Chapter

Future Mobility Advances and Trends

Michela Longo, Wahiba Yaïci and Federica Foiadelli

Abstract

The trends of main interest on a global scale are those that can influence the development of humanity in the long term and are sometimes referred to as megatrends. The changes they bring with them can span several generations, profoundly changing society and, consequently, the competitive landscape of companies. The megatrends are numerous and each one involves the development of entire areas of activity. It is important to identify the megatrends of interest for strategic mobility planning and follow their developments, in order to consider them in the planning processes and correctly pilot investments. Megatrends are made possible and also influenced by the offer of new technologies, and lead to changes in cultural models. This chapter shows an era characterized by major technological innovations that are changing people's ways of thinking and acting, with the establishment of new mobility models in order to meet new emerging needs.

Keywords: transportation system, smart mobility, electric vehicle, mobility as a service (MaaS)

1. Introduction

The transport sector acquires a key role in promoting a correct balance between the different components of sustainable development. On the one hand, in fact, the mobility of people and goods and the conditions with which it is met (times, price, safety, reliability) decisively influence the present and future competitiveness of production and territorial systems, and, jointly, the accessibility to a series of basic functions within modern societies: work activities, educational services, social and health services, leisure and recreational activities, etc. [1, 2]. It therefore represents a fundamental component of the economic and social dimension of sustainable development [3, 4]. On the other hand, the quantitative evolution of demand volumes and the relative modal shares is at the basis of important critical issues from the point of view of eco-compatibility and security of supply, or two essential determinants of the concept of intergenerational equity that is at the basis of sustainable development [5, 6]. The inability to completely dissociate the demand for transport from the evolution of economic indicators and the almost absolute preponderance of fossil fuels in satisfying it have in fact led to a continuous increase in the contribution of transport to climate-altering gas emissions in recent decades and, at the same time, to increase the vulnerability of present consumption trends with respect to the exhaustion of non-renewable resources and dependence on foreign countries [7, 8]. In this scenario, transport policy becomes a decisive hub for achieving global environmental commitments, including those envisaged by the Kyoto Protocol and subsequent developments, as well as the objectives of the Community energy policy. The sectoral dynamics also determine effects characterized by a particular territorial connotation, which assumes specific importance at the level of urban areas, where a preponderant share of movements are carried out and where, consequently, a series of characterizing problems are concentrated: delays due to congestion, employment of soil and competition with other uses (homes, commercial activities, non-motorized vehicles, green spaces), local pollution emissions and greater exposure of targets (people and things), visual and landscape intrusion [9, 10]. The management of choices and the ability to change the trends experienced up to now become in this scenario one of the essential components of urban sustainability policies, decisively influencing the quality of life and the overall level of attractiveness of cities. The need to attribute a specific value to transport, both in Ref. to global issues (climate change, energy dependence) and to those related to the local dimension (congestion, atmospheric pollution, noise, etc.), finds recognition in the European Development Strategy Sustainable [11, 12], which identifies the ability to promote a model of "sustainable transport" as one of the seven key challenges that the European system must face in the future.

A challenge based as for the other economic and social sectors, on the affirmation and diffusion of new technological solutions in the production/consumption patterns, but also, if not above all, on the recognition of the need to assign a transversal value to the mobility issue and related choices of satisfaction within the various sectoral policies (trade, industrial logistics, tourism, planning and management of the territory, etc.) in order to pursue the first (and functional to all the others) operational objective, or the dissociation of volumes of demand from economic growth.

2. New paradigms of society

In a constantly changing society there are three fundamental aspects that need to be considered:

- Sharing (sharing economy): resources, especially if in excess, will be shared with others ("prosumer", from consumer to producer of services). The demand will increasingly be oriented towards the use of shared services (in the United States car owners have drastically decreased: from 74% of Generation X, born between 1960 and 1975, it has gone to 48% of Millennials).

- Information (big data and data analytics): there will be large amounts of data available from which to extract information, also to offer new services. Those who can use the data will enjoy enormous competitive advantages.

- Supply of customizable and integrated services: the services will be customizable on the basis of demand, integrating those also provided by different subjects (providers). These trends will change the characteristics of the demand and supply of services also in the field of mobility.

According to [13, 14] it emerged that in 2050 two thirds of the world population will live in urban areas (over six billion people); the total amount of urban kilometers traveled will triple compared to the current situation; the costs for urban mobility will amount to over 800 billion per year; over 17% of the planet's biocapacity will be used for urban mobility. In addition, regarding the urban distribution of goods [15, 16] between 2006 and 2014 the number of commercial vehicles in the world went from

250 to 330 million, mainly due to e-commerce; e-commerce turnover volumes are estimated to increase by 85% between 2015 and 2020 [17]. The demand for mobility of people and goods in urban areas has grown and is destined to increase further and it will not be possible to satisfy it by increasing the infrastructure. It will be necessary to switch to a disruptive technology that is the type of innovation that is considered when it quickly and radically changes a market or the ways in which to operate in it.

Some of interest for mobility may be:

- Artificial intelligence;
- Autonomous vehicles;
- Electric mobility;
- Big data and data analytics;
- Internet of Things (IoT) and Internet of Everything (IoE);
- 5G, connected vehicles (V2X);
- Technologies for Blockchain transactions.

Widely available over the next decade, these technologies will have a profound impact on mobility services.

3. E-mobility

The transport sector, with particular reference to the passenger car segment, being one of the main contributors to CO_2 emissions, must undergo substantial improvements in environmental efficiency. Vehicle electrification is often seen as the primary option to help achieve this goal. Although electrification is a recurring theme in the history of the automotive industry, in recent years some changes in the reference context have opened up new development opportunities for electric vehicles: the phenomenon of climate change, the increase in oil prices and the long-term oil shortages, major technological innovations in sectors relevant to the automotive industry (e.g. in the battery industry), pressures to introduce innovations in the automotive sector and the response of manufacturers to the requirements contained in European legislation for reduction of carbon emissions [18, 19].

E-Mobility has become a keyword. Refers to vehicles that use electricity as their main source of energy, with the possibility of recharging the battery by connecting with an outlet to the electrical network, regardless of whether the vehicles are equipped with an auxiliary internal combustion engine to be used in long journeys distances or to keep the battery charged (battery electric vehicles, plug-in hybrid electric vehicles and extended range electric vehicles). This system is not limited only to passenger cars, but also covers motorized two-wheeled vehicles, quadricycles, vans, etc. E-Mobility currently dominates the debate on the future of transport and is becoming popular with policy makers, research institutes and industry. National and local authorities are already providing support for the introduction of these low-carbon vehicles, granting them special tax treatments or favoring their use, compared to conventional cars, with other measures (parking facilities, access to traffic areas limited use of preferential lanes, etc.). **Figure 1** illustrates the concept of E-mobility.

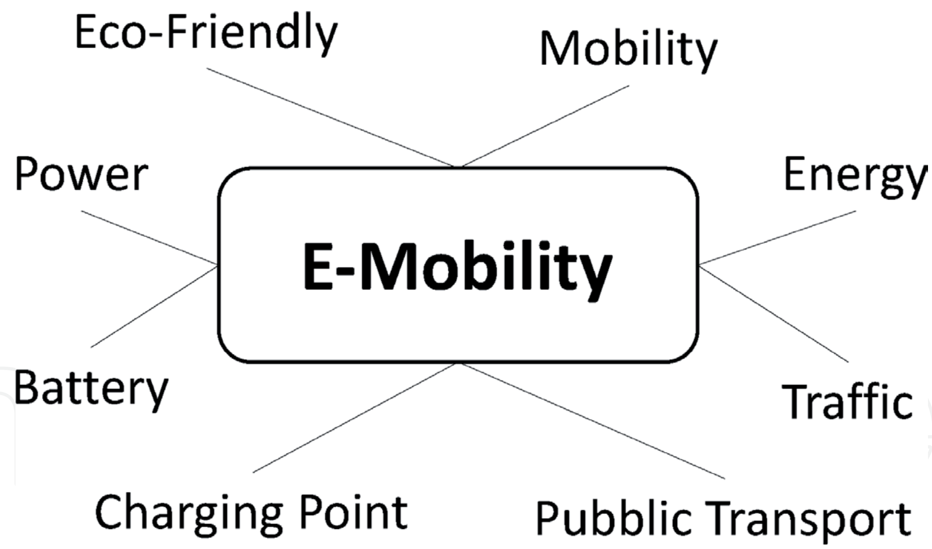

Figure 1.
Concept of E-mobility.

The transition from a conventional to an electric car is not automatic, especially if users are not actively involved in the process and if they are not assisted in understanding the meaning and advantages of these new technologies [20, 21]. It is still necessary to overcome not only some major uncertainties in the market, which affect the propensity to buy and consumer behavior (regarding costs, autonomy and viability of electric mobility), but also delicate political issues. The Authorities should favor the development of e-Mobility without creating market distortions, adopting a principle of technological neutrality: the incentives should be linked to performance in carbon emissions ("from well-to-wheels") and not to a specific technology. Furthermore, the incentives should not further aggravate overall energy taxation; the spread of electric vehicles should be linked to the use of renewable energy (with a positive environmental impact "from the well to the wheels"); Standardization Bodies and the industrial sector should agree, adopting common standards and protocols regarding the systems and devices for recharging batteries and the communication and information systems associated with them.

However, also with the aim of reducing CO_2 emissions by improving the efficiency of internal combustion engines (e.g. by reducing vehicle weight and engine power) and by increasing the use of alternative fuels (methane, biodiesel, etc.), electric vehicles could be an important way to improve individual mobility while minimizing emissions, representing a major challenge for European industries. The development of electric mobility, in fact, will depend not only on the adoption of specific technologies, but also on the ability to organize and manage the activities of different actors: automotive industry, battery manufacturers, mobility service providers, energy suppliers and distributors [22, 23].

It is important to understand the mobility needs and the types of demand that electric vehicles can meet and the performance they can offer to families compared to cars with internal combustion engines. Excluding future advances that may allow the capacity of electric vehicles to be increased, the latter currently offer a limited range compared to traditional cars, with the possibility of quick recharging only by replacing the battery. Therefore, electric vehicles are better suited for travel in urban areas and over short distances. This need not necessarily be a handicap once consumers understand the difference between battery electric vehicles and conventional vehicles, and the benefits the former can offer: zero emissions "from tank to wheels", affordable charging costs, flexibility in urban areas, etc. Electric vehicles offer consumers a wider choice to meet their mobility needs.

The important challenge is to be able to meet the different demand needs even if using different technologies. Therefore, the policies should guarantee the presence on the market of a differentiated mix of technologies. Meanwhile, hybrid vehicles currently on the market - including plug-in hybrids - offer a range comparable to vehicles with traditional engines. Alongside a diversification of the demand for mobility, there are also some changes in the use of the car. The high costs of batteries, current and predictable, associated with a limited range will continue to represent barriers to the purchase of electric vehicles. These difficulties could be mitigated through different mechanisms, such as car-sharing systems, corporate fleets and leasing. A conceptual change in the use of cars is observed, especially among young people: from an owned asset to an asset that can be rented only when necessary, such as is happening with bike-sharing services. Electric cars, such as electric motorcycles and bicycles, could reinforce this new relationship between citizens and mobility.

As a guideline, between 2025 and 2030 we could reach the breakeven point between the prices of electric cars (BEVs) and those with internal combustion power trains. All these will depend on the technological evolution of the accumulators; the growth in demand for batteries; the methods of their reuse and/or disposal; from access to raw materials to make them. As experiences in other countries (Denmark, Norway) show, the spread of electric-only vehicles is strongly linked to the availability of economic incentives. A widespread diffusion of the recharging network (columns) is fundamental. Dynamic inductive charging is being tested and it is not currently possible to understand if and when it will contribute to the spread of BEV power trains. The tendency to promote electric mobility in urban areas is shared by regulators. Technology providers are gearing up to answer this question.

4. Connected and cooperative vehicles

The technology for the highest levels of automation is already available, but it is nevertheless necessary to gradually prepare for the impact that the phenomenon will have on the way of using vehicles. Mobility understood as the ability of people to move, in the shortest possible time, with the least use of resources and at the same time reducing the environmental impact should be a strategic objective for the institutions, with a view to integrating public mobility systems and collective with those of private and individual mobility [24, 25]. Obviously, this integration is also related to the complex issue of traffic management, especially urban traffic and in this sense computer networks will tend to take on ever greater importance due

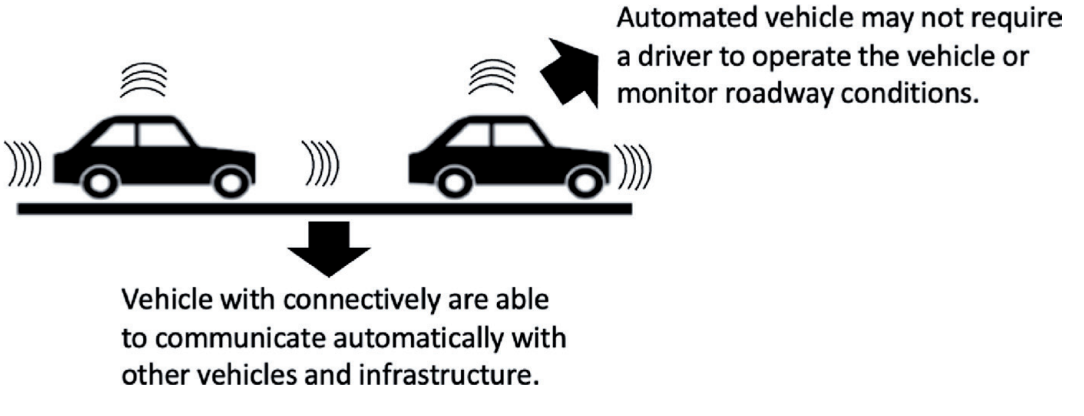

Figure 2.
Example of connected vehicles.

to the amount of useful information that can be exchanged and the possibility of crossing millions of data also in a predictive function. **Figure 2** shows an example of connected vehicles.

Expressions such as smart mobility and smart city are used to indicate intelligent infrastructural and mobility systems. With these terms we mean that set of logistics and transport systems that are supported and integrated by ICT. In particular, smart mobility refers to a new mobility model that uses new technologies for road safety and integrates information and innovations on board the vehicle to increase transport efficiency [26, 27].

Smart city does not mean, of course, digital city, even if in the past the tendency was to essentially make the two expressions coincide. The goal of the smart city is not digitization, which is instead an effective and flexible tool for improving many aspects of the quality of life of citizens and promoting the country's economic growth. The approach to the issue of smart cities brings with its undoubted elements of difficulty, just think of identifying the interventions to be carried out, their alignment with the economic and social context of the city and the assessment of the impact on the community, without considering that the various projects, once conceived, must be able to be effectively carried out in that specific urban and social context. It is possible to argue that a city can be defined as "smart" that is to say "intelligent" when, according to a strategic, integrated and organic vision, using ICT tools to improve the lives of its citizens, it uses real-time information from various areas and exploits both tangible (e.g. infrastructure, energy and natural resources) and intangible (e.g. human capital, knowledge) resources, adapting from time to time to the needs of users with a view to sustainable development [28, 29].

It was estimated that in 2020 approximately 75% of new vehicles were able to connect to the internet, thus accessing different services and potentially allowing the exchange of information with the infrastructure (V2I), with other vehicles (V2V) and, generalizing, with anyone (V2X) (for example for updates of on-board software (SW) or the acquisition of travel information by various service providers). **Figure 3** presents the different types of connections.

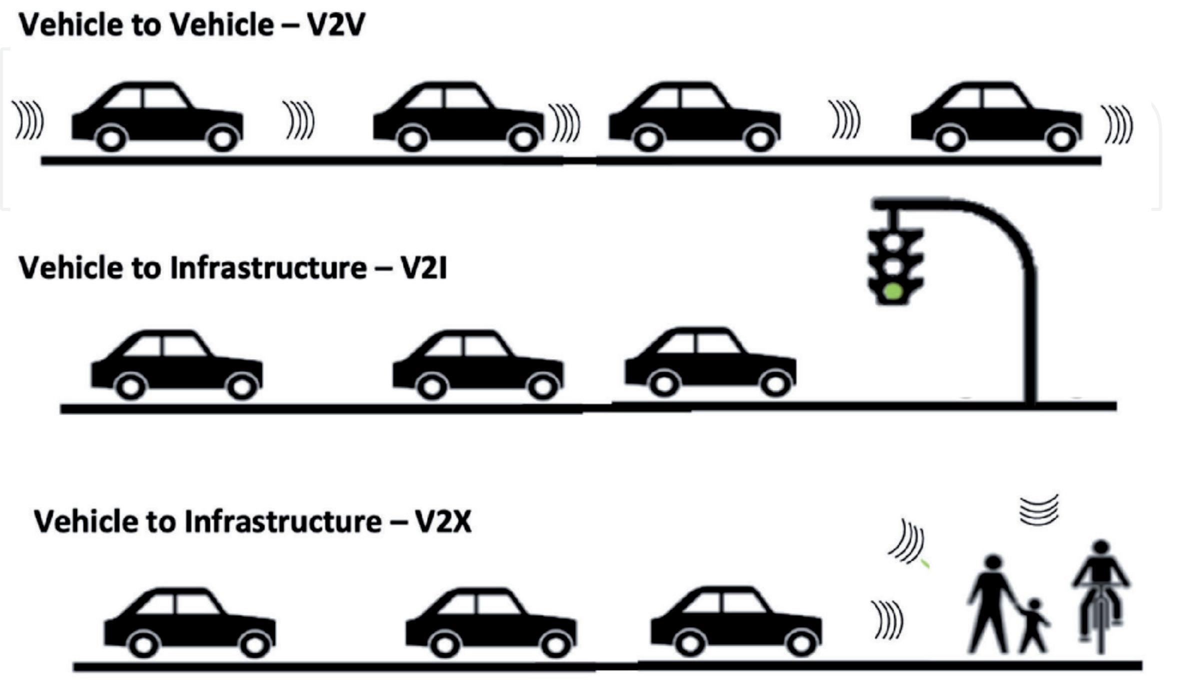

Figure 3.
Different types of connections.

The spread of connected vehicles supports the adoption of increasingly high levels of automation (autonomous driving) and access to articulated mobility services offered by different subjects. Connected travelers and vehicles will become Internet of Things (IoT) or Internet of Everything (IoE) nodes. The demand for mobility will therefore be satisfied through a multimodal, on-demand, and shared offer. The consumer will have multiple offers, more choice between different service levels. Public and private operators will coexist. Vehicles and travelers, as nodes in the network, will generate data that will allow, if shared, an optimization of the offer and resources. The trend to take advantage of shared services and integration into the web through the IoT will push to meet the needs of mobility by accessing a different mobility service according to needs, rather than buying vehicles or making medium-long term choices.

5. Autonomous vehicles

The term autonomous refers to the ability and faculty to govern or stand alone. According to the NHTSA (National Highway Traffic Safety Administration), or the US government agency for road safety, it defines an autonomous car "*a vehicle whose operation takes place without direct intervention by the driver to control steering, acceleration and braking and which is designed in such a way that do not expect to constantly check the road, when the automatic mode is running*" [30, 31].

In order to achieve a certain level of autonomy, the car exploits the ability to detect the surrounding environment through techniques such as radar, LIDAR, GPS and sensors. Therefore, the interaction between these components and the advanced control systems on board the car allows the latter to make decisions about the paths to follow and any obstacles and signals to monitor. To verify the degree of autonomy of the car, there are different classifications and standards coexisting with each other. The most adopted and followed by the scientific literature are the standard published by the NHTSA and the standard published by the SAE (a standardization body in the field of the automotive industry). In 2016, the NHTSA adopted the SAE J3016 standard, which therefore is configured as the reference standard. The latter has established six levels of autonomous driving that are based on the greater or lesser degree of automation of the vehicle, with the relative level of human participation in driving the car [32–34]:

- *Level 0*: No autonomy. The car does not have a driver assistance function and the driver is in full control.

- *Level 1*: Driving assistance. This level of automation requires the driver to make decisions as to when to accelerate, decelerate or steer but is informationally supported by other systems that may indicate the presence of hazards or adverse conditions. The car simply analyzes and represents situations in the form of visual or acoustic alerts. The driver has full responsibility for the vehicle.

- *Level 2*: Partial automation. In this degree of automation, the car is able to manage acceleration and deceleration through different types of systems such as assisted braking and emergency anti-collision braking. The direction and traffic control remain under the control of the driver.

- *Level 3*: Conditional automation. In this level the car begins to automate. It is able to manage acceleration, deceleration and steering, while the driver intervenes in problematic situations such as driving on dirt roads or where autonomous driving is not allowed or is too dangerous, for example in case of bad weather. The driver can, therefore, momentarily divert attention, but must quickly acquire control of the car if necessary.

- *Level 4*: High automation. This level provides for autonomous management of acceleration, deceleration, steering, and traffic control. The car handles the typical situations caused by traffic or traveling on urban or suburban roads. In this situation the car is able to drive in complete autonomy, but it is possible for the driver to regain full control of the car, if he so requests.

- *Level 5*: Complete automation. In this level, no intervention is required from the driver. The car drives exclusively autonomously, completely managing all the typical aspects of driving and based on the required tasks, it autonomously identifies the path to follow, take the right direction, accelerate or decelerate based on traffic conditions or upcoming situations. **Figure 4** shows a summary of automation levels as defined by the SAE.

There is significant consensus that, in the context of urban mobility, robotaxi fleets will be available between 2025 and 2030 (currently being tested). Autonomous vehicles and the services that can be activated thanks to their diffusion are expected to bring significant benefits to mobility [36, 37]. However, regulators will have to carefully govern the dissemination process. The advantages that can be found in the introduction of autonomous vehicles can be:

- Increase of road safety;

- Optimization of traffic flows with consequent reduction of urban congestion and better environmental impact;

- Mobility guaranteed to the entire population (elderly, disabled, minors) and complete territorial accessibility;

- Reduction of the "driver costs" currently incurred with the use of Local Public Transport (LPT) or Taxi;

- Reduction of parking areas;

- Transformation of time spent driving from unproductive to productive;

- Diffusion of a new shared mobility model based on car sharing and ridesharing.

The spread of shared and autonomous on-demand services will offer solutions for Local Public Transport in the first and last mile, as feeder services of the power lines. They must be part of a flexible and integrated public transport service. Autonomous vehicles should be shared as much as possible, and not merely replace the current private vehicles. However, the driverless, without driver is the future of motoring, and more. In a first phase, an authorized driver must in any case be present in the driving seat: he will be able to carry out work or play activities but must always be available to regain control of the vehicle if requested by the computer system. In a second phase, less distant than one might imagine, there will be no driver, but only passengers in a vehicle entirely managed by technology. Every year around 1,400,000 people in the world die from being involved in

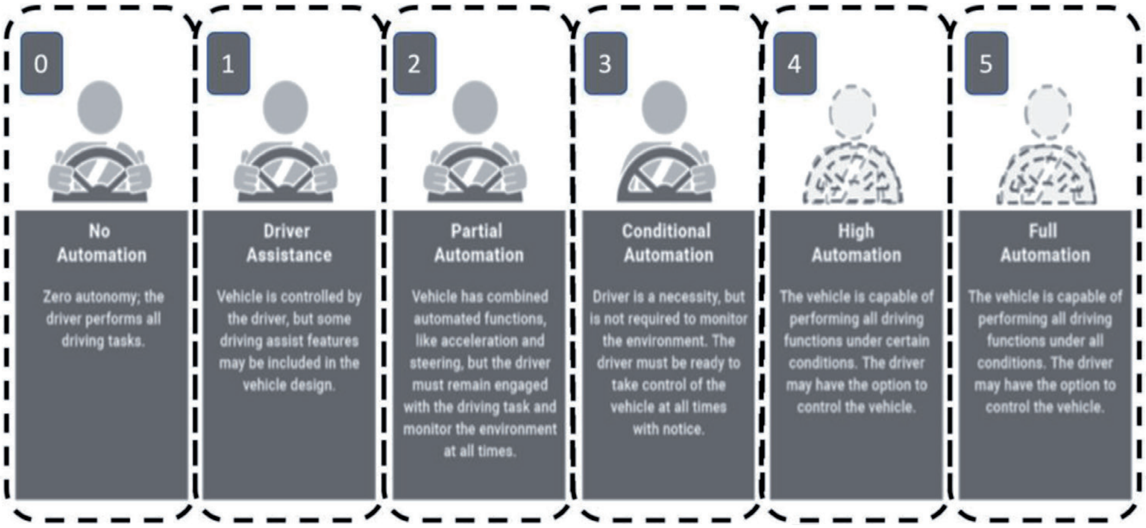

Figure 4.
Automation levels defined by the SAE [35].

road accidents: a massacre. The most accredited statistics on the causes of these accidents attribute them, in about 90% of cases, to inappropriate behavior or distraction of the driver. In only about 2% of cases, the responsibility is attributed to technological defects [38, 39].

With the widespread use of driverless, the decrease in the number and severity of accidents will be drastic: this is indicated by all independent scientific forecasts currently available.

However, technology still poses challenges. For example, environmental perception can be made more robust through the fusion of information from different sensors, a research area in which further development is expected in order to be able to make full use of all the information available. In addition, new deep learning algorithms for object detection have shown significant performance gains, but still need to be extended in order to operate with fused data from different sensors. Still, despite recent advances in solving the localization problem, there are problems with long-term mapping. Updating the maps with static, topometric, activity and semantic data as time changes in order to ensure the vehicle can be located precisely and consistently with respect to the environment is an open research topic with many challenges to be solved.

Despite the significant advances demonstrated in the field of planning algorithms, further improvements are anticipated in the field of real-time planning in dynamic environments. The field of control has also shown important progress in recent years, however, many of the fundamental results obtained have only been validated in simulation. Ensuring that the autonomous system pursues the intentions of higher-level decision making is crucial. Finally, it has been demonstrated how vehicle cooperation (V2V) can increase the performance of the perception and planning process, but there is still much to be achieved to offer greater scalability of multi-vehicle cooperation algorithms and despite the fact that the hardware has been standardized, there is currently no standard that defines what types of information vehicles should exchange [40].

But technological issues are only one, probably minor, aspect of a problem whose solution involves evaluating several issues to consider. One of these concerns the regulatory and ethical problems. The first refers to the legislative question. It is necessary to have a regulation that modifies the highway code in order to allow the circulation of autonomous cars. At the moment only a few states have opened road sections dedicated to the transit of autonomous cars. In the United

States it is possible to test certain cars without a driver on board. In Japan, the test of autonomous cars without humans on board was allowed, as long as they were controlled and monitored remotely. In Germany, the presence of a human being is still required, but it is allowed to carry out technological tests while the driver can take care of other things, without having to keep their hands on the wheel. France is preparing a regulatory evolution to facilitate and expand the opportunities for experimenting with autonomous cars, as long as there is a human being on board.

Furthermore, the legislative problem is intertwined with the ethical-moral question, for which a definitive solution has not yet been found. This refers to who to attribute responsibility in the event of an accident. Who to blame in case of damage, if the manufacturing company or the owner/passenger and what decision to make the car make about who to save for example in a situation where the car has a school group in front of it and has to choose to avoid a collision with another vehicle. These issues are crucial in carrying out this technological diffusion.

6. Mobility as a service

The acronym MaaS (Mobility as a Service) describes a new way of moving which, to the concept of personal ownership of the vehicle, replaces the concept of shared mobility understood as a service to be used according to need [41].

Moving from a lifestyle based on the possession of the means of transport, in particular the car, to a lifestyle based on the concept of Mobility as a Service, is not easy but considering mobility as a shared service offers many advantages for the individual citizen, for society and for the environment. MaaS is an ICT platform to manage the supply–demand meeting of transport and services offered by different subjects through a single information system interoperable with the proprietary systems of the individual operators. Service providers will also be able to operate on larger scales than the local one [42]. A successful MaaS service also brings new business models and ways to organize and manage various transport options, with benefits for transport operators including access to improved user and demand information, and new opportunities to meet unmet demand. MaaS's goal is to provide an alternative to private car use that can be cheaper, more sustainable, help reduce congestion and transport capacity constraints. For the user, MaaS can offer added value through the use of a single application to provide access to mobility, with a single payment channel instead of multiple ticketing and payment operations.

Mobility as a service is a relatively new concept that, in addition to changing the business model for the provision of transport services, promises a change in the means and methods of providing the service. This concept was created to be applied above all in large cities, where traffic congestion and levels of atmospheric and environmental pollution have reached their peak [43, 44].

Technology plays a fundamental role in making possible the spread of this business model, which has as its main feature the possibility for the citizen to choose the most suitable means of transport based on the route to be taken, passing from car to train, up to get to busses, trams, scooters and bicycles. In perspective, in fact, the user, through a single application, will have a service available on his smartphone that will allow him to plan the trip and to choose which means of transport to use for each journey to be made, paying for the single trip or taking advantage of monthly passes or unified rates for several different means of transport. The main feature of MaaS lies in offering travelers solutions based on their real travel needs. To do this, it is essential to combine public transport service providers (such as busses, trams and trains) with private services such as car sharing, bike sharing or

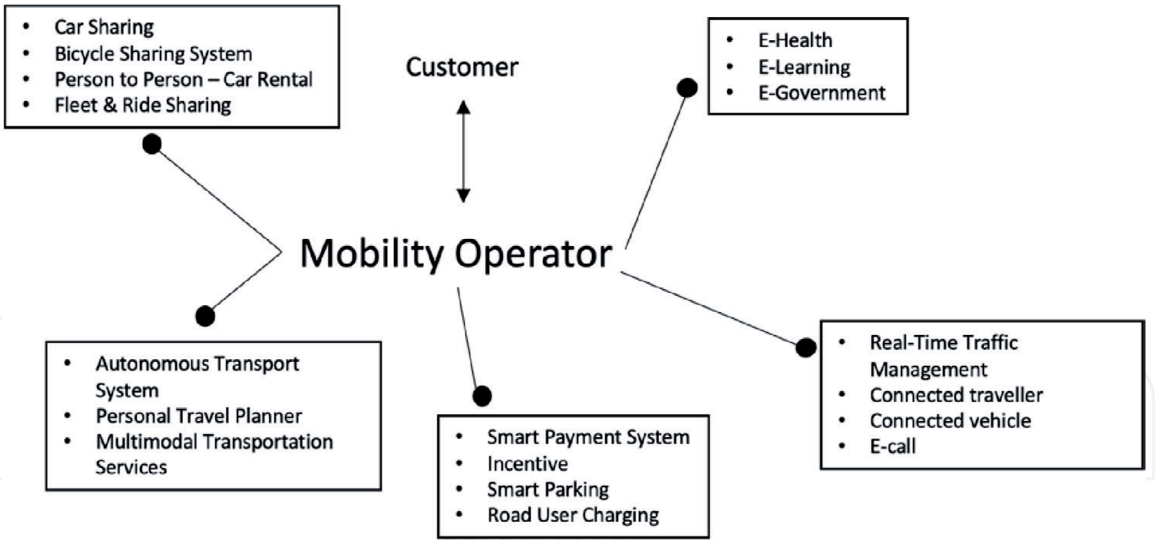

Figure 5.
Mobility as a service framework.

car rental services. In this way, through a single platform, users can plan their trip and pay using a single account. The most advanced platforms will have to be able to show the user the different travel options with relative prices and travel times, to allow him to choose the best solution according to his needs.

Once the trip has been planned, the natural evolution of the service lies in allowing the user to book the means of transport directly in the App (taxi, car sharing, scooter, train) to be sure to arrive at their destination in the manner and on schedule without unnecessary waste of time [45].

In the long term, with a view to increasingly shared and sustainable mobility, Mobility as a Service should also allow roaming: a single application that can be used by the user to move around different cities without having to sign up for different services each time. Customization and flexibility in the transport system is an increasingly requested feature that has generated in recent decades a market space and growing interest in MaaS by both the public and the private sector. In the private sector, many services for sharing cars, bicycles, scooters and busses were born, for citizens and companies. But it is in the public sector that Mobility as a Service can be considered as a real revolution, able to connect trains, planes, trams and busses, to car sharing and bike sharing services that complete the range of customizable travel possibilities by the user. In Europe, the state that has made the most progress towards the concept of mobility as a service is Finland, where there are already pilot cases of MaaS. In Italy, on the other hand, the city that most of all believed in shared and sustainable mobility is Milan. **Figure 5** illustrates the framework of MaaS.

7. Sharing mobility

Shared mobility is a topic of great depth and importance as it is going to revolutionize the traditional essence of transport itself, and which takes the name of Sharing Mobility (SM) or also called Shared Mobility. SM is a particular mobility system, which allows people to move from one place to another, through shared vehicles [46, 47]. Users therefore do not only use proprietary vehicles for travel, but use rental services, which leverage on digital platforms for the provision of the service. This system describes a transport service that includes, public transport and taxis, bike sharing, car sharing, carpooling, scooter sharing, shuttle services and others (**Figure 6**). This shared mobilization system relies not only on private users who make their own vehicle available to others, allowing access to it, but this has also been possible thanks to the birth of companies that make their services available (as for example Car2Go and Enjoy in Italy).

The SM aims to respond to new travel needs, trying to offer new options and solutions for transport. This system is able to provide more mobility choices to the user, put the last mile in contact with the first mile and reduce traffic congestion through the shared use of vehicles. In addition, it helps reduce air pollution, reduce transport costs, increase efficiency, and last but not least, it offers travel options for those who are unable to economically maintain a vehicle they own. This system also seeks to solve some historical problems inherent in traditional mobility, or to facilitate the sharing of vehicles and journeys between individuals, creating "tailor-made" services for each user of the platform, and maximizing the use of latent resources. Recent technological innovations have allowed the sharing of vehicles at lower transaction costs than in the past, thus allowing the sharing of vehicles that were normally designed for personal use (see for example Uber or Auting).

To classify a transport service under the "Sharing Mobility" label, certain characteristics must be present. In the first analysis, there is a need for the sharing of a mobility service, or that this service is shared between two users. This is possible in two different ways: there can be the use of the service simultaneously, as for example with BlaBlaCar, when the service is used simultaneously with other passengers, or differently the service can be offered in succession, when for example it is used a Car Sharing or Car-Pooling service (such as Uber) [48, 49].

Another important feature of shared mobility is the use of digital platforms, these are a necessary support for the creation of an original collaborative service. These platforms are based on the use of websites accessible from desktops, apps for smartphones and other mobile devices. Digital platforms allow levels of

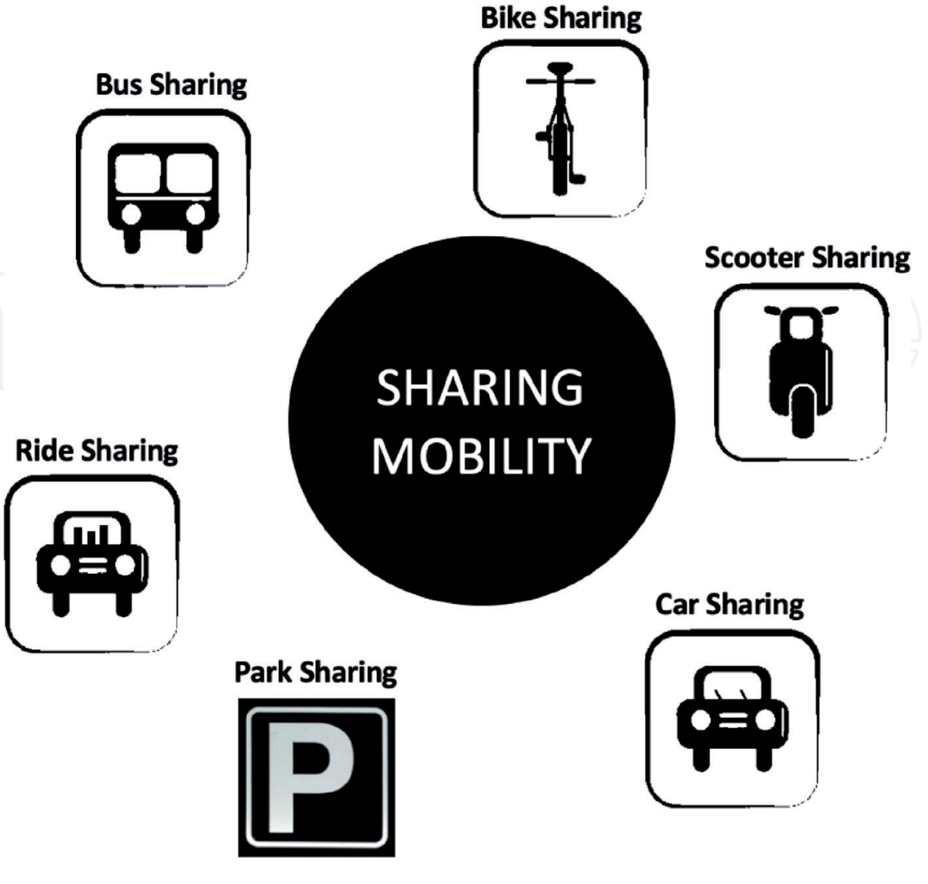

Figure 6.
Sharing mobility.

interactions unimaginable compared to the past, in fact they are able to easily put demand and supply in contact in real time, create relationships with service users, are easy and immediate to use and finally are more effective allowing to reduce transaction costs.

The use of the internet and the development of the "Information Technology System" (ITS) has proved to be of vital importance for these platforms; these tools have in fact allowed niche practices to impose themselves as forms of mass consumption, thus gaining visibility in the minds of consumers and at the same time market share.

The car in the model of traditional mobility is a "Status Symbol", which indicates the acquisition of full freedom by the individual in travel and the ability to satisfy their interests: it is the quintessential symbol of emancipation. This has given rise to a model in which almost every individual owns one or more owned cars to make their trips around the city, with a consequent increase in the number of cars in circulation over time. Today, this increase is causing major problems both in the field of mobility and in the sustainable and environmental sphere, and this is how measures have been developed to reduce and discourage the use of individual vehicles, to induce users to more sustainable forms of transport.

SM can be a useful model for encouraging these behaviors. It is unthinkable to pass from a model that contemplates owned vehicles as a vehicle for travel, to a model that instead contemplates only shared means, without there being a period of experimentation and adaptation. The SM allows you to use your individual vehicle in a shared way, making your vehicle accessible to other users. Access to these services gives users new methods to evaluate which is the most favorable option regardless of the means of transport that you own or otherwise do not have at all. The main objective but also the most difficult to achieve since it must go to break already consolidated paradigms, is to encourage these practices of sustainable mobility, and make sure that the first choice of the individual is not to use his own vehicle, but rather the use of systems headed by the SM. Only in this way will it be possible to have decisive repercussions in the field of sustainability with the reduction of consumption of traditional mobility.

Technology plays a fundamental role in the orientation of users to choose the best vehicle to use for their journeys. There is a need to replace vehicle keys with smartphones, able to search, through mobility service aggregators, what is the best way to move to the preset destination.

SM could also solve traffic congestion problems. Often, in fact, the cars do not travel with their full load capacity, and many drivers are found on the streets who drive their vehicle without any passengers. This is even more relevant at peak times, when users are on their way to work or on their way home. The roads are invaded by thousands of vehicles at the same time, and this causes major traffic problems with consequent queues and delays. MS could partially solve this problem by reducing the number of vehicles on the roads. As previously mentioned, digital platforms are able to connect supply and demand in real time, and to bring users with the same travel needs together. With these tools, it would be relatively easy to organize the sorts of shuttle vehicles, traveling fully loaded to transport users who have a similar destination, thus reducing the number of vehicles needed to move on the roads. These forms of displacement are already present today but are still underused. There is a need to make users understand what the advantages are of sharing a vehicle.

A reduction of vehicles on the roads as well as advantages to the road mobility system would also lead to a reduction in polluting emissions from vehicles. MS is known not only for the use of innovative digital platforms, but also for the use of new forms of energy. This model is increasingly pushing towards an eco-sustainable approach, through the use of vehicles that no longer rely on traditional fuels, but on new electrical technologies. Electric vehicles are known to be non-polluting vehicles as they use electric propulsion for driving and are silent. In the main cities there are today Car Sharing services that use these vehicles, which are parked in special parking areas equipped with an electric charging column. In addition to being vehicles that respect the environment more, they are characterized by low cost of refueling compared to fossil fuel vehicles, they also arouse great interest in people, since electric is still a technology that is little used for traditional travel.

Today we have reached a point where the traditional transport system is no longer able to support the needs of users, everyone wants to go everywhere in the most efficient way, but the road network is now congested by too many vehicles that travel it, creating big problems in moving. The car is the vehicle that guarantees the greatest versatility, it can be used for short urban journeys or for long journeys from one city to another: therefore, it allows the driver a degree of freedom and autonomy that no other public transport can guarantee. People today want to feel free, and they do not want to feel constrained in their movements, so they are looking for the type of mobility that can meet these needs. For these reasons, MS can be the solution to all these problems: it promotes access to mobility services with respect to vehicle ownership and uses a digital platform capable of representing the best travel solutions both from the point of view of the child, travel time and lower cost, both from the point of view of environmental impacts and efficiency. It is a model that goes against the traditional paradigms of mobility, but at the same time wants to satisfy the same needs: freedom and versatility of movement.

Owning a car is a significant cost in families' assets, in fact it can weigh up to 20% on family income. On the other hand, car sharing users are freed from these ownership costs, from the fixed costs of maintaining the vehicle, from insurance, and pay only what they consume. With traditional mobility based on ownership, we have reached a point where a vicious circle has been triggered, in which as the ownership of a private car increases, congestion on the road network and the need for new road infrastructure increases. With SM, on the other hand, we are experiencing the birth of a virtuous circle, in which the decrease in ownership and use of the private car follows a propensity to reduce ownership, which leads to a regeneration of the urban area and better accessibility within cities. Ownership by young people is perceived as something ancient, thanks to the internet they are now used to sharing, exchanging, reusing goods, and services. They are no longer willing to pay to own something for one-time use. They are inclined to pay for the actual use and are not interested in mere possession.

Innovations, especially radical ones, are capable of changing the game rules of a market. An innovation is said to be radical when it gives rise to new technological paradigms thanks to the Research and Development (R&D) of industrial or government laboratories, with the aim of combining product, process and organizational innovations to develop new markets. SM can be part of this context of radical innovation, as it is a model that is challenging traditional mobility and the most common transport methodologies.

Sharing Mobility can also be thought of as a disruptive type of innovation, an innovation that radically changes habits and the way consumers use a good or service, bringing about changes that can affect an entire ecosystem. As we have been able to analyze in the previous paragraphs, MS has led to new ways of conceiving mobility thanks to the support of new technologies, but many wonders if this model is truly capable of overwhelming and replacing the previous one based on ownership and possession of the vehicle.

8. Conclusions

In a decade, as a result of technologies, mobility management will be significantly more complex and business models will change. New mobility services (e.g., robotaxi) will be offered by more and more operators, public and private: carpooling, car sharing, ride sharing. It will be important to provide mobility services based on the integration, including multimodal, of Local Public Transport, private mobility, light mobility, shared transport services, etc. Public Transport operators will have to reposition their offer and services, forge alliances, review the value chain. A dynamic and integrated allocation of resources managed by various different entities (public and private transport services, physical network infrastructures, etc.) will be needed. An "intelligent" transport infrastructure will have to be developed, able to communicate with users and vehicles through multiple standards and control and regulation centers for the transport infrastructure offer will have to be implemented. It will be necessary to spread a greater culture, awareness of the economic value of the data generated as a result of access to shared services and autonomous driving. As a result of the high levels of vehicle automation, the spread of vehicle connections with the web, the cybersecurity aspects will assume absolute importance. As a result of its complexity and integration, mobility could be more vulnerable to malfunctions of its components (communication networks, power grid, control centers, etc.). It is therefore a field of work that is still open, in constant evolution.

Conflict of interest

The authors declare no conflict of interest.

Author details

Michela Longo[1]*, Wahiba Yaïci[2] and Federica Foiadelli[1]

1 Federica Foiadelli, Politecnico di Milano, Department of Energy, Milan, Italy

2 CanmetENERGY Research Centre, Natural Resources Canada, Ottawa, Ontario, Canada

*Address all correspondence to: michela.longo@polimi.it

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