes all relevant actors from inside and outside the transport sector covering all transport modes including international, European and national stakeholders representing users, technology suppliers, policy makers, transport service providers, research organisations. In addition the participation of the stakeholders is strengthened by a visualisation-based story map process delivering, e.g., a jointly created and agreed panorama of the comprehensive vision for transport in 2030.
The MOBILITY4EU project consists of 19 partners from 11 countries in its core consortium and is completed by an extensive associated group of representative bodies for the various stakeholders.

2 Objectives and methodology

The final result of the Mobility4EU project will be an action plan that describes what needs to be done in research, innovation, and implementation both in technical and non-technical domains in order to achieve a future vision of a transport system in 2030 that reflects the various societal drivers in a comprehensive and balanced manner. This action plan will be structured on the one hand according to the most important modes of transportation and their intermodal links, namely in road, rail, water, air, hubs – both passenger and freight, and others. On the other hand, it takes into account the relevant societal drivers due to current megatrends, such as health, climate and environment protection, safety & security, demographic change, urbanization, economic development, digitalization and smart system integration. It will take into account in particular the user needs, reflect the contribution of new mobility concepts to transport efficiency in all modes, highlight the implications of these new concepts on policy, anticipate potential societal resistance to new solutions, and show new business models. Moreover, it will promote consensus building and dissemination of good practices. To come to the final action plan the MOBILITY4EU project aims to achieve following objectives:

- Identification and assessment of societal challenges that will influence future transport demand and supply
- Identification and categorisation of promising cross-modal technical and organisational transport solutions to address these challenges
- Establishing a future vision of a transport system in 2030 that reflects the various societal drivers in a comprehensive and balanced manner
- Development of an action plan including a roadmap for the implementation of that vision taking into account user needs, the contribution of new mobility concepts to transport efficiency in all modes, the implication of these new concepts on policy, examination of resistance to new solutions by society, new business models, promotion of consensus building and dissemination of good practices
- Recommending tangible measures in research, innovation and implementation for meeting the respective targets and challenges
- Engaging a broad stakeholder community into the consultation processes of the project and in implementing its results
- Sustaining the work of the project beyond its duration, e.g. in the form of a new European Transport and Mobility Forum

In order to achieve these objectives, a participatory framework involving all relevant actors from inside and outside the transport sector covering all transport modes including international, European and national stakeholders representing users including specific groups and communities that are vulnerable to exclusion, technology suppliers, policy makers, transport service providers, research organizations is being created. In order to obtain a widely supported and consensus–based action plan a with full participation of the stakeholders in the development phase the project will combine a:

- successfully proven visualization-based and structured workshop facilitation technique for multi-stakeholder engagement in strategic planning processes, the storymap methodology,

and a:

- scientifically established methodology for decision support, the multi-actor multi-criteria analysis (MAMCA) methodology in combination with decision support software (MAMCA software)

The combination of both methodologies will be applied in a highly structured way throughout the project in order to involve, engage and empower stakeholders in the consultation process. The result will be a swift, thorough, participative and transparent consultation process

2.1 Storymap methodology

Graphic visualization of information e.g. on posters is a successful way to interactively facilitate group work. It is particularly powerful in strategic planning processes where new insights shall arise from the engagement and cooperation of many participants with diverse backgrounds. Drawing a big picture of a problem during a meeting can reveal relationships between different aspects and perspectives. It thereby helps to think in systems and to align the group understanding. Furthermore, it creates a memorable product that everybody sees being created. This strengthens the participants' relation with the outcome, helps them to tell the story about the plan and supports the implementation of follow-up actions.

A more comprehensive approach of graphic visualization in the context of strategy development thinking consists in creating so called storymaps, i.e. large murals or a series of posters that represent e.g. the history of a problem, challenges and opportunities, individual values and expectations. Typically, it contains a context map, a commonly drawn picture of the future vision and a roadmap describing the action plan for achieving that vision. This approach is particularly helpful in stakeholder consultation and engagement processes to prepare major organizational or cultural changes. It provides for everybody a way to express themselves, helps to align language and goals in a participatory manner, and creates an understanding how everybody needs to adapt for the common objective. The storymap methodology will be used as a method for stakeholder involvement throughout the MOBILITY4EU project. Step by step, the status and issues of the current transportation system shall be assessed from the standpoint of multiple stakeholders, an inventory of future transport solutions will be recorded, a vision for 2030 shall be created and an action plan will be established – all using graphic visualization. This approach shall complement the rather structured assessment methods like MAMCA, strengthen the involvement of stakeholders during the duration of the project and create a group memory of the agreements, findings and plans

2.2 Multi Actor Multi Criteria analysis

In addition to the storymap methodology, the MOBILITY4EU project will employ a democratic but at the same time structured and scientifically sound methodology to involve stakeholders in drawing up the action plan. The multi-actor multi-criteria analysis (MAMCA) methodology will contribute to structuring the consultation process [7]

MAMCA has seven steps (See figure 2): the process starts with the consolidation of the large number of potential future solutions identified into a limited number scenarios that depict the future of the European transport system (step 1). Then a stakeholder analysis will map all stakeholder groups that are relevant for the evaluation and identify their objectives (e.g. mitigation of air pollution, reduction of traffic accidents, improving equity in rural areas) (step 2) Then, objectives will be translated into simple criteria (e.g. reduction of traffic accidents = traffic safety) and each stakeholder group will attach weights to their criteria to express the importance of these criteria (step 3). Then indicators and measurement methods for each criteria will be identified with international experts (step 4).

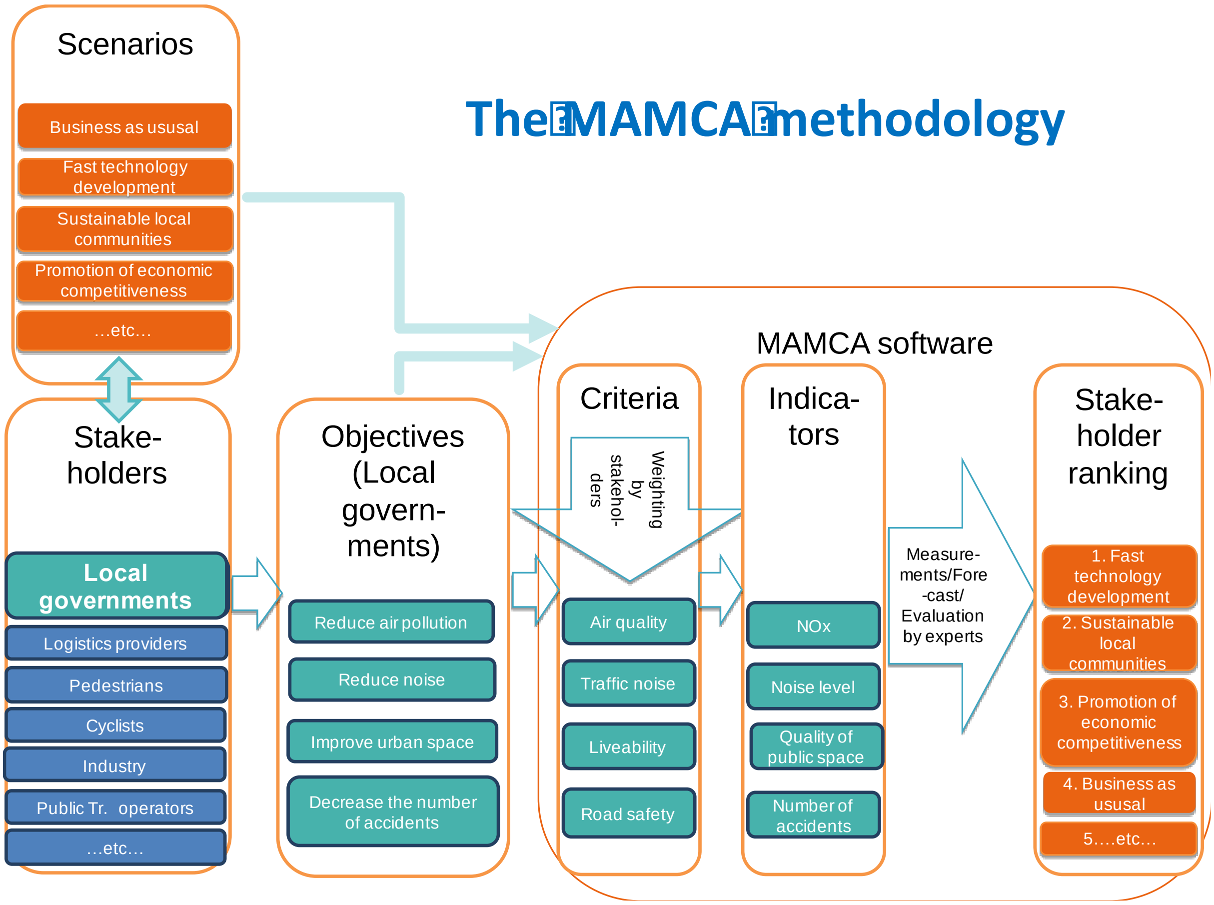

Figure 2: Key steps of the MAMCA Process

Indicators are used to measure the performance of a scenario i.e. how would a certain future scenario impact a criteria (e.g. air quality) compared to the baseline situation (present). After that, the scenarios will be evaluated based on the quantitative assessment of indicators or qualitative assessment by international experts (e.g. slight improvement, significant improvement, etc.) (step 5). Therefore the impact of each scenario on each criteria will be assessed to see e.g. how the scenarios affect for example traffic safety or greenhouse gas emissions. In the next step, the results of the evaluation will be produced by the MAMCA software in the form of the ranking of scenarios for each stakeholder group (step 6). The results of the MAMCA will be discussed with the stakeholders at a dedicated workshop where the outcome of the evaluation process will be presented to and discussed with them (step 7). Since MAMCA does not produce an ultimate ranking of the scenarios this workshop will serve as a consensus-building platform where all stakeholders will come to a consensus on the scenario that best represents their objectives for the future of transport in the EU. This scenario then will be taken forward to the action plan.

The above methodology will be facilitated through an online decision making platform, i.e. the innovative MAMCA software, developed by VUB. It provides an interactive method to weight stakeholder objectives, evaluate options and delivers easy-to-understand visualizations of the evaluation outcomes.

The MAMCA processes will be complemented by a number of workshops to receive direct input from the stakeholder community in a democratic way for the construction of the scenarios, validation of objectives, weighting of stakeholder criteria as well as the final consensus building and selection of the best-ranking scenario. These workshops will make use of graphic visualization techniques and are fully embedded in the story map process.

3 Transport societal drivers and anticipated responding concepts in future mobility

Mobility of passengers and freight is broadly considered as a key feature of modern societies. For this reason many drivers of existing and future, revealed or potential mobility have roots in societal trends. Transport refers to technical and organisational solutions to address mobility needs and it involves vehicles, infrastructures, operators and users. Societal trends will influence all these dimensions of transport, and reciprocally the interaction between transport supply and demand has direct effects on behaviours, lifestyles and hence deep societal implications. A systemic approach has to be developed in order to address these complex interactions. A central focus of the MOBILITY4EU project thus consists in studying the present and future connections between societal trends, mobility behaviour and transport solutions.
In the MOBILITY4EU project studies the following set of relevant societal drivers:

- Environment: Transport has since long time been linked to ecological issues like pollution and noise, with mitigation measures being e.g. ecological corridors. More recently, the impact on climate change raised public concerns and the related mitigation measures became a matter of policies. In 2012, emissions from transport constituted one fifth of all European CO2 emissions and are the only source that is still on the rise. The related countermeasures refer to increasing the energy efficiency of vehicles and reducing the carbon footprint of the energy mix by the use of energy from renewable sources in transport which is enabled by the use of electricity as the energy carrier. A transition towards the usage of renewable energy in the transport sector will additionally avoid the current depletion rate of fossil fuels and the environmental impacts induced during the sourcing of alternative fossil fuels such as tar sand oil and shale gas. However, when optimising the carbon footprint of transportation, a full system perspective is needed, including other life cycle stages and impact categories in order to avoid shifting the environmental burden (for instance toxicity aspects of mining activities for the production of a specific component should be accounted for. Furthermore, the growth of transport activities is a serious problem, particularly in freight. The design of sustainable logistic systems depends not only on transport policies and on logistics service providers, but also on decisions made by shippers and manufacturers and even the end customer. Indeed, dematerialisation, 3D-printing, postponement of final product assembly, reshoring and local sourcing may all significantly contribute to transport reduction. Moreover, sustainable supply chains can also be influenced by governmental regulations. In addition, the increasing awareness of society about the operations behind product and services can lead consumers towards more responsible and sustainable choices, with an impact on the sustainability of the whole supply chain.
- Safety & Security: No transport mode is exempt of safety and security issues and many public policies aim at addressing this problem. Road is mainly concerned with traffic safety; despite a continuous reduction of road fatalities, still 26.000 people died from road accidents in 2013 in the EU, which makes it a major societal issue. Smart integration and digitalisation of road vehicles implies the development of new safety and security measures Urban transit, rail and aviation also have to deal with security and from the operators point of view resilient operations is a constant objective.
- Demographic change: The main current and future demographic trends are aging society and migration. The aging issue will have the strongest implications for the organisation of transport systems. The percentage of Europeans aged over 65 is projected to rise from 16% in 2010 to 29% by 2060. The European population aged over 80 is set to rise from 4.1% in 2010 to 11.5% in 2060 [8]. Europe’s population is also growing, with the EU population set to increase by 18 million people by 2050 [8]. The older European population of the future will have different transport requirements, and current transport and mobility enablers need to adapt to meet these challenges.

- Urbanisation: Urban space has become the dominant European geography. As the share of Europeans living in urban areas is expected to increase between now and 2050 from 74% to 84%, transport movements occur increasingly in an urban context [9]. Growing and extending cities lead to the emerging concept of city-regions, which combines several spatial scales and transport modes. In the context of an artificial land cover increase by 3.4% in Europe between 2000 and 2006 [10], the 50-years lasting car based urban sprawl is more and more seen as an issue by urban and regional planners because of the associated externalities (land consumption, energy, traffic congestion) with proposed alternatives like urban intensification, compact development, Transit Oriented Development (TOD) and, to some extent, smart cities. Regarding urban logistics, it should be mentioned [11] that freight is an important traffic component in cities (10 to 15% of vehicle equivalent miles), load factors for delivery vehicles in cities are very low (e.g. 38% for vans in London) and urban freight is responsible for 25% of urban transport related CO2 emissions and 30 to 50% of other transport related pollutants.
- Lifestyles and economic development: late modern society [12] adds to the modern individualism and tot the post-modern fluidity, the new dimensions of the social networks and the pervasive use of ICT. The so-called generations Z and Y exemplify these evolutions with a lower use of cars than their predecessors. The theme of the shared economy is strongly favoured by these trends. Direct implications for transport involve e-commerce (and the issue of the last mile) and the impact on the employment in the transport sector. Nevertheless, the trend of universal use of ICT comes with refractory groups, those unable to use them and that must be considered. In addition will the trend to develop more carbon-neutral vehicles reduce the dependency of Europe on the import of (expensive) crude oil and as such sustain economic development on a macro-economic scale.
- Digitalisation: Improved environment perception due to advancements in camera and sensor systems as well as methods of sensor data fusion will enable higher degrees of automation in vehicles. Wireless communication among vehicles and between vehicles and the infrastructure add to this trend (V2X). Highly automated functionality, widely applied in aeronautics, is entering the automotive worlds now and will be available in other modes as well. It will increase traffic safety and fleet management significantly, and will sustain traffic control systems. However, new issues arise as well, e.g. related to privacy of data. A major trend for logistics with a 2050 vision is Physical Internet (PI). The aim of PI is to move, store, produce, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient and sustainable. PI aims at extrapolating the way Internet works into the logistics environment, achieving an open global logistic system founded on physical, digital, and operational interconnectivity, enabled through encapsulation of goods, standard interfaces and protocols.
- Smart integration: Information and Communication Technologies (ICT) enable the integration of transport modes for mobility use, this is referred to as the theme of smart integration. Concerning all the mobility-related and transport-related information it mainly involves the transfer between, and use of, different modes, big data and the problems of privacy for users. The key challenges for ICT for logistics are3: intelligent objects, smart devices, Internet of Things, ITS; big data; data analytics; dematerialisation; intelligent nodes; and autonomous logistics operations.

The interaction between technological evolutions with societal drivers results and will result in the new transport and mobility solutions, for the various modes of transport. An overview of examples of such advanced solutions is given in table 1:

Table 1: examples of technical solutions for the various transport modes

Societal drivers							
Modes	**Environment**	**Safety**	**Demographic Change**	**Urbanisation**	**Lifestyles and economic Development**	**Digitalisation**	**Smart Integration**
Road	*Biofuels, EV Lightweight Efficiency*	*ADAS, VRU Protection, Markings, Shared space*	*Human Factors, Entertain-ment*	*Public Shuttles, Electricity charging infrastructure*	*Car Sharing, Uberfication Manufacturing, Peak car*	*Automated Driving, Platooning*	*Navigation, Charging, Tolling*
Urban transit	*Energy storage, Quick electric charge (bus, tram)*	*Automation*	*Accessibility of vehicles and infrastructure*	*Transit Oriented Urbanism (TOD)*	*Personal transit, Stations as "places to be"*	*Transit automation, On-Trip ICT use*	*Ticketing, Real-Time Information*
Rail	*Hydrogen Fuels Cell Trains*	*Automated Trains, Speed*	*Flexible Interiors*	*Underground Freight Pipelines*	*Gas/Fuel Transport, Shuttles,*	*Infrastructure, Monitoring*	*Ticketing, Real-Time Information*
Water	*LPG, Wind, Solar Boats, Emissions*	*Operation in extreme Environment*	*Cruise Ship Design*	*Z-Emission Access Links*	*Small Series Production Concepts*	*Automation on Rivers & Canals*	*Hubs and Ports*
Air	*Lightweight, Electric Aircraft*	*Airspace Control, Security*	*Accessibility of Aircrafts*	*Low Noise Aircrafts, Airports as cities*	*Rapid Certification*	*Unmanned Freight Drones*	*On-Trip Information, Seamless*
Intermodal	*ZE-Road Links*	*Emergency Operations*	*Neighbor-hood level freight*	*City Logistics Network Nodes,*	*Network Reliability, Upgrading, Last mile of logistics*	*Physical Internet*	*ITS, Data Standards, Routing*
Others	*Virtual Travel*	*Monitoring Drones*	*Mobility Robots*	*Urban Cablecar*	*Airships, Pipelines*	*Swarm Robots*	*Hyperloop, Personal Rapid Transit*

4 Conclusions

Current and imminent Global socio-economic and environmental megatrends are strongly influencing mobility and transport solution for the future. Hence, a profound paradigm shift in mobility and transport in which multimodal solutions and electrification play a key role is essential. In order to achieve this an action plan for the implementation of innovative transport and mobility in Europe is needed. The MOBILITY4EU project is developing such a plan considering all modes of transport and a multitude of societal drivers. For that purpose it uses the well-proven technique of story-mapping in combination with the scientifically sound multi-actor multi-criteria analysis (MAMCA) methodology. Major identified societal trends include environmental-, safety- and security issues, demographic change, urbanisation, lifestyle and economics, digitalisation and smart integration.

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