Future Scenarios for Mobility Innovations and Their Impacts in Cities and Transport Models

Javier Burrieza Galán[1], Rita Rodríguez Vázquez[1], Oliva G. Cantú Ros[1], Georgia Ayfantopoulou[2], Josep Maria Salanova Grau[2], Maria Konstantinidou[2](✉), Rodric Frederix[3], and Péter Pápics[3]

[1] Nommon Solutions and Technologies, Madrid, Spain
{javier.burrieza, rita.rodriguez, oliva.garcia-cantu}@nommon.es
[2] Hellenic Institute of Transport- Centre for Research and Technology Hellas, Thessaloniki, Greece
{gea, jose, mariakon}@certh.gr
[3] Transport and Mobility Leuven, Leuven, Belgium
{rodric.frederix, peter.papics}@tmleuven.be

Abstract. Cities should try to combine the various conflicting interests in the field of urban mobility aiming to extract the maximum benefits of the different mobility options. Although this task concerns mainly the current situation, cities should also prioritize future mobility measures. The purpose of this paper is to explore how emerging mobility concepts would evolve under future mobility scenarios related to carsharing services, micromobility services, Demand Responsive Transport (DRT) services, Connected Autonomous Vehicles (CAVs), Urban Air Mobility and Mobility-as-a-Service. Two diverging or complementary scenarios have been associated to each concept expected to transform future urban mobility. A Delphi poll has identified the future scenarios related to data sources and transport modelling and assessed the effects that each mobility innovation may have on urban transportation. The impacts of these emerging mobility solutions on transport planning tools and techniques are also investigated and prioritized. Finally, data sharing between operators and policy-makers and the lack of skills among transport planners are rated by the Delphi poll as the most important gaps in terms of transport data sources and barriers that hinder the modelling of the new urban mobility options respectively.

Keywords: Urban mobility · Alternative futures · Impacts · Transport planning tools

1 Introduction

The disruptive technological developments and the societal changes operate as accelerators for the urban mobility transformation changes. The rapid development of ICTs is facilitating the operation of a wide range of new mobility alternatives grouped under the concept of smart mobility with uncertain impacts for the future of sustainable

The original version of this chapter was revised: The author name has been amended. The correction to this chapter is available at https://doi.org/10.1007/978-3-030-61075-3_111

E. G. Nathanail et al. (Eds.): CSUM2020, AISC 1278, pp. 1129–1138, 2021.
https://doi.org/10.1007/978-3-030-61075-3_108

mobility. The combination of emerging mobility services will boost multimodality, contributing to the promotion of the public transport. A cleaner, cheaper, safer and more efficient transport system with improved accessibility in low demand areas will be the first step towards the reduction of car ownership and road fatalities.

Regarding the success of carsharing systems, the population density and the collaboration between private and public stakeholders have been identified as critical factors [1–3]. The urban areas ensure high demand for operators and targeting to both public and private interests is positively evaluated [3]. In addition, a city with infrastructure for electric vehicle is more likely to provide a successful electric vehicle based carsharing system [2].

Similarly to all privately-led shared mobility services, it is not yet clear if micromobility companies will be profitable in the future, since they are based on their competence to raise funds [4, 5]. Although there are still gaps in the regulatory framework some cities are taking a leading role collaborating with the operators [6]. Beside the stakeholders' cooperation, agreements on data sharing [6–8] and regulations on the public space management [5–7] seem to affect the success of these systems.

In general, DRT are highly subsidized by authorities since they are low profit services [9, 10]. However, there are some Public Transport Authorities that evaluate that the DRT systems contribute positively to their supply networks. Among the success factors are the coordination between the itineraries of the DRT and the scheduled public transport [9, 11], the minimisation of costs and empty trips [11]. Moreover, the strong stakeholders' engagement in providing a sufficient fleet [11] and the customised communication strategies are crucial to the increased attractiveness of the service.

In CAVs field there are already vehicles that have incorporate some automate functionalities but the achievement of higher-level production depends not only on vehicle technical advancements but also on cooperative ITS infrastructure. Although there are some programmes for supporting testing and implementation of CAV technologies in many European countries, the EU is aiming to launch large scale pilots in order to assess the maturity of these technologies [12]. The prerequisites for the successful implementation of CAV can be clustered in two groups: user acceptance and management. It is not yet clear how the users will be convinced to trust a totally automated vehicle [13] while in terms of management, the public-private partnership seems to be a necessary condition [14].

Regarding the UAM there aren't currently commercial services fully responding to the basic operational requirements of these services, but there are some precursors across the world such as Voom services in São Paulo and Mexico City [15] and Uber helicopter services in New York [16]. There are also some relevant initiatives regarding UAM to be launched in the following years such as the case of Paris where a service between Charles de Gaulle airport and the city centre will be provided by Airbus and RATP for 2024 Olympic Games [17]. Furthermore, an initiative related to UAM has been launched by the European Innovation Partnership on Smart Cities and Communities (EIP-SCC). The initiative is supported by 43 members and includes a manifesto aiming to foster UAM demonstration projects.

Finally, regarding MaaS there are two main conditions for their successful implementation based on the experiences and the related literature [18, 19]: (i) the ability of a MaaS operator to deploy its services in a city or region; (ii) users' willingness to change their mobility behavior. MaaS schemes require not only the availability of a wide range of transport modes but also the willingness of operators to share their real-time data with third parties and to sell their services via e-ticketing [20]. Cost savings, user friendly applications, freedom of modal choice and vehicle and high customization levels are reported as fields of MaaS added value [21].

The present paper aims at the identification of the future scenarios for mobility innovations and their impacts in cities and transport models. After the review of the basic concepts behind each of the mobility innovation trends and the detection of the key factors or the obstacles for their successful integration in sustainable mobility, the future scenarios are described in Sect. 2. The results of the assessment of their impacts on the urban mobility resulted from the Delphi poll are outlined in Sect. 3. Finally, a summary of the main concluding remarks is provided in Sect. 4.

2 Future Mobility Scenarios

Two diverging or complementary scenarios for each of the emerging mobility concepts were developed as they are described below. The generation of the future scenarios was based on the literature review of roadmaps, white papers, vision papers and policy documents related to mobility. Moreover, the identification of the success factors and the gaps described in Sect. 1 contributed to the final formulation of the scenarios.

2.1 Alternative Futures for Carsharing Services

In the first medium term horizon scenario the electric carsharing operates as an additional transport mode in the cities. The implementation of stricter urban vehicle access regulations and parking management policies in the metropolitan areas imposes limitations in the use of the private cars. The transport sector is characterized by multimodality, combining mass and individual transport. This situation combined with the high acquisition cost of the electric cars benefits the integration of sharing schemes in the transport sector increasing its modal share up to 20–25%. Electric vehicle infrastructure exists in certain urban areas in order to serves the increasing use of electric vehicles sharing schemes. Electric carsharing is combined with public transport and the new mobility services offer more flexibility and better quality of combined transport options.

The second, long-term time horizon scenario, proposes a holistic housing solution which integrates aspects such as mobility, housing, energy distribution and ICT networks. In this scenario the electric sharing vehicle schemes are included in the modern collective housing policies. The different urban electricity needs throughout the day are balanced through smart energy grids. Thus, the holistic housing-mobility approach leads to an easily accessible community-based electric vehicle scheme with low parking requirements. The large-scale implementation of this approach contributes to the homogeneous modal share of electric vehicle solutions.

2.2 Alternative Futures for Micromobility Services

Micromobility is one of the most recent trends among shared mobility services. The first scenario describes a transport landscape where other transport modes are substituted by micromobility in short distance trips. The regulatory framework for micromobility has been defined in most cities and dedicated lanes for e-scooters and similar vehicles are provided to road users. Thus, they are used for daily short distance trips instead of car and taxi rides since car ownership appears a decline especially in young people who prefer new transport modes based on pay-per-use rather than a car purchase. In addition, since all of the competitors in the field are subjected to the same regulation, new business schemes will emerge based on the results of the pilot projects and the market's needs,

In the long-term scenario, micromobility is a part of a longer combined trip providing most flexible, efficient, and sustainable transport options. It is combined with public mass transport and following a strict regulatory framework it is completely integrated in the transport system. The mobility packages provided to travelers through MaaS platforms include the micromobility option mainly as a mode to reach or leave the transition stations or combined with the private car in Park&Ride solutions. The design is more user friendly for vulnerable users such as disabled or aged people.

2.3 Alternative Futures for Demand Responsive Transport Services

The new intelligent applications facilitated the diffusion of digital content among the travelers and allow the operators to improve the quality of the services (i.e. less waiting time, more accessibility) reducing the operational costs by 2030. On-demand transportation emerges as a supplementary alternative to traditional public transport services combined with the backbone public transport network in first/last mile. Citizens of remote areas and users of special categories such as ageing population or vulnerable users, being dissatisfied of the quality of the traditional bus and railway services, are attracted by the on-demand public services. User visibility allows the efficient demand management providing to travelers a variety of alternatives options of different prices and connectivity to other transport modes.

The on-demand transport system of the first scenario expands to freight and goods delivery by 2050. Both passengers and cargo are transported by the same vehicle in an efficient and safe way. More than one passenger and parcel are allowed in the same vehicle and thus the capacity of the vehicles is completely exploited. The consolidation of the goods flows increases the efficiency of the last mile deliveries since the unnecessary/empty vehicle movements in urban areas are avoided. Innovative logistics business models which integrate the use of public transport infrastructure for both passenger and goods delivery are developed thanks to shared data.

2.4 Alternative Futures for Connected Autonomous Vehicles

The use of Connected Autonomous Vehicles for passenger delivery will bring disruptive changes in the current transport system. In the short-term scenario, privately owned CAVs Level 4 have been already introduced into the car fleet by 2030.

Conventional vehicles are limited to highways and motorways. This means that the car-share fleets are used mainly for short-distance trips within cities. Due to high cost of the purchase and the maintenance, the CAVs' ownership is limited to the wealthier part of society. The intercity CAV traffic is prohibited in the inner cities, due to the lack of parking spaces and therefore, the creation of P+R parkings and the connection with the public transport is required. Since the majority of CAVs are electric, the level of the total emissions from cars will be reduced.

After the availability of Level 4 CAVs, Level 5 vehicles will also enter the market by 2050. Completely autonomous vehicles without human interaction over any kind of traffic situation will be available. All transport modes are connected thanks to the advanced information sharing systems and multimodal trips provided through MaaS platforms are promoted. As a result, private car use is decreased and a boost in the public transport use is observed. Fewer parking spaces are required and the majority of them are converted to hubs for mobility services. C-ITS equipment has been installed over various kinds of traffic infrastructure, when not only V2V but V2I connectivity is considered. Full automation provides more safety and convenience compared to the current fixed public transport lines.

2.5 Alternative Futures for Urban Air Mobility

Urban Air Mobility (UAM) is based on highly automated and efficient air vehicles for the transportation of passenger and cargo within metropolitan areas. In the short-term scenario, the willingness of manufacturers and other stakeholders to operate UAM services contributes to the advancement of regulatory framework for this mode but the high requirements of coordination among stakeholders hinders the progress in this field. Sustainable production levels have been achieved by the manufacturers but car production schemes are still at an early stage. Although European aviation authorities have leaded some demonstration projects in certain metropolitan areas, there are still issues that have not been solved. Thus, the adoption of a holistic standard system across Europe is not yet the case. Except of some large cities that have planned to use heliports and create some additional vertiports in suburban areas, the majority of the cities have a lack of related infrastructure. UAM is still an exclusive mode and it is not included in the public transportation system of the city.

In the long-term scenario, profitable business models for UAM are developed. Cooperation among different public and private stakeholders is achieved and the technological advances contribute to high production volumes. Standards for urban air traffic management have been set by the EU aviation authorities after intensive funding of research activities and demonstration projects. Large cities are funded for the deployment of UAM infrastructure. Vertiport network that covers airports, transport hubs and important nodes in suburban areas have been developed and UAM services have been incorporated in the mobility packages of MaaS aggregators. Thus, UAM is gradually become part of the cities' transport system.

2.6 Alternative Futures for Mobility-as-a-Service

The introduction of MaaS in the transport system is expected to result in a shift from private towards multimodal and sustainable modes. In the first scenario MaaS are limited in large cities at a local level offering to citizens an alternative for their daily trips instead of private car use. Individual providers are responsible for the organisation and pricing of the traffic services. The MaaS provider just plan trips and provide a limited number of fixed package purchasing simply bundled individual tickets of the specific transport providers. There is no flexibility in the pricing and route options and the same options are addressed to everyone.

In the second scenario, an EU-level network of MaaS services is created beyond city boundaries reaching areas that would be impossible to be served with traditional public transport modes. MaaS stakeholder group comprises of cooperating stakeholders from mobility providers to local and regional governments, who are all strongly engaged in the planning, operation and maintenance of transport services. There are no more bundles of individual tickets but single mobility offers from point A to B irrespective of the modes used. Individual mobility patterns and attributes are considered in the offerings of a MaaS app to design a package and a price that fits a given person's needs. Public transport services are still the key element of MaaS services (trains, trams, and metro lines).

3 Impacts

A Delphi poll is conducted in MOMENTUM project, assessing the impacts of emerging mobility solutions in urban transportation and the planning techniques and tools.

3.1 Future Impacts in Cities

In the 1st Round, the factors and impacts of emerging mobility solutions for cities are identified by the participants of the Delphi poll through open-ended questions. The collected answers were prioritized in the 2nd Round. Among the current factors underlying the emergence of the mobility solutions, the collaboration between public and private stakeholders, the societal benefits as well as the improvement of mobility services' quality for the users are mentioned. In terms of current impacts in European cities, 25% of the panel answered that there are no current impacts but they were aware about potential future impacts such as modal shift from public transport services and car ownership decrease.

In addition, the participants share their opinions about the factors for the successful implementation of the presented mobility options. The deployment of Urban Vehicle Access Regulations (UVARs) as well as parking regulations were the most common answers followed by services reliability and affordability and the cooperation between operators and cities towards the deployment of the systems. Interestingly, the answers for the future impacts were by far more positive, with few exceptions. In the 2nd

Round, these impacts were grouped in terms of importance in an adverse and a positive group as it is shown in Fig. 1 and Fig. 2 respectively.

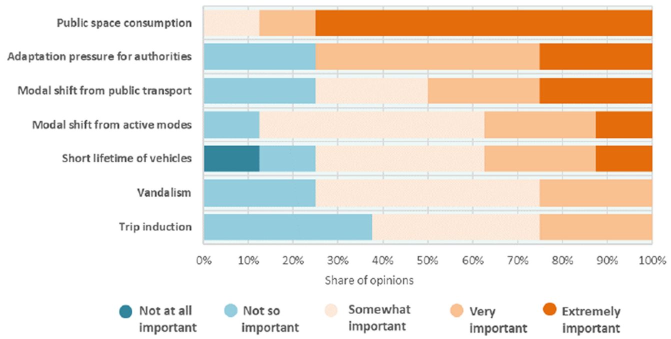

Fig. 1. Importance of new mobility options' adverse impacts

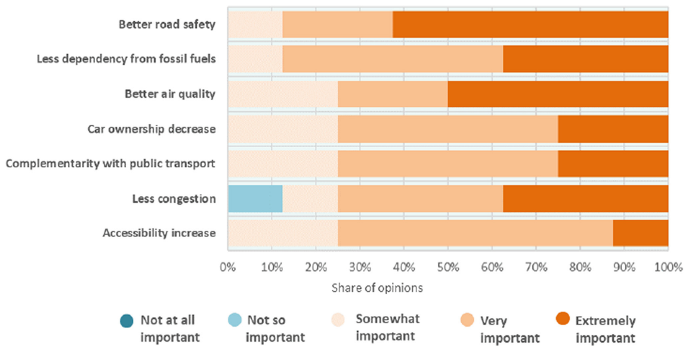

Fig. 2. Importance of new mobility options' benefits

3.2 Future Impacts in Transport Models

The Delphi poll also discussed about the effects of the emerging mobility solutions in transport planning tools and techniques. Participants believe that the shared mobility, micromobility and MaaS already represent a challenge for these techniques. The DRT, shared mobility systems and micromobility are expected to be included in transport planning techniques between 2020 and 2030. On the contrary, the majority of the panel considers that the inclusion of CAV and UAM in the transport planning techniques will not happen before 2030 and a percentage of 10–20% considers that this will not happen. The research gaps and challenges among transport data sources and modelling tools identified by the Delphi poll are presented in Fig. 3 and Fig. 4.

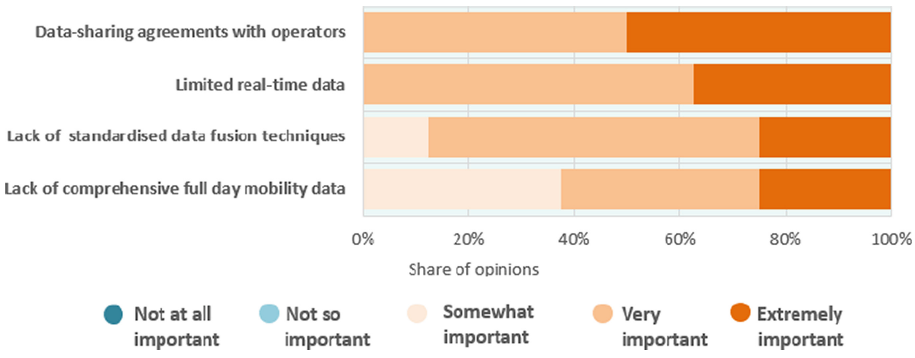

Fig. 3. Importance of gaps in transport data sources for new mobility options' modelling

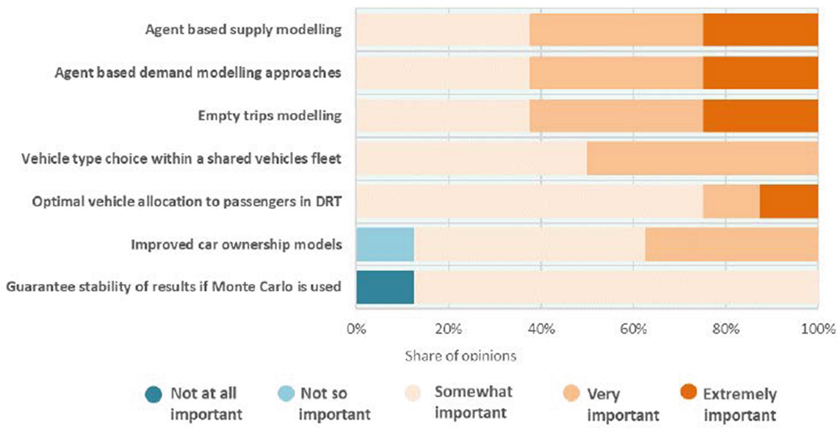

Fig. 4. Importance of transport modelling gaps for new mobility options' modelling

In terms of the barriers that appear in planning cycle during the modeling process of the new mobility options, the lack of skills among transport planners, the lack of resources among transportation departments and the limited cooperation between transport and urban planning are mentioned by the experts. Finally, the panel outlined that indicators related to emission levels, safety, accessibility, modal split, car ownership, public space consumption, energy consumption changes and general comprehensive indicators related to urban life quality will have crucial role in the future transport planning.

4 Conclusions

The present paper captures the future mobility scenarios of the emerging mobility concepts related to carsharing services, micromobility services, Demand Responsive Transport services, Connected Autonomous Vehicles, Urban Air Mobility and Mobility-as-a-Service. The identification through the Delphi poll of the more challenging factors for the successful implementation of these services and the effects that each mobility innovation may have on urban transportation and the transport models could be a valuable input for the stakeholders, from the planners to providers and local and regional governments, who are all participate in the planning, design and operation of transport services.

Acknowledgments. Research supported by the European project MOMENTUM-Modelling Emerging Transport Solutions for Urban Mobility funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815069.

References

1. Arndt, W.H., Drews, F., Hertel, M., Langer, V., Wiedenhöft, E.: Topic guide: integration of shared mobility approaches in sustainable urban mobility. Rupprecht Consult (2019)
2. Seign, R., Bogenberger, KP.: Rescriptions for the successful diffusion of carsharing with electric vehicles. In: Conference on Future Automotive Technology (2013)
3. Terrien, C., Maniak, R., Chen, B., Shaheen, S.: Good practices for advancing urban mobility innovation: a case study of one-way carsharing. Res. Transp. Bus. Manage. **20**, 20–32 (2016)
4. Eckhardt, G.M., Houston, M.B., Jiang, B., Lamberton, C., Rindfleisch, A., Zervas, G.: Marketing in the sharing economy. J. Mark. **83**(5), 5–27 (2019)
5. Crozet, Y., Santos, G., Coldefy, J.: Shared mobility and MaaS - The regulatory challenges of urban mobility. Centre on Regulation in Europe. https://www.cerre.eu/publications/shared-mobility-and-maas-regulatory-challenges-urban-mobility. Accessed 12 March 2020
6. Zarif, R., Pankratz, D.M., Kelman, B.: Small is beautiful: Making micromobility work for citizens, cities, and service providers. https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/micro-mobility-is-the-future-of-urban-transportation.html. Accessed 15 Febrauary 2020
7. Machado, P.: SUMP and Shared Mobility in Lisbon: Presented at the 6th European Conference on Sustainable Urban Mobility Plans, Gröningen, The Netherlands. https://www.eltis.org/sump. Accessed 18 Febrauary 2020
8. Clewlow, R.: The Micro-Mobility Revolution. Populus. https://medium.com/populus-ai/the-micro-mobility-revolution-95e396db3754. Accessed 25 March 2020
9. Mageean, J., Nelson, J.D.: The evaluation of demand responsive transport services in Europe. J. Transp. Geogr. **11**(4), 255–270 (2003)
10. Ryley, T.J., Stanley, P.A., Enoch, M.P., Zanni, A.M., Quddus, M.: Investigating the contribution of demand responsive transport to a sustainable local public transport system. Res. Transp. Econ. **48**, 364–372 (2014)
11. Enoch, M., Potter, S., Parkhurst, G., Smith, M.: Why do demand responsive transport systems fail. Presented at the Transportation Research Board 85th Annual Meeting, Washington DC, United States (2006)

12. European Commission: STRIA Roadmap on Connected and Automated Transport- Road Rail and Waterborne (2019)
13. Banerjee, S.S., Jha, S., Cyriac, J., Kalbarczyk, Z.T., Iyer, R.K.: Hands off the wheel in autonomous vehicles. A systems perspective on over a million miles of field data. In: 2018 48th Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), pp. 586–597. IEEE (2018)
14. National League of Cities: Autonomous Vehicle Pilots Across America (2018)
15. Lascara, B., Spencer, T., DeGarmo, M., Lacher, A., Maroney, D., Guterres, M.: Urban Air Mobility Landscape Report. MITRE (2018)
16. Porter, J.: The Uber for helicopters is now Uber. The Verge. https://www.theverge.com/2019/6/6/18655126/uber-copter-new-york-city-jfk-airport-elevate-helicopter-flying-taxi-price. Accessed 23 September 2019
17. UAS Vision: Airbus Studies Urban Air Mobility for 2024 Olympic Games in Paris. UAS Vision. https://www.uasvision.com/2019/06/24/airbus-studies-urban-air-mobility-for-2024-olympic-games-in-paris. Accessed 24 January 2020
18. Audouin, M.U.J.: Towards Mobility-as-a-Service: a cross-case analysis of public authorities' roles in the development of ICT-supported integrated mobility schemes. EPFL (2019)
19. Durand, A., Harms, L., Harms, L., Hoogendoorn-Lanser, S., Zijlstra, T.: Mobility-as-a-Service and Changes in Travel Preferences and Travel Behaviour: A Literature Review. KiM Netherlands Institute for Transport Policy Analysis, Netherlands (2018)
20. Li, Y., Voege, T.: Mobility as a service (MaaS): challenges of implementation and policy required. J. Transp. Technol. **7**(02), 95–106 (2017)
21. Harms, L., Durand, A., Hoogendoorn-Lanser, S., Zijlstra, T.: Exploring Mobility-as-a-Service: insights from literature and focus group meetings. Netherlands Institute for Transport Policy Analysis (KiM) (2018)