Building Scenarios for the Future of Transport in Europe: The Mobility4EU Approach

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Abstract This paper outlines the scenario-building approach of the Mobility4EU project that aims to create a vision and action plan for mobility and transport in 2030. Scenario building is the first step of the Multi-Actor Multi-Criteria Analysis (MAMCA), the methodology used to conduct a broad stakeholder consultation. To emphasize the participative nature of the scenario building, the scenarios were created using the intuitive logics technique and participatory workshops. Each scenario describes future trends and technological, organisational or policy-related solutions. Based on a survey of stakeholders, "policy & legislative framework" and "lifestyle and user behaviour" emerged as pivotal uncertainties to steer the scenario building. They provided the basis for the development of four scenarios: Data World, Digital Nomads, Slow is Beautiful, and Minimum Carbon. The paper describes the trends and solutions that comprise these scenarios.

Keywords Scenario building · Mobility · Logistics · Participative · Multi-actor multi-criteria analysis

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1 Introduction

Looking into the future is always an exciting task. Contemplating how we will live, work and travel 10–15 years from now can help us to prepare for several possible futures or to try to achieve our own preferred future vision. The future is indeed uncertain since there are several development paths possible. The role of strategic planning is to devise actions that are appropriate for the most probable paths so that the society is prepared for possible positive or negative events and trends.

Such a foresight is also essential in the field of mobility and transport so that European, national and local policy makers can take the necessary steps to react to ongoing or upcoming trends within and beyond the transport sector with potentially great social and economic impact. The Mobility4EU project funded by the European Commission investigates these trends, potential solutions and future developments paths aiming to create a vision for mobility and transport in 2030 and an action plan to reach that vision. While there have been many similar efforts before (Bernardino et al. 2015; Leppänen et al. 2012; Krail et al. 2014), the approach applied in this project differs from previous studies in that it explicitly involves the representatives of the users of the transport system to explore future trends, solutions and development paths in an effort to balance technocentric views and user needs.

Our participatory approach has three pillars. On the one hand, based on a study of trends and transport solutions (Mobility4EU 2016; Mobility4EU 2018), future scenarios for transport and mobility in Europe including trends and solutions have been co-created with a wide range of stakeholders from and beyond the transport sector. Furthermore, a structured evaluation process, the multi-actor multi-criteria analysis (MAMCA) (Macharis et al. 2009) is used to evaluate the scenarios and find the synergies and conflicts between stakeholder groups. Finally, the story mapping technique is used to unleash stakeholders' creativity through workshops contributing to the scenario building and the creation of the vision (for details see the following chapter in this book and Muller and Meyer 2018).

This paper focuses on the first participatory element, i.e. the co-creation of scenarios. Nevertheless, this process is closely linked to the other two participatory methods: the co-created scenarios form the basis of the stakeholder-based evaluation within the MAMCA; in addition, the story mapping process contribute to exploring dominant trends and solutions that form integral parts of the scenarios.

The goal of this paper is to outline the process of the development of the scenarios for the future of mobility in Europe and present the scenarios that were co-created with the stakeholders i.e. the consortium members, associated partners and external stakeholders of the Mobility4EU project.[1]

The paper first outlines the scenario building approach, then the four scenarios are described that were co-created with the stakeholders. In the last section, the further steps of the participatory evaluation of the scenarios are briefly outlined.

[1]This paper is partly based on Deliverable D3.1 of the Mobility4EU project (Keseru et al. 2016).

2 The Scenario Building Approach in Mobility4EU

2.1 What Are Scenarios?

Scenarios represent a range of possible, probable and desirable developments in the future and paths that lead to that future. Since we can never be sure how the future finally develops, scenarios are hypothetical based on assumptions. Therefore, scenarios are not capable of providing precise predictions of future development paths i.e. they do not deliver a comprehensive description of the future but rather focus on its specific elements (Kosow and Gaßner 2008).

In the Mobility4EU project, the scenarios have a *communicative function* to enhance the cooperation of different actors in the transport and related domains; a *goal setting function* to define what the European Union intends to achieve in the transport sector until 2030 and contribute to *decision-making* since a 'best' scenario is selected and transformed into a vision and action plan after evaluating several alternative scenarios with the MAMCA methodology (Bröchler et al. 1999; Greeuw 2000). In addition, scenario building helps to explore and understand the relationship between political, environmental, economic, social and technological factors which is often very complex (Wright et al. 2013).

2.2 Participative Scenario Building Approach

A multitude of methods have emerged in the past to create scenarios (Wright et al. 2013). One of the most used techniques is the intuitive logics method. Intuitive logics is based on the estimates (intuition) of experts as a reference point (Wack 1985). The process focuses on decision-making. It is called intuitive because besides relying on objective data, intuitive estimates of future trends by experts are also considered. This technique has the advantage that it considers unpredictability and covers the so-called scenario transfer, i.e. the final stage of the scenario process when the scenarios are used for strategy making (Kosow and Gaßner 2008). The intuitive logics method has been found to enhance the understanding of the relationships between major factors that define the future and it can challenge conventional thinking (Wright et al. 2013).

This technique is often criticised for being expert-led allowing little involvement of stakeholders (Wright et al. 2013). To overcome this deficiency and involve a wide range of stakeholders in the process we combined the intuitive logics method with participatory workshops. This technique allows for the involvement of stakeholders, although the process is quite time-consuming (Kosow and Gaßner 2008).

The key steps of our combined approach are (Kosow and Gaßner 2008):

1. Scenario field identification: What is the purpose of the scenarios? What is the issue to be addressed?
2. Identification of key factors or driving forces

3. Clustering of key factors
4. Analysis of key factors for unpredictability and impact
5. Scenario generation: studying the scenario logic, i.e. to create a manageable number of scenarios focusing on 'pivotal uncertainties'
6. Drafting the scenario narrative
7. Scenario workshop to co-create scenarios and provide a better understanding of the scenarios as well as increase the legitimacy of scenarios
8. Scenario writing and optimisation
9. Participatory evaluation of the scenarios with the multi-actor multi-criteria analysis
10. Scenario transfer selecting concrete strategies.

2.3 Scenario Building for the Future Vision and Action Plan for Europe

Based on the above stepwise approach, first, we defined the scenario field. The scenarios should address transport and mobility in 2030 in Europe with focus on societal trends and user needs. Then, we identified key factors and driving forces i.e. trends that will influence transport and mobility by 2030. 34 trends were identified i.e. societal challenges, requirements and needs that will influence the future transport demand and supply. This work was based on desk research and an interactive workshop with stakeholders (Berlin, 03/05/2016) (Mobility4EU 2016). The trends were clustered into 9 broader categories: distribution of wealth and labour market developments; lifestyle and user behaviour; urbanisation and smart cities; environmental protection: climate change, pollution resource and energy efficiency; digital society and internet of things; novel business models and innovation in transport; safety in transport; security in transport; legislative framework [see also following chapter in this book and Mobility4EU 2016]. Then, in October 2016, a survey was carried out among stakeholders to identify which of these trends may have the highest degree of uncertainty and impact. The survey was filled in by 33 respondents representing a wide range of stakeholder organisations. Each trend was assigned a score between 1 and 4 for both uncertainty and impact. The aggregated results are shown in Fig. 1. The dots represent the 34 trends which are plotted on a graph in which the horizontal axis represents the impact of the trend while the vertical axis shows uncertainty.

Based on their score of uncertainty and impact, the trends can be classified according to the categories in Table 1 (Kosow and Gaßner 2008).

We selected trends that have the *highest uncertainty and the highest impact* (trends that received a minimum score of 2.4 for both attributes). These trends are situated in the upper right-hand side quadrant of the graph in Fig. 1 and they are called *pivotal uncertainties*. Table 2 lists the pivotal uncertainties that we identified and their broader thematic categories.

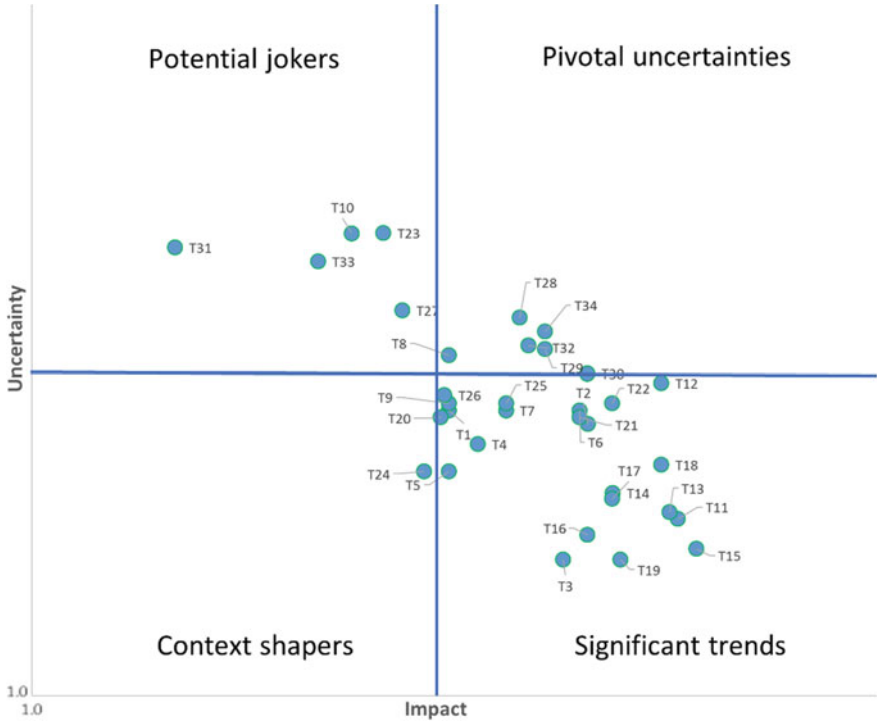

Fig. 1 Distribution of trends according to their degree of uncertainty and impact based on a survey of 33 stakeholders

Table 1 Categories of trends based on their degree of uncertainty and impact (Kosow and Gaßner 2008)

Uncertainty	Impact	Category of key factors
High	High	*Pivotal uncertainties*
High	Low	*Potential jokers*
Low	High	*Significant trends*
Low	Low	*Context shapers*

If we look at the larger thematic categories of the identified pivotal uncertainties, *policy & legislative framework* and *lifestyle & user behaviour* emerge as the key driving forces that have the highest uncertainty and greatest impact in terms of mobility demand in 2030 in Europe. These *pivotal uncertainties* define the differences between scenarios and hence provide the basis for the development of alternative scenarios. Figure 2 shows how the four possible combinations of the two extremes of the *pivotal uncertainties* define the four scenarios.

Besides major trends that influence mobility, the Mobility4EU scenarios comprise a selection of the technological, organisational and policy-related solutions that respond to these trends. 87 technological, organisational or policy-related

Table 2 List of trends with the highest score of uncertainty and impact

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

solutions were defined through a workshop with stakeholders and desk research (for details see Mobility4EU 2018).

Preliminary scenarios combining trends and solutions were created by the consortium. They were not prescriptive; rather they provided a starting ground for discussion. They were further refined at a scenario building workshop (Brussels, 05/07/2016) where the scenarios were co-created in a participative manner. The event brought together experts for passenger and freight transport across all modes. First, they validated the trends included in each scenario. Then they selected and

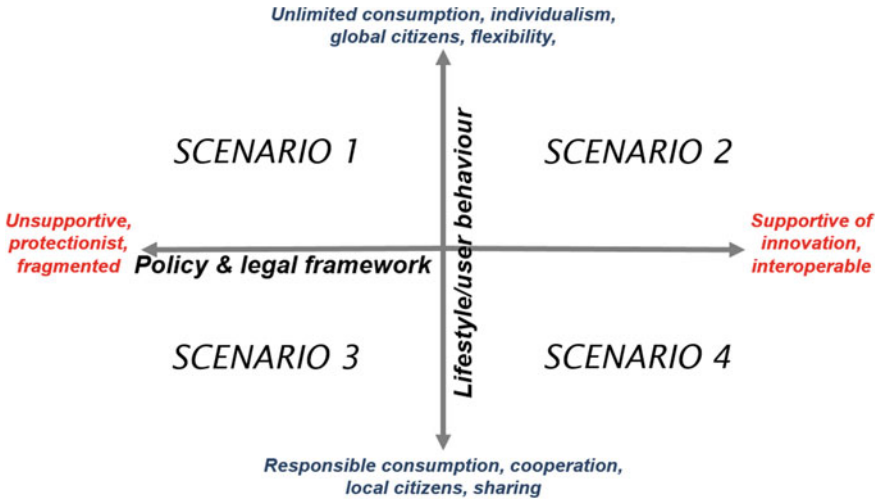

Fig. 2 Four scenarios combining the possible outcomes of the pivotal uncertainties

matched technological, organisational or policy-related solutions to the scenarios and their trends using cards depicting each solution and scenario boards representing the four preliminary scenarios (see Keseru et al. 2016 for more details). After the workshop, the input received from the stakeholders to make the scenarios more realistic and consistent was analysed and considered when drafting the next version of the scenarios.

3 Scenarios for the Future of Mobility in Europe

Based on the above methodology we identified four scenarios (Fig. 3):

1. Data world
2. Digital nomads
3. Slow is beautiful
4. Minimum carbon.

Each of the scenarios is described below with its underlying trends. Each scenario is divided into two parts: trends and solutions for freight transport and passenger mobility.

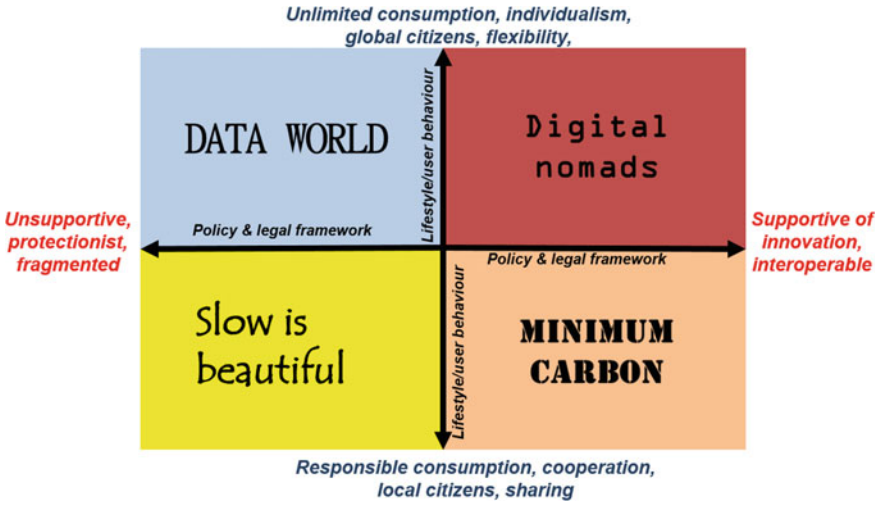

Fig. 3 The four Mobility4EU scenarios

3.1 Scenario 1: DATAWORLD

Industry and consumption increasingly rely on production outside Europe and hence demand for intercontinental freight flows is increasing. Increased trade flows from the E7 countries[2] are expected to change the scene in global supply chains and logistics. As a reaction to market demand, port operators extend seaport capacities by installing floating delivery hubs and automated container terminals, port operations and transshipments.

A growth in E-commerce stimulates intra-European freight flows as well. Supply chains become more complex, requiring tailored solutions that are industry- or even customer-specific. There is, however, little collaboration between delivery companies and shippers (e.g. retailers) to promote bundling flows and optimize deliveries.

As a response to increased demand from customers for instant deliveries and to save cost, delivery companies start to introduce personalised delivery systems using airborne drones and small autonomous freight trucks for first- and last-mile deliveries. Organised platooning of freight vehicles (road trains) will become widespread thanks to the deployment of cooperative ITS. This will increase capacity for long distance freight transport while also contributing to better safety and better fuel economy. Increased use of information and communication technologies and especially big data exploitation facilitate supply chain optimisation (i.e. cost/time reduction, load factor improvement etc.). Cybercrime becomes a great concern.

In passenger mobility, demand for information and online services to book and pay for mobility services is high. Internet connectivity and direct data collection from users is key for the management of the transport system. Technology companies provide continuous and reliable internet connection at stations and on vehicles. Their business model is to collect users' data extensively in return for free internet, travel information and entertainment.

National and local governments exercise little control over the provision of mobility services. A few large, private, multinational mobility providers emerge and compete. They own, manage and process the immense amount of mobility data collected from smart sensors in the infrastructure and vehicles and by engaging transport users through gamification using data from their connected devices. They provide real-time traffic optimisation and safety information to transport authorities. Due to the lack of expertise, governments mostly rely on these big data integrators for the management of their intelligent transport systems, road and rail infrastructure.

Travel demand continues to increase as people become increasingly mobile and flexible. The strategy of multinational mobility providers is to focus on individual needs, reduced travel time (faster travel) and specific consumer groups (e.g. young adults, families with children, medium-high income households), mainly in urban areas where demand is high. Therefore, they push governments to increase the capacity and improve maintenance of the transport network especially for roads and high-capacity public transport. Many major infrastructure investments (motorways, major roads and bridges in urban areas, high-speed railways) are implemented by private

[2]China, India, Brazil, Mexico, Russia, Indonesia and Turkey.

companies that levy a charge for the use of infrastructure. Due to the lack of government regulations the prices vary considerably across operators and no common payment system is introduced across major operators and across Europe.

Public and private transport services converge in Mobility as a Service (MaaS) initiated by these large mobility companies providing real-time trip planning, booking and payment services for all transport modes. Within MaaS, mobility companies promote their own transport solutions such as car-sharing (in cooperation with car manufacturers) and widely deployed ride-sourcing. Traditional public transport and taxi companies become subcontractors of the mobility companies to retain business. To serve individual needs the first commercial personal rapid transit systems are promoted in urban areas by private investors. Personalised and individualised transportation to, from and within airports are developed by mobility companies and airports. Public transport operators adopt flexible timetables and modular trains to provide flexibility to adapt to passenger needs and demand. Airlines differentiate flight cabin classes and zones according to individual needs and provide high-speed internet connection and virtual reality entertainment services. Airlines and aircraft manufacturers develop the first small on-demand aviation services to provide flexibility to customers with tight schedules.

The mobility companies focus on satisfying travel demand by high capacity and individualised transport solutions (self-driving solutions, public transport with improved comfort and commercial speed). Cycling and walking are only niche markets for them. Nevertheless, shared smart electric bicycles carrying advertisements are introduced in urban areas for which the rental fee depends on the visibility of the ads (how long the trip is).

Due to fragmented local regulations and differing priorities in transport policy in the member states, diverse proprietary solutions are developed for connected and autonomous vehicles, charging stations, data platforms and safety solutions. Due to fierce competition and the lack of supranational regulations autonomous transport systems have a low level of compatibility across regions or countries. Government regulations on vehicle emissions and infrastructure operations are less severe, the emphasis is on the voluntary sustainability initiatives of vehicle manufacturers and infrastructure managers.

Security is a major concern in all walks of life, but there are no strict regulations in place to increase security in a way that would contribute to delays and a deterioration of comfort for passengers. Pan-European cooperation for transport security is at a low level. This leads to a fragmentation of rules, regulations and procedures in cross-border traffic.

3.2 Scenario 2 Digital Nomads

Growing concerns about climate change, stricter EU-wide regulations to reduce CO_2 emissions and an increased focus on renewable energies and materials have brought innovative technologies and business models into the limelight.

A reindustrialisation takes place in Europe based on the latest technologies and innovation driven by increasing transportation costs. This mainly affects non-labour-intensive industry, which can be easily automated. Labour-intensive industries remain outside Europe. Trade barriers have been lifted.

European and national policies support and enforce cooperation between players and transport modes in the freight sector. Shippers, freight forwarders and receivers of goods are obliged to share their data on logistics operations with each other. Data sharing supports the development of the physical internet, an open global logistics system that allows for a more sustainable logistics chain where modular containers of different standardized sizes are equipped with a protocol and an interface to allow better handling and transshipment. Digital security becomes a great concern. Freight and public transport is integrated through co-modality by using available space on public transport vehicles during non-peak-hours (e.g. at night) or on duty vehicles (e.g. cleaning or maintenance vehicles). For last- and first-mile deliveries, small electric vans, electric bikes or tricycles are used because in most cities low emission zones are introduced. Full digitalization of the transport system promotes the automatization of all logistics operations at terminals and vehicles (ships, trains, organized platooning of trucks) as well as beyond terminals.

Despite increasing migration and security concerns, borders within the EU remain open and the remaining non-Schengen countries join the area of free movement. Airports introduce the 'No borders' approach i.e. the integration of passenger information and security checks. Seamless security checks and intelligent CCTV technology at airports and high-speed rail stations utilize preselection based on big-data and advanced screening equipment. Advanced digital security devices are also used to increase security in public areas through advanced face recognition and risk analysis. Since aviation relies fully on digital communication and management, protection against cyber threats is strengthened.

People are becoming increasingly flexible in their work and private lives. The boundaries between private life and work disappear as people become always online and available. Travel time is used for multitasking (e.g. working) to add useful minutes to an otherwise very crowded daily schedule.

Governments embrace the 'internet everywhere and for everyone' concept which requires transport operators and vehicle manufacturers to provide internet connection at all stations and on board all vehicles including private cars.

Governments focus on improving the efficiency and capacity of existing road and parking infrastructure and construct new high-capacity infrastructure where needed to cater for increasing demand for travel. New roads are built only where ITS and demand management cannot provide a solution to congestion problems. New infrastructure is mainly built in public-private partnership where public authorities retain control over user charges.

Governments support full digitalisation of the transport system. Strict pan-European regulations ensure interoperability of the transport infrastructure and digital interfaces as well as data privacy. Cooperative Intelligent Transport Systems (C-ITS) are developed in public-private partnership to increase road safety and road capacity. C-ITS is comprehensively implemented on

motorways, the main and secondary road network and provides detailed real-time information about incidents and roadworks, speed limits and diversion routes. The vulnerable road user protection system will increase safety of pedestrians and cyclists by alerting drivers of the presence of vulnerable road users. Preventive and predictive maintenance of road and rail infrastructure is increasingly automated (remote asset inspection, autonomous operations, and integrated scheduling and system control). Local governments introduce dynamic road user and parking pricing using smart sensors.

Existing public transport and new mobility services focusing on individual needs (personal rapid transit, personalised transit to airports, ride-sharing, parking-sharing etc.) are strictly regulated and they are required to be integrated in mobility as a service systems with services that are accessible to the disabled and older people. These systems mainly promote motorized modes (road and rail rather than cycling and walking) to cater for the increasing travel demand and travel distances. Intermodal mega-hubs are built in public-private partnership to connect transport modes and host commercial activities.

Long distance travel is supported by faster and more energy efficient high-speed trains with inductive charging and a seamless integration of other modes with air transport to reduce the maximum travel time between any two points in Europe to 4 h. Flight cabins provide internet connection.

Vehicles will be produced mainly from advanced lightweight materials to increase fuel efficiency and emissions. There is a high degree of standardisation of charging, connectivity and safety systems for cars and other motorised vehicles.

There is high demand in urban areas for battery-operated personal mobility devices (e.g. Segway), local authorities adapt the walking and cycling infrastructure to accommodate these devices. The purchase of smart electric bicycles is subsidised by the government to enable longer trips even on hilly terrain.

The older population embraces digital communication technologies and benefits from easier and more accessible local and long-distance travel. Autonomous vehicles provide new opportunities for door-to-door transport for older people. Special financial aid is provided to them and the disabled who would otherwise not be able to afford such vehicles or services.

3.3 Scenario 3 Slow Is Beautiful

Governments turn inwards to guarantee national security and supply of resources to their citizens. 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. Citizens aim to produce what they consume within their neighbourhood. Bottom-up initiatives of local communities thrive with few legal limitations on local sharing and production initiatives. Willingness to pay for eco-friendly solutions increases.

To support self-sustaining urban communities, there is a growing market for electric cargo-bikes that are used to distribute goods within the local communities where no motorised vehicles are allowed. Logistics companies set up urban freight consolidation hubs from where goods are distributed by e-bikes and minivans. Goods deliveries also increasingly rely on sharing courier platforms connecting people who need items that are delivered with drivers and couriers 'going there anyway'. Public transport services (rail, trams, inland waterways and underground) are also used for deliveries and collection of waste.

Also, supply chain de-stressing gains momentum through different practices (i.e. synchromodality, slow steaming etc.), to reduce supply chain complexity by using the right mix of transportation modes to operate sustainably at lower cost with higher quality.

A service sector based on sharing resources such as time, space and vehicles emerges supported by local social networks. "Slow, healthy and sustainable" are the new buzzwords. People appreciate spending more time with their friends and family within their neighbourhood and rediscover their local environment. Mixed-use developments aim to decrease the distance between residential areas, jobs, education and services.

Local neighbourhood planning is initiated more and more by local citizens using social media and online co-creation platforms. More and more cities introduce car-free city neighbourhoods and various other restrictions on road traffic (e.g. limited parking). Road user charging is initiated in some urban centres using 'low-tech' solutions such as relatively low flat rates, number plate recognition or vignettes. There is, however, no EU-wide coordination of road charging schemes, payment systems and signage of restrictions. Peer-to-peer applications and online services developed by small local start-ups have replaced many of the car-sharing and ridesharing services of big corporations. Mobility applications and sharing initiatives can easily be launched with lax legal and government control concerning user rights and privacy. The popularity of cycling and other electric two-wheelers is on the rise. Cyclists are encouraged to use existing roads as shared spaces.

There is a cautious approach to the introduction of autonomous vehicles especially in urban areas. Due to societal resistance (safety concerns, lack of trust in technology, concerns over jobs in the transport sector), autonomous private vehicles are only allowed on designated motorways.

Transport providers remain primarily national and local with little cross-border activities. Financial resources to build new transport infrastructure and maintain the existing ones are scarce. Therefore, there is more focus on the optimal use of existing roads and railways by retrofitting them.

In cities, bus rapid transit corridors are built by private investors using existing road infrastructure instead of new rail or tram systems due to the lower cost.

3.4 Scenario 4 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.

Companies are required by government regulations to significantly reduce their environmental footprint therefore sustainable and bio-production are supported. Large international manufacturing and retail corporations adapt to the new requirements and regionalise their production. 3D printing becomes widespread boosting customised local production. Customers prefer to buy products with the smallest carbon impact. Local programmes are launched by the government to recirculate materials inside the neighbourhood and the city to reduce waste and carbon emissions associated with mass production and long-distance distribution chains.

Logistics companies are required by law to measure and report their carbon footprint through smart sensors in vehicles and infrastructure. Products transported and logistics services receive Eco-labels based on this calculation therefore logistics companies are incentivised to improve their load factors and the environmental performance of their vehicle stock. Carbon taxation is widely introduced to reflect the amount of CO_2 generated by transport activities. National and local road charging schemes are also widely introduced with electronic tolling and variable rates based on demand to reflect external costs (especially noise, air pollution, congestion). Deliveries in or to city centres are restricted to small electric vehicles and electric bicycles. Urban cross-modal logistics uses all available modes of transport to provide the lowest possible carbon footprint. Urban goods distribution regulations are harmonised in municipalities.

Strict European regulation demand good energy efficiency of freight vehicles and the use of renewable fuels, in all modes (ships, aviation, road, rail). The electrification of waterborne transport by electrifying ferries and vessels is forced by international agreements.

Burn-out from fast-paced work have turned people towards healthier and active life. Work is arranged to require less travel, in neighbourhood flexi-offices, by supporting work from home and by distributing smaller offices in city districts. Long-distance travel is expensive due to the carbon taxation introduced across Europe. People prefer to spend their free time and holidays in the proximity to their homes.

Cities embrace car-free neighbourhoods to improve liveability. Tax-incentives discourage private car ownership and support car- and ride-sharing instead. National and local road charging schemes are widely introduced with electronic tolling and variable rates with a standardised Pan-European payment and monitoring system. Use of fossil fuels is prohibited in most urban areas and heavily taxed elsewhere. The environmental footprint of aviation is strictly monitored and a carbon tax is built into ticket prices across Europe.

Smartphone or wearables apps encourage users to travel in a sustainable way and oblige them to respect the personal 'carbon budget' (the maximum amount of CO_2 they can generate per month), which is assigned to everyone by the government.

Smartphones, smart sensors and intelligent CCTV recognition technology enable the monitoring of the carbon budget for everyone.

Smart online apps empower citizens through digital technologies to participate in planning and impact monitoring for urban mobility. There is a high level of integration of mobility services steered by publicly managed transport partnerships (regional associations integrating all shared and public transport services, travel information and payments). There is a significant increase in demand for public transport due to the introduction of the personal carbon budget, the extension of capacity, however, does not keep pace with demand due to the limited availability of space and the potential negative impact of infrastructure investments. Ridesourcing and ridesharing are fully integrated with public transport to provide seamless first- and last-mile solutions.

The introduction of autonomous vehicles is limited to long distance travel. C-ITS systems are fully deployed only on motorways. Cities focus more on improving walking, cycling and public transport. Cycling is fostered by building interconnected cycle highways with added services (repairs, charging) and large capacity bicycle parking is built by local governments at public transport stations.

Travel demand is reduced through supporting densification i.e. living in densely built urban areas. Superblocks restrict road traffic to major roads around residential blocks where only local traffic is allowed with restricted speed (10 km/h). Everyone has the right to access to basic services guaranteed by the government. The walking and cycling environment is adapted to the needs of the older population, children and the disabled. Intelligent pedestrian crossings adapt to pedestrian demand. Internet of Things devices are used to enhance safety and security of pedestrians and cyclists integrated into everyday items such as wearable reflectors for children and smart monitors for older people to monitor their well-being and location. On the other hand, carbon rationing takes the activity level of citizens into account and allocates more opportunities for public transport capacity to the active population (e.g. commuters), also limiting the time periods when the non-active population can use such services (e.g. only outside peak hours).

4 Further Steps

Scenario building outlined above is the first step of the participatory evaluation of future scenarios for mobility and transport in 2030. The four scenarios then undergo a stepwise participatory evaluation. First the relevant stakeholders are identified, then their objectives and criteria. Then, each stakeholder group weights its own criteria to express their relative importance. After that, indicators and measurement methods for each criterion are identified with international experts. 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. In the next step, the impact of the scenarios on the stakeholders' criteria is determined by an international expert panel. After that, based on the stakeholders' weights and the

experts' evaluation, the ranking of scenarios is calculated for each stakeholder. This shows the synergies and conflicts across the stakeholder groups. Finally, stakeholders come to a consensus on the best scenario at a consensus making workshop. The consensus scenario is then used to create a vision for mobility and transport in 2030 and the action plan to fulfil that vision (Macharis et al. 2009; Keseru et al. 2018).

5 Conclusions

The scenario building and evaluation approach applied in the Mobility4EU project to develop a vision and an action plan for mobility and transport in Europe in 2030, provides a participative approach to building visions and strategic plans for the future. While it builds upon the knowledge of experts, it also opens up the scenario construction to stakeholders by linking the intuitive logic scenario technique with participatory workshops as it was demonstrated in this paper.

The scenarios described above address all transport modes for both freight and passenger transport. At the same time, scenario descriptions are meant to be short, easily comprehensible texts. Therefore, it is unavoidable that some trends or solutions that some experts or stakeholders would find important are not included. Also, the feasibility of implementing the solutions proposed for each scenario by 2030 has not been investigated in detail. In the next steps, a thorough multi-stakeholder evaluation was carried out to select the most promising scenarios which can act as visions to work towards.

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