GECKO
GOVERNANCE FOR NEW MOBILITY SOLUTIONS

Review of new mobility services and technologies and set-up of knowledge

22/10/2019

Author(s): Valerio Lubello, UB and Yannick Bousse, UITP

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824273.

SUMMARY SHEET

Deliverable No.	1.1
Project Acronym	GECKO
Full Title	Governance principles and mEthods enabling deCision maKers to manage and regulate the changing mObility systems
Grant Agreement No.	824273
Responsible Author(s)	Valerio Lubello, UB Yannick Bousse, UITP
Responsible Co-Author(s)	Marisa Meta, FIT Ping-Jen Kao, UCL Anne Reynaud, IRU Marius Jasmin, CHT Maruša Benkic, CORTE
External Review	Arnd Bätzner, Baetzner Metropolitan
Quality Assurance Committee Review	Ping-Jen Kao, UCL
Date	22/10/2019
Status	Final
Dissemination level	Public
Abstract	Deliverable 1.1 provides a review of new mobility services and technologies that are currently available in the market or will become available in the near future (up to 2040).
Version	1.0
Workpackage No.	1
Workpackage Title	Technological, operational, business and social trends and innovations
Programme	Horizon 2020
Coordinator	UITP – The International Association of Public Transport
Website	www.h2020-gecko.eu
Starting date	December 2018

Number of months	30

CONTRIBUTING PARTNERS

Organisation	Country	Abbreviation
FIT CONSULTING SRL	IT	FIT
UNIVERSITY COLLEGE LONDON	UK	UCL
IRU PROJECTS ASBL	BE	IRU
CAPITAL HIGH TECH SARL	FR	CHT
CONFEDERATION OF ORGANISATIONS IN ROAD TRANSPORT ENFORCEMENT	BE	CORTE
UNIVERSITA COMMERCIALE LUIGI BOCCONI	IT	UB

DOCUMENT HISTORY

Version	Date	Organisation	Main area of changes	Comments
0.1	20-06-2019	UB	Draft structure	
0.1.1	27-06-2019	UITP	Draft updated	
0.2	3-07-2019	FIT, UCL, IRU, CHT, CORTE, UB	Review of draft	
0.3	17-07-2019	FIT, UCL, IRU, CHT, CORTE, UB	Technological, Operational, Social and behavioural, Business, Future scenario, Cybersecurity, Data, Safety, Ethics sections added Market Analysis Methodology added	
0.4	24-07-2019	FIT, IRU, CHT, CORTE	Market Readiness, Market Positioning, Market Maturity	
0.5	6-09-2019	POLIS	Review by POLIS and Baetzner Metropolitan	
1.0	22-10-2019	UITP	Final review and submission	

LIST OF ACRONYMS

AI – Artificial Intelligence
API - Application programming interfaces
APL - Automated Parcel Lockers
AV - Automated Vehicles
CAGR - Compound annual growth rate
CASA - Civil Aviation Safety Authority
CAV – Connected and Automated Vehicles
CCAM – Cooperative, connected, and automated mobility
D – Deliverable
EGNOS - European Geostationary Navigation Overlay Service
FAA - Federal Aviation Administration
GNSS - Global Navigation Satellite Systems
GSM - Global System for Mobile communication
GPS - Global Positioning System
ICT – Information and Communication Technologies
MaaS – Mobility as a Service
MRL – Market readiness levels

OECD – Organisation for Economic Co-operation and Development
OEM – Original equipment manufacturer
ORION - On-road Integrated Optimization and Navigation
POI - Points of Interest
TM - Traffic Management
TM2.0 – Traffic Management 2.0
UAS - Unmanned-aerial systems
UTM - Unmanned traffic management
V2C – Vehicle-to-cloud
V2I – Vehicle-to-infrastructure
V2V – Vehicle-to-vehicle

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. EXECUTIVE SUMMARY

The objective of this deliverable is to review new mobility services and technologies that are available in the market or will become available in the near future up to 2040.

This deliverable will lay the foundation of disruptive technologies and new mobility services for GECKO in Chapter 2. The disruptive technologies and new mobility services have been classified according to three thematic areas and four categories in Chapter 3. The document also aims to provide a market analysis of disruptive technologies and new mobility services. Definitions of market readiness, positioning and maturity are set out in Chapter 4. The methodology of the market analysis is set out in Chapter 6. Case studies have been selected for further investigation in Chapter 7. This has been structured according to four components: technological, operational, social/behavioural and business. It includes for each innovation relevant information on security and cybersecurity, safety, data and social protection, ethics requirements. Followed by the analysis of market readiness, positioning and maturity. This will enrich the contents of the Knowledge Bank, and enable the clustering and selection of innovation cases for impact assessment undertaken later in the project. Finally the set up on the GECKO Knowledge Bank is described in Chapter 8.

This review focuses in particular on in-depth investigation of technological and operational innovations, while concerning social and behavioural trends and business models the key elements are identified, paving the way for the D1.2, End-users' perspectives and mobility needs and D1.3, Business models for integrated and intermodal transport systems.

Stakeholders will be engaged during the project for the identification, review and elicitation of the relevant innovations and for the analysis of market readiness, positioning and maturity. This together with D1.2 and D1.3 will feed into the D1.4, Final update of new mobility services and business models.

This document has also been made in close cooperation with D2.1, Analysis of regulatory responses and governance models, which sets out the regulatory responses and governance models for the categories of innovation described in this document.

The rapid proliferation of new technologies and disruptive innovations are taking the world by storm, threatening well established players across many sectors. Regulators and decision-makers at different levels of government are overwhelmed by the challenge, acknowledging that existing frameworks may be inadequate in terms of protecting society, fostering business development and achieving integrated, sustainable mobility.
GECKO's main goal is to support authorities with tools and recommendations for new regulatory frameworks to lead the transition to the new mobility era of cooperative, inclusive, competitive, sustainable and interconnected mobility across all modes, through evidence-based research.

GECKO provides a holistic approach with innovative concepts, methodologies and forward-looking tools to enable this transition to take place, leading to new, adaptive and anticipatory regulatory schemes and balanced governance.

The project builds on the strong networks of its partners to ensure solutions are co-designed and validated. A number of key indicators and cooperation models will help to develop the Regulatory Frameworks Dashboard, though which the maturity of given regulations can be judged with respect to emerging mobility solutions.

GECKO outlines an implementation plan including actions required up to 2040 for policy makers to devise regulatory approaches for disruptive innovations and new regulatory frameworks streamlining uptake. GECKO advises policy makers on challenges and policies that need to be addressed to move towards integrated, accessible and sustainable mobility across modes for both passenger and freight transport.

The project provides recommendations to policy makers to enable adaptive and anticipatory regulatory schemes and governance with novel policies that contribute to sustainable mobility goals.

2. DISRUPTIVE INNOVATION IN URBAN MOBILITY

2.1. Definition of disruptive innovation

According to the Christensen Institute[1] disruptive Innovations have the potential to be an incredibly positive force in the world. If there is no uniformly accepted definition of disruptive innovation, at least some criteria to qualify an innovation as a disruptive one can be identified. It is important to start by presenting what disruptive innovations are not[2]: disruptive innovations are not new technologies that make good products better[3]. The commonly accepted definition of disruptive innovation is the definition from Clayton Christensen[4] according to which disruptive innovation is:

> *"a process by which a product or service initially takes root in simple applications at the bottom of a market, typically by being less expensive and more accessible, and then relentlessly moves upmarket, eventually displacing established competitors[5]."*

According to this conception the first car developed by Carl Benz in 1886 would not be qualified as a disruptive innovation because the vehicle was targeting exclusive consumers, a training was required to learn how to use it, and it included high-end features, while the Ford model T from 1908 is considered disruptive because it was affordable, easy to use and included only basic features. According to the Christensen institute there are three elements to qualify innovation as disruptive:

1. First there must be an enabling technology, an invention that makes a product more affordable and accessible to a wider population. The smart phone or the internet are key examples of enabling technology.
2. The second element is an innovative business model which according to this definition targets non consumers, new customers who previously did not buy a product, did not use a service in a given market or were the least profitable customers.
3. The third element is a coherent value network, so a network in which suppliers, partners, distributors, and customers are each better off when the disruptive technology prospers. These criteria can also be aligned with the definition of regulation as described by the OECD[6] in Deliverable 2.1 Analysis of regulatory responses and governance models.

The urban mobility innovations in Chapter 8 Case Studies have been selected using the above definition.

---

[1] Christensen institute
[2] Harvard business school online, 4 keys to understanding Clayton Christensen's theory of disruptive innovation, Chris Larson.
[3] Disruptive innovations, Clayton Christensen institute.
[4] Harvard business institute, what is disruptive innovation?
[5] See supra.
[6] OECD, key points of the hearing on dispute innovation, 16-18 June 2015

2.2. Global trends driving innovation

In 2030, a little more than ten years from now, about 60% of the world population will live in cities. With this increasingly rapid urbanisation process, metropolitan areas will have to rely on their best assets to address the threats and seize opportunities. With the increase of urban population inevitably comes an increase of mobility demand[7].

Transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of air pollution in cities. The transport sector has not seen the same gradual decline in emissions as other sectors: emissions only started to decrease in 2007 and still remain higher than in 1990. Within this sector, road transport is by far the biggest emitter accounting for more than 70% of all GHG emissions from transport in 2014. Cities and local authorities will play a crucial role in a shift to low-emission mobility. They are already implementing incentives for low-emission alternative energies and vehicles, encouraging active travel (cycling and walking), public transport and bicycle and car-sharing /pooling schemes to reduce congestion and pollution[8].

Digitalisation has accelerated the trends towards a sharing economy, which is bound to play an essential role in the future of urban transport. Car/Bike/Scooter-sharing, Ride-hailing, demand-responsive transport and other flexible and shared modes are increasing their presence in our urban landscape. Their usage will only grow, slowly replacing individual vehicles. For the first time in over a century, car ownership is no longer a synonym of freedom for urban dwellers. On the contrary, individual cars are becoming an economic and social burden in cities. Digitalisation and the sharing economy have changed the paradigm: from transport to service, from supply-led to on-demand transport, from ready-made to tailor-made.

As regards the mobility of goods, the rapid growth of e-commerce is revolutionizing the entire supply chain (transport organization, warehouse management, deliveries in the city...) and customer expectations are increasing considerably in terms of speed and flexibility of deliveries. In this context, the extreme fragmentation of deliveries is aggravating the problems of logistics in urban centres. These dynamics are at the base of the "logistics of whim", which must find ways to optimize the physical distribution of packages, reducing costs. Therefore, freight transport is seeing disruption from new business models as well as new technologies that are likely to reach market readiness over the next 10 years (including Drones and Autonomous Ground Vehicles).

This is made possible by the development of new solutions introduced by new actors coming from different sectors: IT, media, automotive industry, banking etc. They generate mobility products with an added value that everyone wants to harness.

[7] UITP PUBLIC TRANSPORT TRENDS REPORT 2019

[8] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A European Strategy for Low-Emission Mobility

Innovation also has a dual nature, it is “contextual”, what is considered an innovation in Bratislava will not be necessarily an innovation in Singapore, but at the same time, innovation has increasingly a global character[9].

[9] Urban Mobility Innovation Index

3. NEW MOBILITY SERVICES AND TECHNOLOGIES

3.1. Three thematic areas

It is critical to identify disruptive innovations in the transport sector. Christensen Institute has noted that disruptive innovations involve three elements: the enabling technologies, innovative business models, and coherent value network. These three elements are correlated with each other. In particular, coherent value network are usually aligned with the enabling technologies and innovative business model.

Although the conceptualisation of disruptive innovation is commonly accepted in the innovation literature and practitioner reports, it neglects the importance of digitalisation and big data in modern environment. The data-rich trend has significantly influenced how practitioners develop disruptive innovations in the transport sector[10].

On the basis of Christensen Institute's conceptualization of disruptive innovation and the digitalisation and big data trend, this deliverable therefore proposes three thematic areas for this project: 1) technologies, 2) business models, and 3) data utilisation. The development of new products and services often stem from these areas. For example, the realisation of autonomous vehicles is enabled by emerging technologies and data utilisation as well. By the same token, shared-on-demand mobility development is facilitated by innovative business models and data utilisation as well, and network management and optimisation are improved by the analysis of big data. Figure 1 presents these three thematic areas.

[10] Troilo, G., De Luca, L. M., & Guenzi, P. (2017). Linking data- rich environments with service innovation in incumbent firms: A conceptual framework and research propositions. Journal of Product Innovation Management, 34(5), 617-639.

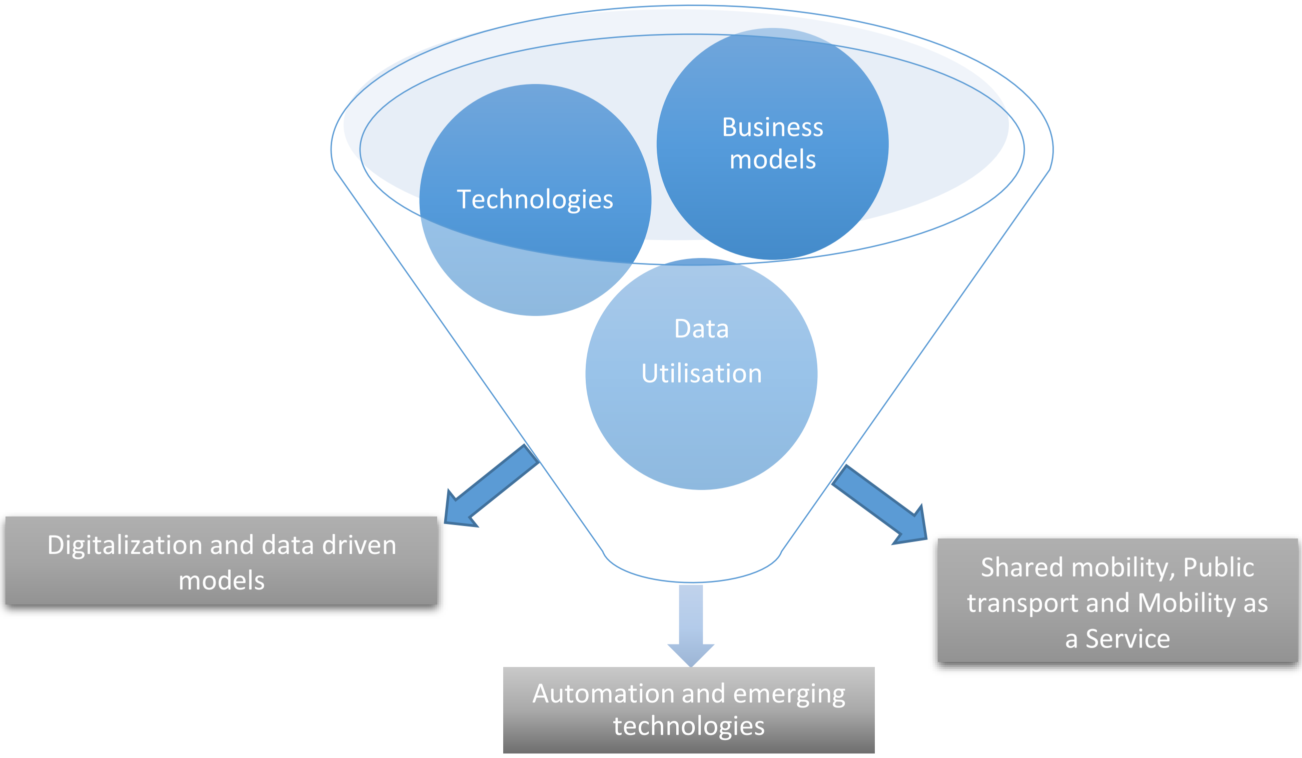


Figure 1: Three thematic areas

3.1.1. Technologies: Automation and emerging technologies

The first thematic area is *technologies: automation and emerging technologies*. This thematic area involves disruptive automated and emerging innovations in transport sector, such as connected and automated vehicles (CAV), drones and flying vehicles, information and communication technologies (ICT) development, and ticketing solutions with the application of blockchain technology. These emerging technologies serve as a solid foundation for different stakeholders to develop disruptive products or services, which in turn, transforms mobility industry in a significant way.

3.1.2. Business models: Shared mobility, public transport, and mobility as a Service

The second thematic area is *business models: shared mobility, public transport, and mobility as a service*. This thematic area includes new and traditional mobility services for passenger and freight transport, transport authorities and regulators, and community associations. It also includes a wide range of innovative business models (e.g., car-sharing, bike-sharing, ride-sharing, ride-hailing, public transport, smart parking, electronic vehicle, charging infrastructure, crowdsourcing operators, and smart delivery) across different types of cities (i.e., mega-cities, large cities, and small cities). These innovative business models have significantly changed the ecosystem in the transport industry. Nowadays, all actors have to adapt the way of operating relevant services due to these disruptive business models. Resource integration and the collaboration between different partners become a key for sustainable business operation. New services of shared mobility can produce both positive and negative externalities[11]. As for positive externalities, from new services could generate new taxation incomes, with new forms of taxation. On the other hand, the usage of data by new mobility providers is at the foundation of the marketplace control. In this vein, through the usage of data new operators can adopt anti-competitive practices, where regulation on data property would lack.

3.1.3. Data utilisation: Digitalisation and data-driven models

The third thematic area is *data utilisation: digitalisation and data-driven models*. This thematic area consists of the development of digital data platform and the application of big data. Specifically, transport regulators, transport operators, service providers, and other relevant stakeholders face the trend of big data from 2015. Big data is critical to the future development of transport industry. However, it will be less valuable if we cannot transform the ubiquitous data into meaningful models and statistics. The output of big data analysis will help all actors to spot the pattern, make real-time decision, and develop innovative offerings to the industry. Therefore, the data utilization is another critical area for disruptive innovations. As afore-mentioned, control over data correlate to control over market. Thus, some have suggested that states should exert some form of control over data, without limiting their role to the enabler of data systems development or open data policy for private companies[12].

3.2. Categories of transport innovations

Based on three identified thematic areas, this deliverable further categorises four transport innovations that are most disruptive in today's transport sector. These categories are: 1) cooperative, connected, and automated mobility (CCAM), 2) infrastructure, network, and traffic management, 3) MaaS and MaaS platform, and 4) shared on-demand mobility. Each innovation category has linked to three thematic areas to different extents. Table 1 shows that these four innovation categories are related to three thematic areas. However, CCAV is more relevant to technologies; infrastructure, network, and traffic management and MaaS and MaaS platform are more relevant to data utilisation; shared on-demand mobility is more relevant to business models. In the following sections, the definition of each innovation categories are briefly discussed.

[11] https://www.sciencedirect.com/science/article/pii/S096585641731090X?via%3Dihub
[12] https://www.sciencedirect.com/science/article/pii/S096585641731090X?via%3Dihub

	Technologies	Business Models	Data Utilisation
CCAM	*High relevance*	*relevance*	*relevance*
Infrastructure, network, and traffic management	*relevance*	*relevance*	*High relevance*
MaaS and MaaS platform	*relevance*	*relevance*	*High relevance*
Shared on-demand mobility	*relevance*	*High relevance*	*relevance*

Table 1: Four innovation categories and relevance to thematic areas

3.2.1. CCAM

Most of modern vehicles and drones already have connected devices. A connected vehicle is defined as a motor vehicle "that connect to other vehicles and or devices, networks and services outside the car including the internet, other cars, home, office or infrastructure"[13]. In the future, they might directly interact with each other and with the road infrastructure. This interaction is the domain of cooperative mobility, which is enabled by digital connectivity between vehicles and between vehicles and transport infrastructure[14]. An automated vehicle is defined as "a motor vehicle which has technology available to assist the driver so that elements of the driving task can be transferred to a computer system[15]." In contrast, an autonomous vehicle is defined as "a fully automated vehicle equipped with the technologies capable to perform all driving functions without any human intervention[16]." Example of disruptive innovations in this category includes connected and automated vehicles, passenger urban air mobility, and drone last mile delivery.

3.2.2. Infrastructure, network and traffic management

Infrastructure can be defined as innovations in infrastructure management, pricing, taxation and finance, digitalization and integration[17]. Network and traffic management can be defined as the system controlling traffic. Traffic can be controlled through a properly implemented system of

[13] Gowling WLG, Are you data Driven?
[14] Intelligent transport systems
[15] European Parliament, Briefing January 2016, Automated Vehicles in the EU.
[16] European Parliament, Briefing January 2016, Automated Vehicles in the EU.
[17] Transport Infrastructure Expert Group.

signals, as wll as (in a predictive manner) trough information. Signals are the most important tool for a city to manage traffic in a safe and efficient manner, and their timings are determined by traffic circulation plans. Network and traffic management conceived as information “provides guidance to the European traveller and haulier on the condition of the road network. It detects incidents and emergencies, implements response strategies to ensure safe and efficient use of the road network and optimises the existing infrastructure, including across borders. Incidents can be unforeseeable or planned: accidents, road works, adverse weather conditions, strikes, demonstrations, major public events, holiday traffic peaks or other capacity overload”[18]. Example of disruptive innovations in this category includes big data for fleet management and logistics, TM 2.0, and Hyperloop.

3.2.3. MaaS and MaaS platforms

“Mobility-as-a-Service (Maas) is a user-centric, intelligent mobility management and distribution system, in which an integrator brings together offerings of multiple mobility service providers, and provides end-users access to them through a digital interface, allowing them to seamlessly plan and pay for mobility.”[19] “The MaaS Platform is the IT structure that is used by the MaaS Operator to provide the final service of mobility to the end-users”. Example of disruptive innovations in this category includes MaaS and MaaS platforms

3.2.4. Shared on-demand mobility

Shared mobility and on-demand mobility are two trends emerged as a response to the change in traveller need for cheaper transport (e.g. sharing the cost of travel), to the need for easy access to a transport (service) at a given moment, and to reduce traffic congestion due to private vehicles circulation. Shared mobility and on-demand mobility can also reduce congestion and space by private vehicles in cities. Shared mobility can be defined as usage of shared resources, in this case vehicles, which are made available to registered users at various locations in the city. On-demand mobility, on the other hand, is service provided ‘on-demand’, when requested by the customer, and not based on a fixed schedule. Example of disruptive innovations in this category includes car-pooling, bike sharing, e-scooter sharing/ micromobility, ride-hailing and TNC, and on-demand ridesharing.

For each innovation category, specific case studies will be presented and discussed in Chapter 8. Each innovation will be evaluated based on four components: technological, operational, social/ behavioural, business, and will include for each innovation relevant information on cybersecurity, data, safety, and ethics. To deepen the insight of this deliverable, 2040 future scenarios will also be set up in each innovation category.

---

[18] Intelligent Transport Systems, Traffic Management

[19] The MaaS Dictionary

4. MARKET ANALYSES

4.1. Market readiness

Market readiness definition is not unique and there is no scientific consensus on it. Starting from the NASA first use in the 1980's[20], John Markins definition focuses on a technological approach, according to which Technology Readiness Levels (TRLs) are a systematic metric/measurement system that supports assessment of the maturity between different types of technology"[21]. The different term Market Readiness Levels assumes a complementary role to TRLs and its use provide a "market oriented perspective on innovation and technological development that will enhance market-led innovation and improve market orientation for technology led research"[22].

Whilst the purpose of achieving 'market readiness' is to develop a commercial offering for a group of customers, the concept can be successfully applied to developing a service offering for a group of users or stakeholders. Market readiness levels (MRLs) feature four business process oriented phases, from Ideation to scaling business to a sustainable – and resilient – commercial operation[23].

0	Perception of a need		
1	Basic research		*Need is described, no evidence*
2	Needs formulation	IDEATION	*Articulation of needs based on customer/users stories*
3	Needs validation		*Initial stakeholder interest on the product*
4	Small scale stakeholder campaign	TESTING	*Campaign with stakeholders (friendly, usual customers, business partners, etc.)*
5	Large scale early adopter campaign		*Campaign with early adopters (target groups, intended customers)*
6	Proof of traction	TRACTION	*Paying customers*
7	Proof of satisfaction		*Positive feedbacks from paying customers*
8	Proof of scalability	SCALING	*Stable pipeline and stron understanding of the market, solid revenue projections*
9	Proof of stability		*KPIs matched and predictable growth*

[20] Sadin, Povinelli, Rosen, 1989
[21] J. C. Mankins, Technology Readiness Levels, a White paper
[22] D. Dent. B. Pettit, Technology and Market Readiness Levels, Dent Associates, White papers 11-01
[23] CloudWATCH2 - H2020

			Source: CloudWATCH2 - H2020 (adapted from)

Table 2: Market Readiness Scale

Market readiness indicators

$$G_{MKT_R} = L_R + \frac{\sum_{i=1}^{m}[\beta_{Ti}(E_{Ti}) + \beta_{Si}(E_{Si}) + \beta_{Ei}(E_{Si})] - \sum_{i=1}^{n}[\propto_{Ti}\,(B_{Ti}) + \propto_{Si}\,(B_{Si}) + \propto_{Ei}\,(B_{Si})]}{3(m+n)}$$

L_R = Level of readiness of the technology
m = number of enablers
$\beta_{T,S,E}$ = Probability of contribution to improve access to the market (by the enabler)
$E_{T,S,E}$ = Importance (low, medium, high) of technological/operational/economic (T), social/behavioral (S) and environmental/energy efficiency (E) enabler

n = number of barriers
$\propto_{T,S,E}$= Probability of contribution to the failure to improve access to the market (by the barrier)
$B_{T,S,E}$ = Severity (low, medium, high) of technological/operational/economic (T), social/behavioral (S) and environmental/energy efficiency (E) barriers

5.2 Market positioning

Innovative mobility services must identify the market position in which they plan to operate. In The Four Steps to the Epiphany, Steven G. Blank[24] describes four different types of market:

MP	Market Positioning	
A	Existing market	
B	New market	
C	Re-segmentation of an existing market as a low-cost player	
D	Re-segmentation of existing market by employing a niche strategy	

[24] Blank, S.G. (2005). The Four Steps to the Epiphany. Self-published: Cafepress.com

Table 3: Market Positioning

The first two market types suggested by Blank are mutually exclusive, but the latter two are specific sub-categories of the existing market. The category in which a new product falls depends on the competitive strategy of the service as either a low-cost or niche strategy.

According to Blank, each market type has its own characteristics and implications, listed below:

Existing market

In an existing market, the users, the market and the competitors are known. In this environment, one competes on product features and performance.

New market

A new market is created if your product enables a large number of customers to do something they were unable to do before you came along. In a new market, customers and their preferences are unknown and direct competitors are non-existent. In the absence of competition, product features take on less importance; identifying customers and making them believe in your vision are the name of the game. This is more time-consuming than if you were in an existing market, which puts extra emphasis on managing cash flow.

Re-segmentation of an existing market as a low-cost player

This approach is based on a belief that a "large enough" market segment will start using a product that may be inferior in terms of features but "good enough" to solve the problem as long as the price is low enough. If such conditions exist and you can be profitable under such circumstances, the strategy is viable. The emergence of low-cost airlines exemplifies such a strategy.

Re-segmentation of an existing market by employing a niche strategy

A niche strategy is viable if you can identify a part of the market which can be captured through a more focused solution than anything currently available. The idea is that a more focused solution will provide higher value to a particular market niche than any of the existing alternatives. The challenge is to demonstrate enough value to motivate a sufficient amount of customers to abandon existing market relationships.

5.3 Market maturity

Whilst market readiness research analyses the level of readiness for a product/service to be introduced in the marketplace, the market maturity analysis, describes the different stages of life of a marketplace. As written in the 1965 Harvard Business Review article by Theodore Levitt[25], the

[25] Harvard Business Review, Theodore Levitt, 1965

product life cycle has 4 very clearly defined stages, each with its own characteristics that mean different things for business that are trying to manage the life cycle of their particular products.

Introduction/ Development Stage

This stage of the cycle could be the most expensive for a company launching a new product. The size of the market for the product is small, which means sales are low, although they will be increasing. On the other hand, the cost of things like research and development, consumer testing, and the marketing needed to launch the product can be very high, especially if it's a competitive sector.

Growth Stage

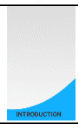
The growth stage is typically characterized by a strong growth in sales and profits, and because the company can start to benefit from economies of scale in production, the profit margins, as well as the overall amount of profit, will increase. This makes it possible for businesses to invest more money in the promotional activity to maximize the potential of this growth stage.

Maturity Stage

During the maturity stage, the product is established and the aim for the manufacturer is now to maintain the market share they have built up. This is probably the most competitive time for most products and businesses need to invest wisely in any marketing they undertake. They also need to consider any product modifications or improvements to the production process which might give them a competitive advantage.

Decline Stage

Eventually, the market for a product will start to shrink, and this is what's known as the decline stage. This shrinkage could be due to the market becoming saturated (i.e. all the customers who will buy the product have already purchased it), or because the consumers are switching to a different type of product. While this decline may be inevitable, it may still be possible for companies to make some profit by switching to less-expensive production methods and cheaper markets.

MM	Market Maturity	
I	Introduction/ Development	
II	Growth	
III	Maturity	

IV	Decline	

Table 4: Market Maturity

Marker maturity indicators

$$G_{MKT_M} = \frac{\sum_{i=1}^{m}[\beta_{Ti}(E_{Ti}) + \beta_{Si}(E_{Si}) + \beta_{Ei}(E_{Si})] - \sum_{i=1}^{n}[\propto_{Ti}(B_{Ti}) + \propto_{Si}(B_{Si}) + \propto_{Ei}(B_{Si})]}{3(m+n)}$$

m = number of enablers

$\beta_{T,S,E}$ = Probability of contribution to the consolidation of the market (by the enabler)

$E_{T,S,E}$ = Importance (low, medium, high) of technological/operational/economic (T), social/behavioural (S) and environmental/energy efficiency (E) enabler

n = number of barriers

$\propto_{T,S,E}$= Probability of contribution to the failure of consolidation of the market (by the barrier)

$B_{T,S,E}$ = Severity (low, medium, high) of technological/operational/economic (T), social/behavioural (S) and environmental/energy efficiency (E) barriers

6 METHODOLOGY MARKET ANALYSES

Marketplaces are analysed through a general pattern, with the aim to return an adequate representation of the state of play of each innovation. This representation is the result of a review on five main features: technological advancement and its barriers, the socio-behavioural context, business model and future scenarios. In general, for each of these features we refer to the general framework for the analysis of innovations (R readiness, P positioning, M maturity):

Technological
- Technology state of play (R) - Barriers/ enablers (R) (M)
Social and behavioural
- Is there a social context ready for the innovation ~~Are the social contexts correct for the innovation~~? (R) (M) - Will the innovation lead to sustainable behaviour change? (R) (M)
Operational
- What makes this innovative compared to the traditional operation of service? (market positioning (P) - Costs of operation (P)
Business
- Revenue (M)
Future scenario
- Development of the innovation until 2040 (R, P, M) - What actions are needed to improve the innovation until 2040 (R, P, M)

The general approach is coherent with the information gathering conducted in the case studies description section. In parallel to the research questions explicated, specific indicators must be considered in order to robustly assess the market characteristics.

6.1 Methodology Market Readiness

As said, market readiness relies on nine levels:
0 Perception of a need/ 1 Basic research/ 2 Needs formulation/ 3 Needs validation/ 4 Small scale stakeholder campaign/ 5 Large scale early adopter campaign/ 6 Proof of traction/ 7 Proof of satisfaction/ 8 Proof of scalability/ 9 Proof of stability

Research question: is a new product/service ready for the market?

According to this work approach, the research relies on four questions for the stakeholders:
1 - State of the art of technology (from 0 to 9, self-explaining)
2 - Barriers/enablers

3 - Are the social contexts correct for the innovation?
4 - Will the innovation lead to sustainable behaviour change?

The first question reflects the current level of market readiness. The other questions will reflect the needed steps to be ready for the market.

A possible scheme for the assessment of the market readiness (connected to the data gathering and stakeholder engagement process) is the following (*for tables see ANNEX I*):

Question 1- Level of readiness of the technology

Question 2a – Describe the major barriers (technological/operational/economic) to market readiness

Question 2b – Describe the major enablers (technological/operational/economic) to market readiness

Question 3a – Describe the major social and behavioural barriers to market readiness

Question 3b – Describe the major social and behavioural innovation elements able to foster the go-to-market

Question 4a – Describe the major environment/resource efficiency elements related barriers to market readiness

Question 4b – Describe the major environment/resource efficiency elements able to foster the go-to-market

Results will be integrated into a market readiness indicator.

6.2 Methodology Market Positioning

Market positioning relies on 4 categories: A Existing market, B New market, C Re-segmentation of an existing market as a low-cost player, D Re-segmentation of existing market by employing a niche strategy

MP	Market Positioning	
A	Existing market	

B	New market	
C	Comparable core product with deliberately different positioning in the market	
D	Re-segmentation of existing market by employing a niche strategy	

Research question: where is the new product service positioned in the market towards its competitors?

According to our approach, we rely on 2 questions to the stakeholders:
1 - What makes this innovative compared to the traditional operation of service? (market positioning (P)
2 - Costs of operation (P)

A possible scheme for the assessment of the market positioning (connected to the data gathering and stakeholder engagement process) is the following:

Question 1a – Describe the major competitors (products/services)

Question 1b – Describe the major competitive advantages of the new product/service? (connected to the previous question)

Question 2a – Compare the cost structure (connected to the previous)

Question 3 - According to the previous answers, we will be able to define the market positioning (if the new product/service belongs to more market, express the focus on % of business):
A Existing market
B New market
C Comparable core product with deliberately different positioning in the market
D Re-segmentation of existing market by employing a niche strategy

Question 4a – Describe the major drivers of change for the market positioning

Question 4b – How the market positioning (in % of business related to the answers to question 3):
A Existing market
B New market
C Comparable core product with deliberately different positioning in the market

D Re-segmentation of existing market by employing a niche strategy

6.3 Methodology Market Maturity

Market maturity relies on 4 levels:
I Introduction/Development, II Growth, III Maturity, IV Decline

Research question: where does the new product/service relied in the market lifecycle?

According to our approach, we rely on 4 questions to the stakeholders:
1 - Barriers/ enablers (R) (M)
2 - Are the social contexts correct for the innovation? (R) (M)
3 - Will the innovation lead to sustainable behaviour change? (R) (M)
4 - Revenue (M)

A possible scheme for the assessment of the market maturity (connected to the data gathering and stakeholder engagement process) is the following:

Question 1a – Describe the major barriers (technological/operational/economic) to the achievement of a steady market share

Question 1b – Describe the major enablers (technological/operational/economic) to the achievement of a steady market share

Question 2a – Describe the major social and behavioural barriers to the achievement of a steady market share

Question 2b – Describe the major social and behavioural innovation elements able to foster the achievement of a steady market share

Question 3a – Describe the major environment/resource efficiency related barriers to the achievement of a steady market share

Question 3b – Describe the major environment/resource efficiency elements able to foster the achievement of a steady market share

Question 4 – Market maturity (for each of the segments identified in the market positioning section)

Level of maturity of the current market (market positioning, question 3): I Introduction/Development, II Growth, III Maturity, IV Decline

Level of maturity (market positioning, question 4b): IIntroduction/Development, II Growth, III Maturity, IV Decline

Results will be integrated into a market maturity indicator.

7 CASE STUDIES

7.1 Connected, cooperative and automated mobility

7.1.1 Connected and Automated Vehicles

Technological
Connected and Automated Mobility (CAM) refers to autonomous/connected vehicles or self-driving cars (vehicles that can guide themselves without human intervention).[26] Connected vehicles are vehicles that use any of a number of different communication technologies to communicate with the driver, other cars on the road (vehicle-to-vehicle [V2V]), roadside infrastructure (vehicle-to-infrastructure [V2I]), and the "Cloud" [V2C]. The technology can be used to improve vehicle safety, as well as to improve vehicle efficiency and commute times. [27] Autonomous vehicles are also referred to as self-driving, driverless or robotic. Given that driver error is considered a major culprit in over 90% of all road crashes and it has recently been estimated that 94% of public roadway crashes happen due to human errors,[28] one of the benefits of CAVs include **crash elimination**, as a vehicle can monitor the environment continuously and compensate for lapses in driver attention. **Reduced traffic congestion** is another potential benefit of CAM. Experiments show that with as few as 5% of vehicles being automated and carefully controlled, it is possible to eliminate stop-and-go waves caused by human driving behaviour. The researchers found that by controlling the pace of the autonomous car in the study, they were able to smooth out the traffic flow for all the cars.[29] The reduction in congestion will most likely result in a **reduction of CO2 emissions** as well. A recent report estimates that connected autonomous electric vehicle will play a vital role in emerging revolution in sustainable low-carbon mobility and will be at the forefront of rapid transformation in transportation, due to their potential to operate with higher vehicle efficiency.[30] In addition, by accelerating and decelerating more smoothly than a human driver, CAM technology can **reduce fuel consumption** and result in further improvements from reducing distance between vehicles and **increasing roadway capacity** and **reduced travel times**. Other potential cost-saving domains include **reduced manpower**, i.e. drivers and law enforcers.

[26] https://ec.europa.eu/digital-single-market/en/connected-and-automated-mobility-europe
[27] http://autocaat.org/Technologies/Automated_and_Connected_Vehicles/
[28] Li, T. & K. M. Kockelman, Valuing the Safety Benefits of Connected and Automated Vehicle Technologies. https://www.caee.utexas.edu/prof/kockelman/public_html/TRB16CAVSafety.pdf
[29] https://www.itsdigest.com/10-advantages-autonomous-vehicles
1. [30] Vaidya, B. & H. T. Mouftah, 2019. Connected Autonomous Electric Vehicles as Enablers for Low-Carbon Future https://www.intechopen.com/online-first/connected-autonomous-electric-vehicles-as-enablers-for-low-carbon-future

Further benefits will regard urban spaces and living, as CAM can reduce traffic and and consequently generate dense urban living[31]. However, the systems underlying AVs (sensors, radar, and communication devices) are **expensive compared to older vehicles** which leads to the questions about the affordability of the CAM technology.[32] Other barriers include **liability, licensing, security and privacy concerns**.
Social and behavioural
High technology costs play a crucial role in wide adoption of CAVs, but **public perception** of CAV is a crucial component of predicting the rate at which the technology will be implemented. At the moment, encounters with CAV on the roadways are rather rare for most people. When an Uber self-driving car fatally struck a pedestrian in Arizona in 2018, this attracted a wide media attention and raised questions related to the safety performance and acceptance of autonomous vehicles (AVs).[33] The results of one study on the perceptions and expectations of AVs provide some evidence that interactions with AVs of vulnerable road users increase perceptions of safety and approval of this technology, and suggest that increased opportunities to interact with AVs would lead to improved public attitudes toward the technology.[34] On another hand, a study conducted by MIT in 2017 has found that nearly half of 3,000 respondents said they would never purchase a car that completely drives itself. The respondents said that they feel uncomfortable with the **loss of control** and that they do not feel self-driving cars are safe. The increase in the development and deployment of CAV also raises a number of **ethical issues** which are further discussed in one of the following sections.
Operational
As already mentioned, **high operational costs** of CAVs compared to traditional cars are often considered as one of the major barriers to their adoption. Past research assumed that the necessary AV technology would **increase vehicle price** by an average of 20%, leading to higher acquisition and interest costs. However, due to more balanced driving of AVs, it is further assumed that automation lowers fuel costs by 10%. In addition, it is expected that AVs will need less components maintenance due to more considerate automatic driving. Based on earlier research it was assumed that safer driving resulting from VAs would **lower insurance rates** by 50%, but more recent research regards this as conservative, as today's Tesla Autopilot is reported to have already decreased accident rates by 40%. However, this estimate is highly uncertain.[35]
Business
It is expected that AVs will initially be offered for sale not to private owners but to **robo-taxi-fleet operators**. Robo-taxis refer to driverless ride-sharing services which are being tested in the United States (for example, by Uber but also by other companies). This is due to two

[31] Shaheen, S., Totte, H., & Stocker, A. (2018). Future of Mobility White Paper. UC Berkeley: Institute of Transportation Studies at UC Berkeley. http://dx.doi.org/10.7922/G2WH2N5D Retrieved from https://escholarship.org/uc/item/68g2h1qv

[32] https://hbr.org/2019/01/the-cost-of-self-driving-cars-will-be-the-biggest-barrier-to-their-adoption

[33] https://www.sciencedirect.com/science/article/pii/S0040162518316603

[34] See 19.

[35] https://www.sciencedirect.com/science/article/pii/S0967070X17300811

reasons, the first one being a very high price of the sensors. For robo-taxis that will be a lesser problem because vehicles will be operating and thus generating revenue throughout the day, while private cars are in use only about 5% of the time. Second, safe functioning of AVs will be much easier in limited geographical ranges that have been mapped in fine detail, such as city centres.[36] When it comes to the use of AVs in freight transport, investors have been supporting start-ups that are developing the technology for self-driving trucks as these could lower the cost of shipping goods by eliminating drivers (Amazon is an example of a company that is already using autonomous trucks to move cargo in the United States). The AV industry relies on collaboration and sharing of data among companies, therefore it is expected that there will be more mergers and acquisitions as well as partnerships between auto manufacturers and technology companies in the future.[37]
Future scenario
Research conducted by IHS Markit in 2018 predicted that **more than 33 million autonomous vehicles will be sold globally in 2040** (meaning that 26% of new cars will have autonomous mobility by that year), with the first substantial increase in the volume occurring in 2021.[38] A study conducted by Victoria Transport Policy Institute in 2019 investigated how quickly self-driving vehicles are likely to be developed and deployed based on experience with previous vehicle technologies, their benefits and costs. The analysis indicated that some benefits, such as more independent mobility may begin in the 2020s or 2030s, but **most impacts** such as reduced traffic, parking congestion and therefore infrastructure savings, increased safety, energy saving and reduced pollution will only be significant when AVs become common and affordable, probably **in the 2040s to 2050s**. In addition, some benefits may require prohibiting human-driven vehicles on certain roadways, which could take even longer.[39]

Market readiness
When it comes to CAVs, solutions exist at the “Ideation” and to some extent at the “Testing” market readiness level. Many governments (e.g. USA, UK, China, Germany and Australia) have been developing plans and guidelines for the introduction of CAVs. In terms of the **readiness of the road network**, developers like Google and Tesla are talking about developing self-driving vehicles that can run effectively on existing infrastructure and using existing static communications, therefore not requiring a significant amount of infrastructure change. Meanwhile, other stakeholders have been more cautious by warning that self-driving vehicles could cause different operational problems and arguing for better vehicle connectivity. It is argued that **infrastructure change** will need a 30-year planning. Therefore, CAVs are unlikely

[36] https://www.economist.com/special-report/2018/03/01/self-driving-cars-will-require-new-business-models

[37] https://www.cnbc.com/2019/07/01/autonomous-vehicles-face-two-challenges-technology-and-business-model.html

[38] https://technology.ihs.com/599099/autonomous-vehicle-sales-to-surpass-33-million-annually-in-2040-enabling-new-autonomous-mobility-in-more-than-26-percent-of-new-car-sales-ihs-markit-says

[39] https://www.vtpi.org/avip.pdf

to develop to their fullest potential without planning by transport policymakers, planners and engineers to ensure that infrastructure change is adequate.[40]
Market positioning
Among the major players in the rapidly growing CAV industry are companies such as **Tesla, Uber** and **Alphabet**. However, a number of **auto brands**, **start-ups** in auto tech market, large **corporations**, big **technology brands**, **telecommunications companies** and other investors are also investing in autonomous R&D. In 2019, **Amazon** announced their investment in **Rivian**, a competitor to Tesla, and in **Aurora**, an independent automotive startup.[41] Since 2018, **Apple** has been building out the beginnings of its self-driving car fleet, with 66 vehicles officially on the road as of July 2018. It was also reported that Apple was working to provide autonomous cars for employee transit between corporate facilities. **Audi** has revealed several autonomous vehicle prototypes derived from its A7 and RS 7 models, including consumer-oriented test vehicles. Together with **Daimler** and **BMW**, Audi is part of the German consortium that bought Nokia's HERE precision mapping assets, which has designed an open specification for vehicle sensor data collected and transmitted to the cloud by connected vehicles. In July 2017, Audi unveiled its new flagship A8, which at the time it was the first vehicle in production that could actually allow its users to "drive" hands-free. **Mercedes** has also been taking other steps toward self-driving cars by deploying semi-automated advanced driver assistance systems to many of its newer models. **Bosch**, one of the world's largest automotive suppliers, has dedicated more than 2,000 engineers to driver-assistance systems. The company is also partnering with GPS maker TomTom for the mapping data necessary for this endeavor. **Samsung** has been testing self-driving cars on South Korea's public roads. Their self-driving cars are based on Hyundai vehicles equipped with cameras and sensors. [42]
Market maturity
The AV market is driven by several factors such as increasing efforts from governments as well as consumers to ensure road safety and to develop CAV infrastructures, which boost the demand for a reliable transportation system. In addition, increased government focus boosts **market growth**. Moreover, factors such as increasing focus on vehicle platooning, a transition from car ownership to MaaS, and revenue generation opportunity for different layers of the automotive ecosystem is expected to create opportunities for the market growth. However, factors such as reliability issue with the AVs, inadequate infrastructure, cybersecurity threats due to increasing data, etc. limit the market growth.[43]

Cybersecurity

[40] Johnson, C. 2017. Readiness of the road network for connected and autonomous vehicles https://www.racfoundation.org/research/mobility/readiness-of-the-road-network-for-connected-and-autonomous-vehicles

[41] https://hackernoon.com/competition-in-the-autonomous-vehicle-industry-is-heating-up-22524d71ca5

[42] https://www.cbinsights.com/research/autonomous-driverless-vehicles-corporations-list/

[43] https://www.prnewswire.com/news-releases/global-autonomous-vehicle-market-to-2028-increasing-focus-on-vehicle-platooning--transition-from-car-ownership-to-mobility-as-a-service-maas-300809220.html

The risks associated with hacking AVs and surrounding infrastructure is high and could be motivated by a number of reasons (such as terrorism threats, ransom, etc.). The risks related to cybersecurity are two-fold. First, there is a **risk of a third party taking control of the vehicle or infrastructure**, causing a major collision or other security threat. The second risk is related to **access to an individual's personal information**, such as biometric information used to lock and unlock vehicles through facial recognition software that could be hacked and used for other applications, such as logging into bank systems, etc. In order to mitigate cybersecurity risks, contractual frameworks should contain strong protection for valuable and safety-critical data and systems. In this sense, government should play a key role in driving the best practice by developing guidance and coordinating cyber security information sharing.[44]
Data
Beside the machine-learning aspect of AVs, the incoming data that enable vehicles detect hazards and respond accordingly is a crucial element. **Data collection and storage** can substantially influence the pace of development of AVs. Autonomous test vehicles generate between 5TB and 20TB of data per day, per vehicle, which includes cameras, as well as sonar radar systems and GPS. The main challenge for manufacturers is to ensure that sensors are collecting the right data and that it is processed immediately, stored securely and transferred to other technologies in the chain. **5G** represents an enormous potential for the data volume of autonomous vehicles, as it allows data transfer without wide area network coverage. Thus, industry experts believe that autonomous driving will not be truly achievable without 5G.[45]
Safety
As pointed out by the European Transport Safety Council, many crashes that involve human error also involve other factors that may still lead to a crash, such as errors linked to poor roadway design or faulty vehicle and interface design. In addition, **non-driver-related errors** (errors made by pedestrians or cyclists) must also be taken into account, and since they won't be automated, these errors are not expected to be eliminated by automation. In the short and medium term, **AVs safety failures** may actually cause collisions that would not have otherwise occurred (such as previously mentioned fatal crash involving a prototype Uber vehicle which occurred while the safety driver responsible for monitoring the system was distracted). AVs safety systems that actively assist the driver with the full attention of a human may therefore be a better short-term solution in terms of safety concerns.[46]
Ethics
The main ethical issue raised in relation to CAVs is the **moral dilemma**, in which a fatal collision is imminent and a vehicle must, based on its prior programming, 'choose' who to save, whether the passengers or external parties such as pedestrians.[47] In 2016, MIT launched the Moral Machine, an online survey that asks people variants of the trolley problem to explore moral decision-making regarding AVs. The experiment presents volunteers with scenarios involving driverless cars and unavoidable accidents endangering various combinations of pedestrians and passengers. The participants had to decide which

[44] https://www.lexology.com/library/detail.aspx?g=07517404-4169-4e11-86ab-c56bb376653c
[45] https://iotnowtransport.com/2019/02/12/71015-data-storage-key-autonomous-vehicles-future/
[46] https://www.governmenteuropa.eu/autonomous-vehicle-safety-ongoing-concern/91624/
[47] https://publications.parliament.uk/pa/ld201617/ldselect/ldsctech/115/115.pdf

lives the vehicle would spare or take based on factors such as the gender, age, fitness, etc. The researchers gathered nearly 40 million decisions from 233 countries worldwide over the period of 18 months. They found out that a number of moral preferences was shared across the countries, including saving the largest number of lives, prioritising babies in strollers, children and pregnant women, and valuing humans over animals. However, the results also showed that there is **no universal ethics** across different cultures. For instance, participants from Latin America as well as France and its overseas territories strongly preferred sparing women, the young and the athletically fit. Moreover, in developed countries with strong laws and institutions, jaywalkers were saved less often than people who obeyed traffic laws. The scientists also found **controversial moral preferences**, for example, overweight people being more likely to die than fit people, or homeless people having 40% greater chance of dying than executives.[48]

Example
EasyMile is a high-tech startup specialised in providing both software powering autonomous vehicles and the last mile smart mobility solutions. The company is headquartered in Toulouse (France) with offices in Singapore and Denver (USA).[49] They are developing in particular driverless electric shuttles (robo-taxis). Their battery-powered **autonomous electric bus EZ10** seats up to six people and allows four more passengers to ride standing, or can accommodate a wheelchair, with the aim of helping to bridge the first mile/last mile of a trip. It has been deployed in more than 30 cities and 16 countries.

7.1.2 Passenger urban air mobility

Technological
Urban air mobility can contribute positively to a multimodal transport system.[50] It refers to the use of aerial autonomous vehicles or vertical take-off and land (VToL) vehicles to transport people living in populated urban areas. There are three key technologies that influence the successful implementation of urban air mobility. • Advanced automated technologies: an automated system is essential for the success of urban air mobility. It can detect external environment and automatically calculate the best and safest route for passengers. This automation needs to be cost-effective in order to make urban air mobility affordable to potential passengers. • A dedicated 5G network: the use of 5G technology is crucial for future air traffic control.[51]

[48] https://www.insidescience.org/news/moral-dilemmas-self-driving-cars
[49] https://www.crunchbase.com/organization/easymile
[50] Airbus Urban Mobility
[51] Urban Air Mobility Will Not Succeed Without a Dedicated 5G Network

• Infrastructure: Taking urban transportation to the sky require robust and integrated city infrastructure, such as weather and GPS satellite, uninterrupted power supply, and vertiport.[52] In addition, fast charging infrastructure is needed for urban air mobility because most VToL will be E-VToL in the future. Without the support of well-developed infrastructure, the implementation of urban air mobility will become less possible.
Social and behavioural
Urban air mobility will contribute to the sensitive population groups. For example, E-VToL might be used for transferring elderly or disabled people to the doctors and hospitals. The national government might also use it to connect rural and suburban areas to urban areas. Since urban traffic congestion significantly influences people's daily life. urban air mobility is also a solution for future transport. It might address the emerging social needs of residents and travellers in urban areas. Moreover, the arrival of urban air mobility will bring substantial change to business and tourism travellers. These travellers care more about the time and convenience rather than the cost of service. In the case of elderlies and emergencies, the scenario of the government to subsidise such services could be explored. In the case of business travellers and tourists, it is expected that this transport mode will be too expensive and as such refer to a very specific population group who have high willingness to pay.
Operational
A recent report suggests that around 100 000 passenger drones would be in operation in 2050 in about 100 cities worldwide (with 1000 passenger drones in operation in each city)[53]
Business
The urban air mobility market is projected to grow at a rate of 16.2% by 2030, to reach USD 7.9 billion in 2030 from USD 3.1 billion in 2023.[54]
Future scenario
It is important to have a robust city infrastructure and adaptive regulatory framework to support the implementation of urban air mobility. In 2040, urban traffic congestion may be mitigated if most of urban cities have adopted suitable business models for urban air mobility.

Market readiness
MaaS markets are already in place in some locations, but their development is at different stages. Some solutions exist at a "TESTING" state, such as the Communauto/Bixi project in Quebec, where some public transport companies are proposing packages including also bikesharing and carsharing. The more advanced solution is that of WhimAPP in Helsinki, at "TRACTION" level.

[52] Infrastructure barriers to the elevated future of mobility
[53] Roland Berger
[54] Reports and Data

Still, the development of MaaS platforms is limited in its territorial scope and also in its diversity of supply. The main barrier is the lack of interoperable databases, namely the main infrastructure that MaaS relies on. Indeed, the development of complex journey solutions require a huge amounts of transport data, including fares. The other main barrier is the reluctancy of transport operators to coexist (and cooperate) in the same platform, as they consider themselves as competitors. Thus, proper public policy could help developing proper infrastructures also by obliging operators to share their data, as well as proper developed MaaS platforms would be attractive for operators. The shift from a car-owning to a ride-sharing paradigm will boost for the development of MaaS marketplaces. Also, the regional factor could play a vital role: Metropolitan areas, where owning a car is not a suitable solution for transportation, are fertile contexts where MaaS paradigm can evolve. In this vein, moreover, in some regions such as the Scandinavian area, commuters are used to use public transportation and other transport services more than owned vehicles. On the other hand, some remote inner areas would not be suitable for the development of MaaS systems.
Market positioning
MaaS is a new market. The ecosystem is mainly composed by transport operators, platform providers and insurance companies. Whereas public transport companies play the leading roles, the major actors are ride-sharing companies. The key players are BMW Group (Germany), Alliance Corporation (Canada), Apple Inc. (U.S.), Xerox Corporation (U.S.), Lyft, Inc. (U.S.), Uber Technologies Inc. (U.S.), MaaS Global (Finland). (Germany), Daimler AG (Germany), and Communauto (Canada)[55]. The provision of tailored and multimodal journeys solutions by using a single app represent the main competitive advantage of MaaS.
Market maturity
MaaS solutions are positioned in different stages of market lifecycle depending on regional areas. In some areas of US and Canada, MaaS systems are in development, as stakeholders are formulating new solutions combining public and private transport offers. In Helsinki MaaS is growing, with local authorities adopting new policies to enable an evolution of the system and drafting regulations to allow a sustainable development for the city and the commuters.

Cybersecurity
Cybersecurity is critical to the implementation of urban air mobility.[56] An integrated cybersecurity strategy (e.g., firewalls, encryption support, and network security mechanism) is required to avoid potential cyber-attack.
Data

2. [55] Market Research Future, Mobility as a Service Market Research Report- Forecast 2023.
[56] Urban Air Mobility Market Study

Data is critical for urban air mobility. Firms need to collect big data and conduct different analyses to identify the transport pattern and help make real-time decision.
Safety
Safety is an issue for urban air mobility. Therefore, other supporting technologies need to be developed, in addition to core technologies for urban air mobility.[57]
Ethics
Ethics issues need to be addressed by local, national governments as well.

Example
Uber is one of the leading players in the air mobility race. It established UberAIR, which is a platform that offers a drone hailing service for individuals. UberAIR will work in a similar way as UberX and UberBLACK. Uber will use the big data collected from their existing ride hailing app to determine the hub locations, platform size, and minimum ground time. This service is expected to be launched in Tokyo, Osaka, Mumbai, Delhi, Bangalore, Melbourne, Sydney, Rio de Janeiro and Paris.[58] There are other urban air mobility services are developed now, such as Airbus urban mobility, SkyGrid, and Aeromobil.

7.1.3 Drone last mile delivery

Technological
Drones rely on several sophisticated technologies, but many of these still have to be improved so that drone delivery becomes a common practice: • Autonomous flight: even if some drones are already able to fly without the support of a user who controls his route, this technology is not yet consolidated. Currently the most mature unmanned-aerial systems (UAS) applications involve short-range surveillance and associated photographs or videos. All drones that travel further the operator visual line of sight require unmanned traffic management (UTM)[59]. Recently the Federal Aviation Administration (FAA) and UAS stakeholders created the Low Altitude Authorization and Notification Capability program, which provides UAS with access to controlled airspace near airports by processing airspace authorizations at low altitudes in near real time[60]. • Battery performance: the energy density of lithium-ion batteries is growing by 5 to 8% every year and their lifespan is expected to double by 2025. This improvement will allow delivery drones to fly for more than an hour without recharging.

[57] Urban Air Mobility: on the path to public acceptance
[58] UberAIR
59 a system of radar, beacons, flight-management services, communication systems, and servers that coordinate, organize, and manage all UAS traffic in the airspace
60 Air-mobility solutions: What they'll need to take off (McKinsey&Company), 2019

• Detect-and-avoid technologies: these systems, which help drones avoid collisions and obstacles, are not yet mature; drones currently available have such systems but are still unsophisticated. Strong solutions are expected to emerge by 2025. Location technologies: drones must be able to identify their position even in areas where GPS signals are limited, such as densely built cities and remote locations. The widespread rollout of a GPS alternative is more than ten years in the future.
Social and behavioural
A survey[61] on a total sample of 1465 Americans reveals that the majority of the population (44%) is in favor of the idea of drone delivery, against 34% unfavorable, while 23% say they are still undecided. Analyzing the reasons why Americans still do not trust drone technology, drone malfunction is the public's primary concern (46%) - far more than fears about intentional misuse (14%). In terms of generations, young people are more likely to accept the new delivery service: 65% of interviewed millennials say they are favourable, against just 24% of Baby Boomers. It also emerged that the people who had previously seen or heard about the drone delivery concept are more inclined to accept the idea (75%), compared to those who had never heard of it (24%). The services that arouse the most interest are, in order: One-hour delivery; Delivery in cases of emergency; Delivery to hard to reach locations (mountains, islands, etc); Delivery to wherever I am, not just my home; Delivery to remote locations where few people live; Sunday delivery; Evening delivery.
Operational
Companies view the delivery drones as an opportunity not only to increase the speed of delivery for customers but to also increase the safety and efficiency of the overall transportation system by reducing road traffic. Delivery drones find application also in the field of food delivery, as in the case *Domino's*, whose drones have a delivery radius of 1.5 km[62]. As for other application for small goods delivery, in 2017 DHL started a trial in Tanzania using a Wingcopter to fly medical supplies from Mwanza, on the shores of Lake Victoria, some 60km to a clinic on Ukerewe Island. The drone journey took 40 minutes, compared with six hours by road and ferry. In June 2019 Amazon executive Jeff Wilke presented its delivery drone; drones will be able to fly up to 15 miles and deliver packages under five pounds to customers in less than 30 minutes. According to Wilke, despite the limited load capacity, between 75 and 90% of Amazon deliveries could technically be handled by the drone. Overall, the use of drone can be a reasonable solution to reduce traffic congestion and pollutions in small goods delivering, as well as to reach rural or remote areas.
Business
Drone delivery could allow companies to bypass the many problems related to the last mile segment. On the one hand, e-commerce companies want to cut costs and delivery times; on the other hand, logistic service providers are accelerating experiments with drones, not being overwhelmed by start-ups and technology companies that see the drone delivery as an

61 Office of inspector General - United States Postal Office, Public Perception of Drone Delivery in the United States, RARC Report, Report Number RARC-WP-17-001, October 11, 2016

62

opportunity to access this market[63]. In any case it is estimated that the adoption of drones in companies is set to increase and it is estimated that worldwide drone deliveries will increase with a compound annual growth rate of 66.8% (CAGR) between 2017 and 2023 to reach 2.4 million, but a mainstream adoption will take place as regulations are put in place and drone technology improves[64].
Future scenario
A report of European ATM Master Plan[65], estimates that by 2035, skies will be about ten times more crowded with the most flying hours performed by drones operating beyond line of sight (BVLOS) in all environments using U-space[66] to deliver several kinds of services: inspection of critical infrastructure, deliveries, cargo freight, transport of people / air urban mobility, precision agriculture, etc. Another research[67] highlighted how investment in autonomous flying aircraft is accelerating (including ultra-efficient batteries, autonomous systems, and advanced manufacturing processes). It estimates that autonomous urban aircraft could become a $1.5 trillion industry by 2040. This would pave the way for delivery drone to become a widespread reality, since, with respect to the transport of people, the transport of goods has lower degree of technological barriers (weight, size, etc.) as well as fewer regulatory hurdles.

Market readiness
Some companies such as Amazon, Google, UPS, DHL have tested drone delivery since 2005. Australia's Civil Aviation Safety Authority (CASA) recently gave approval to Wing - a Google-funded start-up to deliver packages via drone, after a trial of the service proved successful. Therefore the technological level is already sufficient to guarantee the service so the Technological Readiness Level is 9 even if further progress is being improved and developed (e.g. battery performances and Detect-and-avoid technologies). From the market point of view it can be stated that the Market Readiness Level of the delivery service with drones, in its most advanced applications (which can be observed in the countries where the civil aviation authorities have authorized the service), is 6- Proof of traction, as consistent feedback from customers does not yet seem to be available. However, some questions regarding the adoption of drones for delivery services have been raised, for example concerning the need to relocate or build new distribution centres closer to customers. Currently a drone can travel at a maximum distance of 24 km. The economy of delivery services depends, among other factors, on the number of deliveries that can be made during each run. At least for now, drones are not capable of making many deliveries in one run, so companies would need a large fleet to guarantee the quality of the service. In any case, numerous investments and researches seem to show that the industry is seriously considering this delivery alternative: for example, Amazon

[63] Jonathan Camhi, Business Insider, The Drone Delivery Report : Opportunities and challenges in automating logistics with drones, May 18, 2017

[64] Ayoub Aouad, Business Insider, Delivery companies are embracing drone technology, Jun. 1, 2018

[65] https://www.sesarju.eu/sites/default/files/documents/reports/European%20ATM%20Master%20Plan%20Drone%20roadmap.pdf

[66] U-space is a set of new services that rely on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones

[67] https://www.morganstanley.com/ideas/autonomous-aircraft

Technology Inc. has just patented a fulfilment centre designed to accommodate landing and take-off of unmanned aerial vehicles in densely populated areas (called drone-beehive).
Market positioning
Drone delivery is a new market. The main players in the delivery drones market are big companies such as Amazon (U.S.), United Parcel Service (U.S.), JD.com (China), Uber Technologies Inc. (U.S.), EHANG (China), DJI (China), Skycatch Inc. (U.S.), Airbus S.A.S (France), Zipline International Inc. (U.S.), Alibaba (China), Flirtey (U.S.), FedEx Corporation (U.S.), and Google (U.S.). On the other hand, it is worth emphasizing that several public sector entities also perceive the idea of delivery by drones as a potential opportunity. Numerous national post enterprises entered partnerships with start-ups specialized in delivery services by drones and launched pilot projects. Remaining in the public perspective, the construction of tailored drone distribution centres could enable joined delivery systems where different freight carriers could cooperate to jointly deliver goods to customers and potentially also collect from retailers.
Market maturity
From a combination of technological progress and economic activity, according to Giones and Brem (2017)[68] UAVs for small package deliveries is still in the first stage of the path to industry: the concept validation phase. However at the moment several pilots have been placed and Drone Company Wing, part of Alphabet/Google, has just received regulatory approval to make drone deliveries in Australia. US authorities have followed suit by granting Wing approval as a commercial airline in the US.

Cybersecurity
Spoofing' consists on sending of a fake GPS signals, so that it is "hijacked" from its programmed path. The consequences of the "spoofed" drone would be attributed to the drone operator since it is very difficult to prove the origin of the navigation signals. But, while the "spoofing" problem is solved by the encryption used in the military GPS, the drone's GPS navigation unit remains vulnerable to "jamming". In a jamming attack, the drone is overwhelmed with signals to the GPS antenna. In this scenario, involuntary collisions seem to be inevitable, especially in an unregulated environment. Several incidents have occurred without the persons responsible being identified.
Data
The information transmitted by cameras and sensors on drones operating in the consumer space may be valuable to attackers and easier to target. If a drone is attacked, it is difficult for the owner to guarantee information security. This raises the question of airspace over private property and about the standards and expectations of its protection. In public spaces such as parks or streets, but also in private property that is visible from public spaces (e.g. swimming pools, people in the pools, or even peeking through windows), there is no legal basis for submitting a request for infringement of privacy as long as the view is limited to eye level. Drones disregard expectations of reasonable privacy since they operate in a public place. Yet,

[68] Giones, F. and A. Brem (2017) From toys to tools: The co-evolution of technological and entrepreneurial developments in the drone industry, Business Horizons, 60 (6) 875–884

drones can capture videos and sounds that aren't traditionally available to the public[69]. Specific regulations on drone use would be necessary. In this vein, data protection authorities could undertake regulatory instruments meant to specifically deal with the use of drones in publica spaces.
Safety
Currently, the use of drones in civilian airspace has raised several concerns regarding the fact that small mistakes could result in crashes that threaten the health, well-being and property of the public. Furthermore for the delivery service it is necessary to consider not only the safety of the drone but also of the load; intentions of the drone operators have been questioned, as at the moment, there is no regulation that controls the payload that is transported on the drones.
Ethics
The main ethical issues of using drones for deliveries concern the acquisition and security of information transmitted by cameras and sensors (please see the "Data" section).

Example
An interesting application of drone delivery is that of Reykjavik In August 2017 AHA a supplier which delivers on behalf of restaurants and shops in Iceland's capital, started a drone delivery service across Elliðárvogur, an inlet that divides Reykjavik from its eastern suburbs. The flight took four minutes instead of the 20 or more required to drive around Elliðárvogur. Iceland's transport authorities authorized them to run 12 other routes across Reykjavik, including journeys over land. Currently, if weather conditions are favourable, customers (who must first obtain permission from neighbours for flights to pass overhead) can order goods using the online app and be served by a drone: the drone is loaded by a company employee, who dispatches the craft after entering the destination using a hand-held device. The customer gets a message to say the drone is on its way and can use the app to follow its progress on a map. When it arrives, the customer enters a pin into the app to accept delivery and the drone lowers its package on a line[70].

7.2 INFRASTRUCTURE, NETWORK and TRAFFIC MANAGEMENT

7.2.1 Big data for fleet management and logistics

Technological
The rapidly changing customer demands and preferences are creating new demand patterns for the commercial freight transportation and logistics industry. Fleet operators can have major gains from advanced analysis of the data collected from the vehicles in their fleet, such as location, mileage, fuel consumption, driving behaviours, in order to **improve fleet**

---

[69] The societal impact of commercial drones, Bharat Rao, Ashwin Gopi, Romana Maione, NYU Tandon School of Engineering, Brooklyn, New York Article in Technology in Society · May 2016

[70] Commercial drones are here: The future of unmanned aerial systems (McKinsey&Company), 2017

management but also to **eradicate vehicle misuse by drivers**. On the other hand, the major obstacles are the large amounts of data generated, and the various formats in which they are provided.[71]
Social and behavioural
When it comes to behavioural aspects, big data provides fleet managers with the capability to better **understand the behaviour patterns of drivers** thanks to sensors installed in fleet vehicles which provide data on how drivers typically use their vehicles. This allows them to identify unsafe behaviour, such as speeding or accelerating aggressively.
Operational
The use of big data allows fleet managers to **optimise** their **fleet's efficiency, productivity, and safety** while reducing costs for the company. The use of predictive analytics enhances safer working conditions for drivers, as well as maintenance and repair scheduling for fleets, leading to a reduction in overall costs and avoiding expensive repairs later on. It also allows fleet managers to monitor the total fuel costs as well as how fuel is being used, therefore allowing them to make improvements to **increase efficiency of fuel consumption**.[72] From the point of view of **national authorities**, data access and data use is also very useful to improve **efficiency of operations** in order to enhance road safety and help enforcement authorities to fight against frauds and abuses.
Business
The big data extracted from trucks not only allows the OEMs to cut their costs and improve efficiency of the fleet, but also help fleet customers generate more revenue by enabling them to understand how their vehicles are being used, and reduce their operational costs based on these insights.
Future scenario
In the future, **Artificial Intelligence** may be the key to better process and understand large amounts of data generated in various formats. Novel **machine learning** techniques and **advanced big data analytics** could process and analyse data to automatically learn the normal behaviour of the vehicles, drivers and fleet, in order to detect cyber threats and other issues such as fraud attempts. In addition, machine learning could automatically highlight other important alerts, such as car theft, vehicle misuses, etc.[73]

Market readiness
Fleet management and e-commerce companies as well as other businesses have been investing into using big data to gain insight into their businesses and their customers, in order to optimise their processes and customer experience. Some solutions have been developed and exist at the "Traction" market readiness level. One example is **LUCA fleet**[74], developed by the big data unit of Spanish multinational Telefonica. The solution aggregates and analyses fleet's data based on frequent routes, consumption, driving behavior, POIs (points of interest)

[71] https://www.upstream.auto/blog/artificial-intelligence-and-automotive-fleet-security/
[72] https://www.thomasnet.com/insights/big-data-and-the-new-fleet-management/
[73] https://www.upstream.auto/blog/artificial-intelligence-and-automotive-fleet-security/
[74] https://luca-d3.com/gestion-de-flota/index.html

or maintenance and allows client autonomy to use, consult and interpret the data. Another example is **TMT Predict** developed by a US-based company Trimable[75], which is a predictive maintenance application that enables fleet professionals to anticipate and address potential vehicle breakdowns and other unscheduled service needs before they occur. However, logistics has been a bit slower to implement the full potential of big data. According to Supply Chain Management World research, 64 percent of executives think **that big data and the insights it brings will have a major disrupting power**.[76] There is an increasing need from the customers for real-time updates on product availability, manufacturing details, delivery dates, etc. In this sense, big data analytics help trace changes in customer behaviour and foresee their manufacturing preferences. This enables companies to expand their operation, simplify distribution, prevent risks, achieve faster shipments, etc. Powered by AI algorithms, logistics companies are able to get more insights into products, freight shipment methods, shipment locations, and more.[77]
Market positioning
Amazon as the e-commerce giant has been investing in pioneering technologies disrupting the retailing and online retailing, including the use of big data in their fleet management operations. With using big data for an improved customer service and offering remote computing services via their Amazon Web Services (AWS), Amazon has moved away from a pure e-commerce player to a major big data company. A Chinese multinational e-commerce company **Alibaba** has also been focusing on big data to expand market growth and build logistics networks to reach even remote rural areas. It has been reported that Alibaba plans to handle 1 billion parcels per day and do 24-hour delivery across China and 72-hour delivery internationally, due to the correct big data usage.[78] **UPS** offers an illustration in terms of route optimisation through the use of big data. One of their initiatives helps them to optimise its logistics network through the effective use of data, by using real-time data, advanced analytics and artificial intelligence to help employees make better decisions. They have been investing in ORION (On-road Integrated Optimization and Navigation), a fleet management system which uses telematics and advanced algorithms to create optimal routes for delivery drivers.
Market maturity
When it comes to the use of big data in logistics, there is a huge untapped potential for improving operational efficiency and customer experience, and creating useful new business models. One example is **integration of supply chain data streams** from multiple logistics providers which could eliminate current market fragmentation and powerful new collaboration and services.[79]

[75] https://enterprise.trimble.com/about-us/events-news/trimble-transportation-introduces-predictive-maintenance-analytics-help-fleets
[76] https://transmetrics.eu/blog/6-ways-improve-logistics-performance-big-data-guest-article-youredi/
[77] https://www.innovecs.com/ideas-portfolio/impact-of-big-data-on-logistics-and-supply-chain/
[78] https://www.innovecs.com/ideas-portfolio/impact-of-big-data-on-logistics-and-supply-chain/
[79]http://tdan.com/transforming-logistics-using-big-data/22808

Cybersecurity
When it comes to cybersecurity, security requirements are mainly contractually imposed by customers using predictive analytics solutions wanting to protect their data. **Hacker attacks** with the aim of vehicle theft or theft of personal data, for example, are one of the main risks. There are also safety risks in terms of **driver distraction** which can arise if external third parties have uncontrolled access to vehicle's on-board systems and user interfaces. Direct uncontrolled access to the data inside a vehicle or a truck might also lead to unintended consequences from the installation of additional **software** that could potentially cause a serious **malfunction** or even a crash of the system.[80]
Data
A key element for the companies developing big data solutions for fleet management and logistics is to have **more real-time data**, typically **vehicle data**, from OEMs. This data is privately held by the OEMs, and usually only granted access to under strict conditions. In the same manner as in the EU, data sharing agreements provide the only solution to govern access to and/or exchange of data between the numerous stakeholders active in the big data value cycle. This can present issues, as one of the conditions that is often contractually imposed by the data-sharing company is the siloing of data. This hinders optimal efficiency and use of the big data analytics platform. **Opening up of data** enables the companies to innovate and access resources which they would otherwise not be able to access and eliminates a barrier to market entry.[81]
Safety
As already mentioned, in terms of safety, big data allows fleet managers to enhance safer working conditions for drivers by anticipating technical problems with vehicles or predicting road conditions, but it also allows enables fleet managers to **identify unsafe driver behaviour**. Telematics devices which are plugged into a vehicle's onboard computer network report on a driver's performance: frequent harsh braking, for example, may signal distraction or speeding. Fleet managers can use these insights to coach their drivers accordingly, and therefore contribute to the overall road safety.
Ethics
Trust, privacy, surveillance, free will and transparency are some of the main ethical and societal issues pertaining to the use of big data in transport. In terms of big data analytics solutions, one of the main risks is related to **confidence**, i.e. will the end-user be confident about the data and the predictive model a company is producing. The GDPR has had a considerable impact in the domains of **privacy, transparency, consent, and control**. The strengthened legal framework is likely to respond to several ethical issues and thus improve end-users' trust in the use of personal data in a big data context. **Free will** is another issue related to the use of big data and while it is possible that big data-driven profiling practices can limit free will, a huge part of what we know about the world, comes from data analysis. Careful and appropriate information analysis can open up plenty of chances and might reduce the limitations and problems for free will. In addition, the huge amount and diversity of data and data sources provide lots of new

[80] https://cardatafacts.eu/risk-direct-access-car-data/
[81] https://lemo-h2020.eu/newsroom/2019/6/30/deliverable-32-case-study-reports-on-constructive-findings-on-the-prerequisites-of-successful-big-data-implementation-in-the-transport-sector

opportunities but at the same time poses many challenges for online **trust**, notably in the context of transportation.[82]

Example
An American company **Kepler51** has been using advanced predictive analytics technologies to build a real-time logistics tool to increase the efficiency of delivery vehicles. Their big data solutions - **the LiveRoad Geospatial Analytics Platform** - allows for the real-time monitoring and forecasting of risks and delays based on a range of factors (such as weather, temperature, road conditions, departure time, historical analysis, etc.), in order to dynamically route or schedule vehicles for efficient movements.

7.2.2 Traffic Management 2.0

Technological
The traffic management 2.0 (TM2.0) is an innovative platform that was created in 2014 by ERTICO, an organization aiming at promoting and accelerating the Intelligent Transport Systems in Europe. The objective of this platform is to create a Collaborative and Interactive Traffic Management System, by developing synergies between the public authorities, the private service providers and the drivers. “The TM 2.0 concept is based on the: • Provision of individual communication channels between TMC’s and road users/service providers; • Development of a new interface for data exchange between TMC’s and service providers, necessary for individual and collective traffic information and signage; • Cooperation and information exchange with other transport modalities; • Development of (new) business cases with benefit to all stakeholders”[83]. Since 60s, many initiatives have been setup in order to deal with traffic management (TM)[84], from the first guidance highway programmes in the beginning of the 70s which led to the first Traffic Management Centers to the current innovations brought by the development of Intelligent Transport Systems (ITS) due to the digitization of market sectors. Nowadays, mobile applications such as Waze, Google Maps, etc. provides alternative route guidance relying on drivers’ data, while public authorities deliver traffic management plans and inform drivers according to data collected from sensors that are installed on the road :

[82] https://static1.squarespace.com/static/59f9cdc2692ebebde4c43010/t/5d18a8b71d31a90001351d17/1561897187100/20190630_D3.2_Consolidated+case+study+findings_LeMO.pdf

[83] Contractual Agreements in Interactive Traffic Management – looking for the optimal cooperation of stakeholders within the TM 2.0 concept, Tiffany Vlemmings & al., *Paper number ITS-TP0785*

[84] http://www.panorama-ifpen.fr/systeme-de-transport-intelligent-mobilite-3-0-definition-enjeux-acteurs/

- Sensing and surveillance technologies[85], used to assess the number of vehicles at a given time and place and their speeds the vehicles: video vehicle detection, inductive loop sensors to count vehicles, magnetic sensors, lasers sensors, ultrasonic sensors microwave radars and Automated vehicle identification systems.
- Communication technologies used to transfer data[86,87]: GNSS (Global Navigation Satellite Systems), with GPS and GALILEO (Europe) completed by the European Geostationary Navigation Overlay Service (EGNOS), roadside variable message signs, websites, social media, Global System for Mobile communication (GSM), etc.
- Information technologies, data processing and analysis
- Traffic control:

➲ Fixed-time control systems (plans are not real-time updated), systems with feedbacks (closed loop to have real-time implementation plan), adaptive traffic control system (SCOOT, SCATS, RHODES)[88]
➲ Systems with feedback: a closed loop is setup in order to have a real-time implementation plan or to highlight patterns in order to select a pre-developed one.
➲ Adaptive traffic control systems: SCOOT (Split, Cycle, Offset, Optimisation Technique), SCATS (Sydney Coordinated Adaptive Traffic Systems), RHODES, aiming at managing the traffic signal timing changes, relying on the gathered data on intersections.
➲ Public transport authority measure, giving priority to public transport vehicles at the intersections.
➲ Travel time assessment
➲ Traffic signal control
➲ Ramp metering
➲ Variable speed limits
➲ Queue tail warnings

The following table sums up the barriers and enablers regarding the advent of this new paradigm:

ENABLERS	BARRIERS
Many sensors and devices available	Lack of data interoperability
New communication channels (V2V, V2I)	Data security and reliability
Important subsidies from Europe (H2020 programmes for instance)	Data reliability
	Cooperation between public and private parties

Social and behavioural

[85] A Review of Sensing Techniques for Real-time Traffic Surveillance, D. D. Romero & al., *Journal of Applied Sciences 11(1)*
[86] https://civitas.eu/sites/default/files/civitas_ii_policy_advice_notes_12_traffic_visualisation_control.pdf
[87] https://rno-its.piarc.org/en/intelligent-transport-systems-its-technologies/data-and-information
[88] SCOOT= Split, Cycle, Offset, Optimisation Technique ; SCAT= Sydney Coordinated Adaptive Traffic Systems

London was the 6th most congested in the world in 2018, with 178 hours spent in traffic jams, representing a cost of 7.9 B$, according to INRIX Global Traffic Scorecard study[89]. This example highlights that traffic management has a direct impact regarding citizens' quality of life (fatigue, stress, irritability, accident risk increase) and consequently cities' attractivity and economy.
Real-time information and coordinated traffic management strategies are thus required to improve road traffic flows that will address these issues. This is the objective that is targeted to be achieved by TM2.0.
More reliable data will allow better guidance, thus leading to the reduction of congestion and sustainable behaviour change.

Operational

This cooperation model is very innovative in the way that no private-public partnership was setup regarding road traffic management. It is also very challenging on a technical point of view, as larger amount of data will be processed.

Business

Cooperation models aims at defining the best win-win partnership between private and public stakeholders. Private service providers can resell data to public authorities and other services related to data processing and visualization.

Future scenario

- 4 cities will be pilots for testing TM2.0 concept in the framework of the European project SOCRATES2.0[90]: Amsterdam, Copenhagen, Munich, Antwerp. This is a first step towards the deployment of this cooperation framework and new business model development.
- These pilots will be the first experience regarding C-ITS for network traffic management. The lessons that will be learnt from that will allow this cooperation model to be improved and deployed at a larger scale by 2040.

Market readiness

- This cooperation model is being tested in 4 tested in order to be ready for the market, thus the marketing readiness level up to 2.
- Main barriers regarding market readiness are economic: businesses must remain profitable, while keeping public interests.
- Lack of trust regarding private data sharing and processing is one of the main social and behavioural barriers.
- Ability and willingness of public authorities to buy in traffic flow data from third party sources
- However, addressing congestion issues that significantly degrade air quality, citizens' health is a main current challenge that incentivises initiatives such as TM2.0.

Market positioning

[89] file:///C:/Users/CarolineBusquet/Downloads/Traffic_Scorecard_Infographic_2018_UK_FINAL__v2_.pdf
[90] https://socrates2.org/

- Competition will happen for service providers when they will answer to public authorities' tenders regarding the choice of partners when local pilots that will be implemented. But TM2.0 is an initiative for cooperation models and not a new service provider. - The main players in the market are public authorities, vehicle manufacturers, data providers and data scientists. - Public authorities are the main customers regarding road traffic data. - This initiative will allow better reliance of data that are processed, thus leading to a better knowledge, real-time traffic guidance, which are competitive advantages compared to current situation. - Market positioning will rely on the success of TM2.0 pilots.
Market maturity
- Regarding the market lifecycle, TM2.0 is at an early stage: I-Introcuction/Development. - The pilots that will be implemented will allow the first feedbacks from customers. - This cooperation model will lead to a re-segmentation of the market, as data coming from guidance service providers (e.g. Waze, Google Maps, etc.) could be sold to public authorities, as well as usual service providers who are focused only on traffic assessment (e.g. Here), in order to provide better guidance. New business models have to be formulated and tested in order to find the most appropriate strategy for this re-segmentation.

Cybersecurity
- Cybersecurity is critical for road traffic management in order to prevent from data corruption and hacking. - Guidelines and recommendations are currently being suggested to stakeholders to define the best framework.
Data
- TM2.0 members[91] exchange data and are currently defining what type of data will be exchanges in order to perform a better traffic management, while keeping users' privacy.
Safety
- As a better road traffic management will lead to better traffic conditions, driving will be safer.
Ethics
- Guidelines and recommendations are currently being suggested to stakeholders to define the best framework.

Example
- TM2.0 is the example that was chosen, as the only case in Europe.

[91] https://tm20.org/members/

7.2.3 Hyperloop

Technological
A Hyperloop can be defined as an ultra-high-speed ground transportation system. It was proposed in 2013 by Elon Musk, cofounder of PayPal, Tesla Motors and founder of space transport company SpaceX[92]. Hyperloop is a new mean of ground transportation that is meant to carry passenger and cargo at speeds over 1000 km/h inside low-pressure tubes[93]. According to a report published by Elon Musk in 2013[94] Hyperloop consists of a low pressure tube with capsules that are transported at both low and high speeds throughout the length of the tube. The capsules are supported on a cushion of air, featuring pressurized air and aerodynamic lift. The capsules are accelerated via a magnetic linear accelerator affixed at various stations on the low pressure tube with rotors contained in each capsule. Passengers may enter and exit Hyperloop at stations located either at the ends of the tube, or branches along the tube length. Still according to the same report, the Hyperloop consists of several distinct components, including: - The capsules are separated within the tube by approximately 37 km on average during operation and are supported via air bearings that operate using a compressed air reservoir and aerodynamic lift. - The tube is made of steel. Two tubes will be welded together in a side-by-side configuration to allow the capsules to travel both directions. Pylons are placed every 30 meters to support the tube. Solar arrays will cover the top of the tubes in order to provide power to the system. - The propulsion. Linear accelerators are constructed along the length of the tube at various locations to accelerate the capsules. Rotors are located on the capsules to transfer momentum to the capsules via the linear accelerators. Right now, there are 6 companies in the world working on the technology of the Hyperloop including for example: Hyperloop Transportation Technologies (HTT), Virgin Hyperloop one[95], TransPod[96], Zeleros. State of art of technology of the Hyperloop is different per company and thus per country. Currently there is only one test rack existing in the world. This test rack was built by the American company Virgin loop one in the Nevada desert and it is 500 meters long, so far the highest speed recorded on this test rack is 240mph. Barriers: resolving continuing technical challenges (e.g. continuous straight line), developing a viable commercial model, and satisfying regulatory, safety and other stakeholder requirements[97].Enablers: Hyperloop is meant to be a cheap, green, safe and self-sufficient transportation mean. Hyperloops attracts investors.
Social and behavioural

[92] https://www.pcmag.com/encyclopedia/term/65934/hyperloop
[93] https://zeleros.com/hyperloop/
[94] https://www.gearbrain.com/what-is-elon-musk-hyperloop-2505477906.html
[95] https://hyperloop-one.com/our-story#hyperloop-technologies
[96] https://transpod.com/en/company/about-transpod/
[97] https://www.lek.com/insights/ei/hyperloop-challenges

A growing global economy requires faster, cheaper, safer and more efficient transportation modes. Roads, airports, and ports are congested. Hyperloop is meant to be is ultra-fast, on-demand, direct, emission-free, energy efficient, quiet and has a smaller footprint than other high-speed transport modes[98]. Hyperloop aim at changing our perception of distances and as a consequence to lead to less density in cities as current suburbs or suburban area would become more attractive living spaces. The goal of Hyperloop is to solve so called houses crisis happening in many big cities in the world. The impact of Hyperloop is expected to be more important for people leaving in large cities. The development of Hyperloop also risks to potentially increase inequalities between urban and rural areas[99]. But considering the level of development of the Hyperloop technology it is still difficult to evaluate precisely the social and behavioural impact of Hyperloop. Hyperloop technology present also critic features [100] which could generate a negative perception among potential commuters. One is that Hyperloop is vulnerable to not even elaborated terroristic attacks, since a single hole in the tube would be sufficient to be fatal for all passengers. Another issue is related to passengers comfort: Hyperloop as planes require initial and uncomfortable acceleration, but the latter require more time than the planes one.
Operational
The Hyperloop speed makes it innovative. It is meant to be as fast as a plane, faster than any high speed train but it would be a ground transportation mean. When Elon Musk conceived of the Hyperloop high-speed transport system in 2013, he estimated that a route from Los Angeles to the Bay Area would cost about \$6 billion, or \$11.5 million per mile[101]. In 2016 the estimated cost for Hyperloop One estimating the cost of a potential 107-mile Bay Area project to be somewhere between \$9 billion and \$13 billion, or \$84 million to \$121 million per mile. The route between Abu Dhabi and Dubai, which the company recently announced ahead of a new \$50 million round of funding, would cost \$4.8 billion, or \$52 million a mile.[102]
Business
The development of the infrastructure will receive financial support from taxes like any other public transport infrastructure - and the price of tickets will support the functioning cost. So far the price of a one way ticket is estimated at around 20\$. I is meant to work exactly like a metro lien.
Future scenario
Hyperloop technology is still in development even though the basic concept has been around for many years. At the moment, the earliest any Hyperloop is likely to be up and running is 2021[103].

[98] https://hyperloop-one.com/facts-frequently-asked-questions
[99] https://hyperloopconnected.org/2018/04/societal-impact-of-the-hyperloop/
[100] https://www.alphr.com/the-future/1008177/hyperloop-overhyped-underlooped
[101] https://www.vox.com/2016/10/26/13425592/hyperloop-one-elon-musk-cost-leaked-documents
[102] https://www.vox.com/2016/10/26/13425592/hyperloop-one-elon-musk-cost-leaked-documents
[103] https://www.zdnet.com/article/what-is-hyperloop-everything-you-need-to-know-about-the-future-of-transport/

Even after the development of a technically feasible and commercially viable system, some experts suggest that, due to regulatory hurdles, it could still take up to 20 years before a passenger Hyperloop route is in regular operation in North America or Western Europe. This implies a launch date no earlier than 2035-2040[104]. Virgin Hyperloop One - the firm has previously said that an operational system will be ready by 2021[105]. There are some suggested routes already such as Edinburgh to London (414 miles / 660 km) or Toronto to Montreal (400 miles / 640 km)[106].

Market readiness
Hyperloop is not ready for the market. The main technological barriers are interoperability, speed and safety. Also, whereas railways infrastructures are mostly implemented by states, it is doubtfully weather it would be the same for hyperloop tubes. From an operational perspective the barrier is the lack of testing possibilities. In this regard, moreover, a report of U.S.A. department of transportation states that uncertainty characterize both the infrastructure and the cost to construct it[107]. The main enabler for market readiness regarding Hyperloop is the fact that Hyperloop attracts investors.
Market positioning
Hyperloop is kind of alone in its segment. The only potential competition is with plane and high speed trains. The main player in the market is the Virgin Hyperloop One company[108]. The main customers targeted by Hyperloop are people leaving in big cities or suburbs and people who are frequent travellers for work. The main competitive advantage promised by the Hyperloop is the price it is meant to be way cheaper than planes and high speed trains. It is still a bit early to discuss a potential scale up but a cross border Hyperloop could potentially be foreseen.
Market maturity
Hyperloop is still at the introduction phase. The level of research is very high considering, as previously mentioned, the fact that several companies national and private are working on this project. There is no consumer testing yet as Hyperloop only has a very short test rack so far.

Cybersecurity
The only potential problem is if as mentioned earlier Hyperloop gets fully integrated within the transportation eco system and then there might be questions regarding MaaS and ticketing. Please refer to the MaaS section.
Data
The lack of pre-existing data regarding Hyperloop can be considered as a barrier.

[104] https://www.lek.com/insights/ei/hyperloop-challenges

[105] https://www.dailymail.co.uk/sciencetech/article-5069395/Hyperloop-won-t-ready-couple-decades.html
[106] https://www.dailymail.co.uk/sciencetech/article-5069395/Hyperloop-won-t-ready-couple-decades.html
[107] https://rosap.ntl.bts.gov/view/dot/32719
[108] https://hyperloop-one.com/

Safety
Safety is one of the main concerns regarding the feasibility of Hyperloop. Safety & security concerns of passengers are expected to hinder the market growth. For instance, single breach in Hyperloop can cause major damage, as air would rush into the tube at about the speed of sound[109]. There are no at-grade crossings, so there are no interactions with other forms of transport or wildlife. Hyperloops are fully autonomous, so there is no driver related error. Hyperloops are immune from most weather events and will have multiple emergency braking techniques, triggering an immediate braking of the vehicle. Vehicles will have a full suite of life support systems, and we have the ability to re-pressurize the tube if needed. Several Hyperloop companies have a dedicated safety team to work with regulatory authorities to define and implement best practice safety protocols[110].Hyperloop aim at being the safest transportation mean.
Ethics
There are two potential ethical issues link to the development of Hyperloop: The automatization depriving people from working e.g. drivers and sourcing magnets from ethical sources. The powerful magnets Hyperloop would be using require traces of rare-earth elements. Some strong rare-earth magnets use neodymium or samarium, which are significantly more powerful but more expensive than other permanent magnets made from iron ore, cobalt and nickel. Cobalt, combined with samarium to create a supermagnet, presents its own challenges given that cobalt mining relies on child labor[111] according to Unicef[112] and Amnesty International[113]. Another sensitive issue Is the one related to exclusivity. Especially in its use for interurban journeys, Hyperloop can be less affordable than normal subways or other forms of public transport, causing gentrifications and making more wealthy urban areas enclaves. That would be problematic where the implementation of Hyperloop infrastructures would be at expense of traditional railways.

Example
Zeleros in Spain is a Spanish Hyperloop company founded in 2016 and based in Valencia in Spain. Currently, the company is formed by a team of 20 engineers and doctors specialized in different fields, developing and testing the systems and subsystems of the Hyperloop integrators. Zeleros built Spain's first Hyperloop prototype with the support of Purdue University and a 12-meter research test-track in Spain at the university. Zeleros has the support of the Silicon Valley accelerator Plug and Play Tech Centre. In June 2018, the corporation signed an agreement with the rest of the Hyperloop European companies and the Canadian TransPod to collaborate with

[109] https://www.alliedmarketresearch.com/hyperloop-technology-market
[110] https://hyperloop-one.com/facts-frequently-asked-questions
[111] https://www.greenbiz.com/article/what-will-hyperloop-mean-climate-ecosystems-and-resources
[112] https://www.unicef.org/childsurvival/drcongo_62627.html
[113] https://www.amnesty.org/en/documents/afr62/3183/2016/en/

the European Union and other international institutions for the implementation of a definition of the standards to ensure the interoperability and the security of a Hyperloop. In September 2018, the corporation announced the construction of a 2 km test track to perform dynamic tests of the system. The Zeleros team was awarded "Top Design Concept" and "Propulsion/Compression Subsystem Technical Excellence" at SpaceX's Hyperloop Design Weekend. In November 2018, Zeleros received the international award in the World Transport Congress in Omán.

7.3 MaaS and Platforms

7.3.1 MaaS platforms

Technological
The MaaS Platform(s) is the IT structure that is used by the MaaS Operator(s) to provide the final service of mobility to the end-users. The MaaS Platform is split into two elements: the front-end and the back-end, all of which are made up of components developed by the IT Providers.[114] This platform manages all the data and functionalities needed for MaaS operators to offer services.[115] The MaaS platforms can be developed by MaaS operators or IT providers. In general, MaaS platform(s) has multiple functions (as presented in Figure 2): including 1) information and availability (e.g., information about mobility service providers and integrated transport service providers, journey details and location details), 2) journey planning (e.g., trip suggestions, route planning and time constrain filter), 3) booking and payment (e.g., management and cancelation of booking), and 4) reporting (e.g., aggregate reports to MaaS operators, to MaaS end-users, and to MaaS mobility service providers). To support these functions, relevant application programming interfaces (APIs), real-time data, and ICT infrastructure (e.g., mobile network coverage and smart ticketing infrastructure) needs to be available.

[114] MaaS Dictionary
[115] Mobility as a Service (MaaS) and Sustainable Urban Mobility Planning (SUMP)

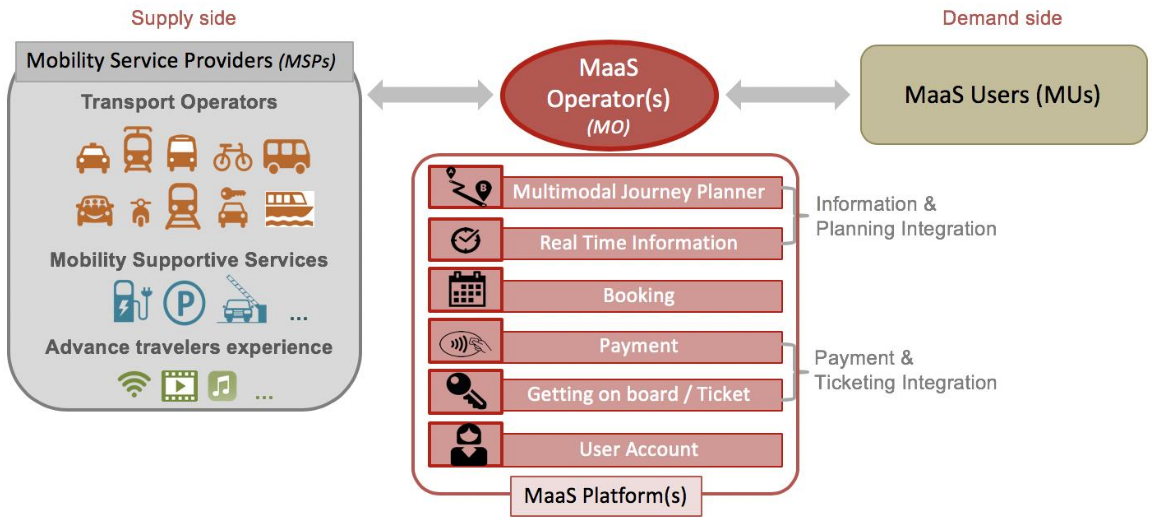


Figure 2: The MaaS platform

(source: MaaSLab, The MaaS Dictionary: https://docs.wixstatic.com/ugd/a2135d_d6ffa2fee2834782b4ec9a75c1957f55.pdf)

Social and behavioural

Public authorities in urban areas have been looking for ways to improve the transport system. The MaaS platform(s), therefore, becomes a practical tool for the cities to efficiently establish and manage the transport system and a MaaS ecosystem. The development of MaaS platform(s) might also change transport operators' behaviour. With a solid MaaS platform in cities, transport operators will actively become a supplier of MaaS solution and redesign their business model to maximise revenue.

Moreover, the MaaS platform (s) can help users know the supply and the demand in real time. By offering personalised MaaS products to the citizens, MaaS platform (s) also might bring substantial social changes. For example, if someone is disabled, the platform could know this information and propose to the disabled end-user only transport modes that could accommodate his/her needs.

Operational

MaaS platform could change the transport ecosystem entirely. All stakeholders (e.g., mobility service operators, MaaS operators, other service providers) have to change their daily operation, which may indirectly increase or decrease costs of operation.

Business

As discussed above, MaaS platform is developed by either MaaS operators or IT providers. For MaaS operators who own MaaS platform, their main revenue source comes from MaaS subscription fees pay-as-you-go fee, and advertising fee. For IT providers, their revenue mainly comes from the cities and regions who buy the tailored MaaS platform that can address their cities' needs.

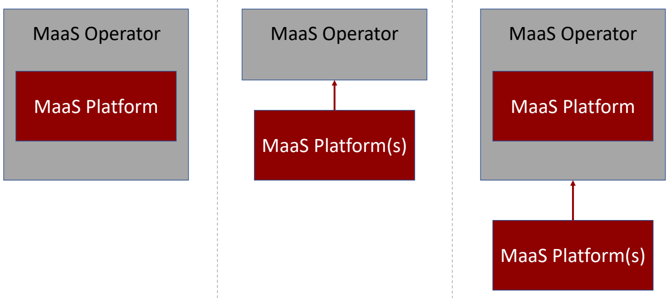


Figure 3: Potential options for the MaaS Platform Provider(s)

(source: MaaSLab, The MaaS Dictionary: https://docs.wixstatic.com/ugd/a2135d_d6ffa2fee2834782b4ec9a75c1957f55.pdf)

Future scenario
MaaS market is expected to reach USD 372.1 billion by 2026.[116] In 2040, the MaaS market will become mature thanks to the other automated technologies and precise big data analysis.

Market readiness
MaaS markets are already in place in some locations, but their development is at different stages. Some solutions exist at a “TESTING” state, such as the Communauto/Bixi project in Quebec, where some public transport companies are proposing packages including also bikesharing and carsharing. The more advanced solution is that of WhimAPP in Helsinki, at “TRACTION” level. Still, the development of MaaS platforms is limited in its territorial scope and also in its diversity of supply. The main barrier is the lack of interoperable databases, namely the main infrastructure that MaaS relies on. Indeed, the development of complex journey solutions require a huge amounts of transport data, including fares. The other main barrier is the reluctancy of transport operators to coexist (and cooperate) in the same platform, as they consider themselves as competitors. Thus, proper public policy could help developing proper infrastructures also by obliging operators to share their data, as well as proper developed MaaS platforms would be attractive for operators. The shift from a car-owning to a ride-sharing paradigm will boost for the development of MaaS marketplaces. Also, the regional factor could play a vital role: Metropolitan areas, where owning a car is not a suitable solution for transportation, are fertile contexts where MaaS paradigm can evolve. In this vein, moreover, in some regions such as the Scandinavian area, commuters are used to use public transportation and other transport services more than owned vehicles. On the other hand, some remote inner areas would not be suitable for the development of MaaS systems.
Market positioning

116 Reports and Data

MaaS is a new market. The ecosystem is mainly composed by transport operators, platform providers and insurance companies. Whereas public transport companies play the leading roles, the major actors are ride-sharing companies. The key players are BMW Group (Germany), Alliance Corporation (Canada), Apple Inc. (U.S.), Xerox Corporation (U.S.), Lyft, Inc. (U.S.), Uber Technologies Inc. (U.S.), MaaS Global (Finland). (Germany), Daimler AG (Germany), and Communauto (Canada)[117]. The provision of tailored and multimodal journeys solutions by using a single app represent the main competitive advantage of MaaS.
Market maturity
MaaS solutions are positioned in different stages of market lifecycle depending on regional areas. In some areas of US and Canada, MaaS systems are in development, as stakeholders are formulating new solutions combining public and private transport offers. In Helsinki MaaS is growing, with local authorities adopting new policies to enable an evolution of the system and drafting regulations to allow a sustainable development for the city and the commuters.

Cybersecurity
Data is a key for MaaS platform. As a result, public sector and MaaS platform firms need to address the issue of cybersecurity. Much of the transport data exists but is not shared with stakeholders. To successfully make MaaS platform profitable, cybersecurity must be taken into account and solved by local or national authorities.[118]
Data
This is highly relevant to cybersecurity so I would not repeat it here.
Safety
This section is not highly relevant to MaaS platform.
Ethics
This section is not highly relevant to MaaS platform.

Example
FluidHub is the platform technology for building MaaS offerings in cities and regions.[119] FluidHub offers a comprehensive toolset for MaaS operators to develop and operate their intermodal mobility apps. Public authorities can also use FluidHub to orchestrate their B2B MaaS ecosystem.

7.3.2 MaaS

3. [117] Market Research Future, Mobility as a Service Market Research Report- Forecast 2023.

[118] The Importance of Data in MaaS

[119] Fluidtime

Technological
MaaS is a new concept aiming to provide consumers with flexible, efficient, user-oriented and ecological mobility services covering multiple modes of transport on a one-stop-shop principle. MaaS could offer multimodal route planners and different services under one fare and on the same ticket[120]. As an intermediate between MSPs and users, MaaS operator uses the data that each MSP offers, buys capacity from the MSPs in order to propose the ideal combination of transport modes to answer user's need within the possibilities offered by network in real time. MaaS can involve the integration of ticketing, integration of payment, ICT support and it can rely on different payment methods such as monthly package subscription and pay-as-you-go. However, integration is often only partial. Wireless networks, especially, provide a key enabling technology fulfilling the physical requirements. For instance, the evolvement of 5G and 4G/3G mobile network technologies together with the integration and expansion of local wireless communication networks pave the way towards a seamless access environment to MaaS systems. The MaaS idea is built on Information and communication technology and to the machines capability to handle with an huge mass of data in real time. By this way, Internet of Things represent an essential starting point for the raising of a new and smart mobility ecosystem. Following this line of reasoning, Maas encompasses public transport system as well as all the sharing and automated transportation services that are rising all over the World.
Social and behavioural
As one of the its main features would be that to meet customized needs, MaaS could significantly improve traffic network efficiency by changing ridership habits, allowing to tap into underutilized mobility capacities and thus solving the problem of waiting. It is expected that data-driven capacity will synergize well with the forthcoming self-driving to provide additional reduction of CO2 emissions. The future of Maas is still not decided, and numerous opportunities are being considered. First, the spatial limits of MaaS do not have to be those of a specific city – technology allows further scaling up. Maas could not only bridge the gap across MSPs in the same city but also across different cities, which may initiate the idea of roaming in the transport sector (UCL). Furthermore, MaaS providers could cover the travel needs of their customers not only in a specific area but anywhere around the world where they operate. From this perspective, a proper development of interoperable MaaS systems could imply a kind of globalization of the services at stake. From cooperation between MaaS operators would stem urban transport standardization across the globe. Every single user could theoretically find the same services in different cities feeling more confident and capable to understand how trips work in a certain city. This could imply new sovereignty issues due to the fact that the transport sector – that during the last decades has been strongly rooted to a certain territory – has now the possibility to rapidly shift to a complete digitalization and centralization of the services. Secondly, technology in the basis of MaaS enables further integration so that mobility supportive services providers (such as fuel providers, parking or high-way operators), and entertainment services providers (such as Wi-Fi providers or movies and games providers) could be considered could become part of the MaaS systems. Finally, the data gathered

[120] Source: http://www.vtt.fi/sites/maasifie

through MaaS could become a valuable resource beyond the use of direct customers. Between the multiple modes, trips, and payments, data is gathered and used to help people's journeys become more and more efficient – it could also help decision-makers make more effective improvements in terms of infrastructure and governance of transport in general.
Operational
For the operational feasibility viewpoint, parties involved in transport and mobility service provision are expected to be influenced by MaaS development. From the supply side, it should be verified potential acceptability to join MaaS for the different transport and mobility service suppliers for each category of service (e.g. public transport, rail, bike sharing, car sharing, carpooling, taxi, etc.). Moreover, existing ride sharing ICT-based platforms which operate in city/region might benefit from joining MaaS, by enjoying a larger potential market. From the demand side, MaaS offering should enable users/customers to enjoy savings in travel expenses and journey time, enhancing transport's accessibility, encouraging sustainable modes, etc.
Business
For businesses, MaaS development means generating new business by profitable markets for new transport services, renewing opportunities for the traditional transport business sectors as part of innovative services concepts, providing smarter transport connections for all sectors, etc. The aim of MaaS is to be the best value proposition for its users, providing an alternative to the private use of the car that may be as convenient, more sustainable and even cheaper. As infrastructural measures mostly entail high investment costs to be covered by the public sector, planning measures delivering more efficient and sustainable resource utilization are of high relevance including digital networks, new ICT technologies, shared mobility as well as new types of mobility offers. MaaS aims at establishing integrated and personalised mobility services. A MaaS provider could introduce a pay as you go system or subscription packages[121] offered to individuals or organization such as companies or university.
Future scenario
IHS Markit foresee that in 2040 the MaaS industry will purchase more than 10 million cars compared to just 300,000 in 2017, as "Mobility service companies will be a prime driver of shifting car sales from personal to fleet economics". This will lead to "An automotive paradox", where car travel will increase but fewer cars will be needed by individuals[122]. Results of another research[123] show that, according to the expert panel consulted, a fully-integrated MaaS will be operating in urban areas before 2020 and in the rural and national areas between 2020 and 2030. In the earlier stage, MaaS will mainly focus on commuting and business trips and Younger generation will be the early adopters of the concept since they are regular public transport users and flexible travellers.

[121] [1,5]

[122] https://news.ihsmarkit.com/press-release/energy-power-media/future-cars-2040-miles-traveled-will-soar-while-sales-new-vehicles-

[123] Working report: Future implementation of Mobility as a Service (MaaS): Results of an international Delphi study-Dr tech Peraphan Jittrapirom, Prof Dr Ir Vincent Marchau , Prof Dr Ir Rob van der Heijden, Prof Dr Henk Meurs, Preprint · July 2018

Market readiness
Currently the availability of each transport mode (e.g. carsharing, bikesharing, ridesharing etc) is very low or fragmented. Hence the MaaS operators face several obstacles to tailor and supply a good combined service. Legislation in the countries varies a lot and in majority of cases, is delaying the MaaS process. In most cities, "parts of the MaaS puzzle exist already, but not the entire picture"[124]. Therefore, the readiness of the MaaS depends strongly on the characteristics of the offer of mobility and on the degree of collaboration of the stakeholders in each local reality. In this regard operators are reluctant to cooperate within a single framework with actor they consider competitors. This issue is especially relevant as for MaaS to be properly developed and implemented, these operators should share their data and fares with other operators. Juniper[125] ranked 15 world cities based on their readiness for large-scale MaaS service deployment. Metrics considered included the existing/planned stage of deployment, cohesion of public transport services and infrastructure development. The top 5 ranked cities were: Helsinki, Stockholm, Vienna, Amsterdam, Austin. Research author Nick Maynard explained: "Helsinki has achieved its winning position in MaaS driven by collaboration between government and MaaS vendors. MaaS Global, which provide the service in Helsinki, can be considered at transaction level (level 6/7) as it received the fourth funding round (venture round) in May 2019[126] but stable pipeline and strong understanding of the market, solid revenue projections don't seem to be available yet. Results from a survey[127] submitted to around 400 private and public stakeholders showed that ticketing/payment, journey planning and customisation constitute the three main service features enabling MaaS. On average around 60 % believed that MaaS concept has to include at least these service features facilitating easy access and providing a unique, integrated service supply over one common interface.
Market positioning
The same survey shows most of the interviewees believes that the organisation of MaaS services will be strongly triggered by public transport (PT) providers/operators. On the other hand, the integration of road operators or private transport organisations such as motorist associations constituted only minor importance. The second place, mobility service providers are seen as essential key-player. In any case, stakeholder partnerships are fundamental to MaaS in order to develop a viable multi-modal system delivering significant cost- and time-savings to the user but cases that have achieved this goal are still very few.
Market maturity
Apart from a few particularly virtuous cases, Maas is still in the Introduction/Development stage of market lifecycle though technology that makes MaaS work is already available (e.g. smartphones and 4G/5G networks, deep learning and artificial intelligence, autonomous drive, dynamic routing). Therefore, in the first place it would be necessary to use of existing technology to better use already existing infrastructure and services. In principle, MaaS is about

[124] https://civitas.eu/sites/default/files/maas_readiness_level_indicators_for_local_authorities_web.pdf
[125] https://www.juniperresearch.com/press/press-releases/mobility-service-replace-2-3-billion-private-cars
[126]
[127] https://www.vtt.fi/sites/maasifie/PublishingImages/results/cedr_mobility_MAASiFiE_deliverable_3_revised_final.pdf

integrating transport modes through the internet[128]. However, the achievement of a potential market share is still strongly hampered mainly by the lack of data passing between organizations.

Cybersecurity
Please, see Maas platform.
Data
The MaaS service might include public transport, rail, taxi, car sharing, bike sharing, etc. In this respect, each individual transport and mobility service supplier should agree to the terms (obligations) which should be set. Obligations might be to provide timetable information (public transport and rail), price information (public transport, rail, car sharing, bike sharing, taxi), booking information (rail, car sharing, taxi), station locations (public transport and rail), locations of parking bays (car sharing and bike sharing), information of special services (car sharing and taxi) as well as drivers' information (carpooling). Operators of different services should indicate the price they charge on a unit basis (e.g. cost for each km/mile, cost for each hour, etc.). On the other hand, operators should also supply several basic information such as real-time information (e.g. instantaneous timetable for public transport and rail, availability for bike sharing and car sharing vehicles, etc.), location information, booking information, etc. Operators might finally provide sustainability information based on vehicle characteristics, enabling users to be environmentally friendly.
Safety
Not relevant
Ethics
Privacy and data protection is the major ethical issue to address. A significant proportion of MaaS data are provided by humans about their lives and their attitudes (user profiles, mobility choices, perceptions and patterns); and data collected remotely that monitors their movements (for example through GPS tracking, geography information systems) or service use (registration, booking, validation, gate access, credit points, etc.). Above data cover all social groups including those most vulnerable and dependent. It is a primary responsibility to ensure that the ethics of personal privacy and dignity, and data protection are not compromised in anyway[129].

Example
IMOVE[130] is an EU H2020 research project aiming at boosting the Mobility-as-a-Service (MaaS) concept and initiatives. IMOVE MaaS Living Lab is implemented in Berlin Brandenburg metropolitan and regional area. Berlin has an outstanding local public transportation network. The network of regional trains, S-Bahn (city train), U-Bahn (subway), trams and buses has a total length of around 1,900 km – roughly equivalent to the distance between Berlin and

[128] ICT-based tools supporting Value-Added Services implementation-Solez Interreg 2018
[129] I-MOVE project, D3.1 – Data management plan (2018)
[130] https://www.imove-project.eu

Moscow. Passengers can get on or off at over 3,100 stations and stops. In addition, several other mobility services are available for the citizens including vehicle-sharing, both free-floating (Car2Go, DriveNow, Multicity) and stationary (Cambio, Flinkster), scooter-sharing (e-Mio, Coup Berlin), bike-sharing (Call A Bike,Next Bike), taxies (Public Taxi, MyTaxi) and Uber. The URBI mobility aggregator is currently providing access to most of these mobility services in a single App, and plans to extend the offering public transport (busses, U-Bahn, S-Bahn) towards a full-fledged MaaS concept, which is introduced in the framework of the IMOVE project.

7.4 SHARED ON DEMAND MOBILITY

7.4.1 Car-pooling

Technological
Ride-sharing or carpooling is the sharing of car journeys so that more than one person travels in a car. Ride Sharing happens mostly spontaneous, however technology is used to connect people to share their rides. The ride-sharing can be split in planned journeys and dynamic journeys. Dynamic ride-sharing is real-time or instant (not planned) ride-sharing. It’s the new hitch-hiking, using your thumb for the smartphone instead of using the thumb as a sign for drivers on the road. (Examples: Car.ma, Flync.) This type of carpooling generally makes use of three recent technological advances: • GPS navigation devices to determine a driver's route and arrange the shared ride. • Smartphones for a traveller to request a ride from wherever they happen to be. • Social networks to establish trust and accountability between drivers and passengers. These elements are coordinated through a network service, which can instantaneously handle the driver payments and match rides using an optimization algorithm.
Social and behavioural
In order to structure carpooling matching platforms and their functions, one has to figure out the factors which are important for carpool users. If these factors are identified, one can create an efficient-working matching platform for attracting more users. For that reason, the main question to be answered is: **“**What factors explain carpoolers’ decision to use carpooling matching platforms?”. The results of a survey[131] show that in terms of information features, the most important aspects are direct informations, experience reports and assessment tools; as regard payment methods, the ability to pay in cash is still considered very important. Messages is considered the most effective communication tools.
Operational
In some cases, drivers and passengers swap roles on alternate days, which remove the need for any payments between parties. There is little formal legislation controlling carpooling, however it is common across the developed world that payments between passengers and

[131] What Factors explain carpoolers’ decision to use carpooling matching platforms? – A survey based observation of carpooling matching platforms in Europe., thesis made by Eva Kesternich submitted at the University of Twente (Nl) in April 2015

drivers in a car pool should not result in a profit for the driver otherwise this could violate terms and condition of their car insurance (see Chan and Shaheen, 2012). All carpooling services require both drivers and passengers to be pre-registered prior to passengers making, or drivers offering, their first journey. The registration process requires names and email address, and a mobile number as verification. Some additional information is asked of drivers such as vehicle model, number of seats, and number plate number of the car. Services which provide on-line booking and payment require drivers (and in some cases also passengers) to provide bank account details, but where direct payment between driver and passenger is possible this is not required. Other details which may be provided by the passenger or driver relate to their preferences (e.g. smoking, music tastes, age, and gender) and linking their account to existing social media accounts / profiles. The possibilities for these vary widely between service providers. The process for offering rides also displays a wide variety of sophistication between service providers. The basic information required includes origin, destination, and time of departure and day(s) of week. Additional information can relate to maximum deviations from direct route, booking mode and payment method (automated via app/on-line or in person). The basic search process that a passenger follows is standard across all carpool service provider platforms. If the booking request has been accepted, the passenger and driver's mobile numbers are exchanged using e-mail. At this stage the exact details of the journey can be discussed. The exact protocol for this has subtle differences between service provider platforms.

Business

The business model of ride-sharing is different for ride-sharing schemes without peer-to-peer payments: revenue comes from mainly long distances, which are very often occasional.

	Corporate ride-sharing	Monetized ride-sharing
Frequency	Recurrent	Occasional
Distance	Medium distance	Long distance
Purpose of ride	Commuting	Leisure/business trips
Flexibility	Less flexible	Flexible
Accessibility	High barrier	Low barrier
Business model	Revenue by enterprises/public authorities	Revenue by users

With sharing economy, user experience, rather than product ownership, has become a market driver for new value propositions and innovative business models, capitalising on new internet and smartphone technologies, and rapid behavioural change. Reshaping cities based on openness, collaboration, and sharing is a resurgent cultural trend that will strongly influence the nature of new mobility services that respond to emerging needs and support user experience in travelling in urban areas. The emergence of web and app-based travel assistance services are themselves triggering changes to the operational models of conventional transport providers, such as public transport providers and taxi companies, by promoting greater cooperation and flexibility. A gradual, but influential wave of new travel services is forcing traditional transport businesses to reconsider their role as independent B2C mobility providers and leading them to form new alliances within increasingly complex and all-encompassing mobility solutions.

Future scenario

In terms of future trends, the following estimates support potential modal shift in urban transport that could be a driver for travel assistance applications:

- the Global Carsharing market is expected to grow at CAGR (Compound Annual Growth Rate of 14.3% in terms of users in the decade 2015-2025;
- the Carpooling market is expected to have a relevant growth up to 30 billion $ in 2020 at global level and it is attracting interest and investments of big players such as Uber, Didi, Lyft (already present in this market), Apple, Google (willing to extend their businesses, also leveraging on their assets related to Location Based Services and Advertisements)

New technologies, mainly in relation to autonomous cars, are expected to radically change carpooling market that today has a critical element relating to drivers (cost, trust, etc.).

Market readiness
Carpooling is one of the most visible and rapidly evolving solution of shared mobility[132] with many companies that already provide the service. For example one of the biggest carpooling platform BlaBlaCar, has reached 70 million members and is available in 22 countries across Europe, Asia, and Latin America. This widespread diffusion allows platforms such as bla bla car to have a strong understanding of the market and to plan to cover further market segments such as suburban areas, smaller cities and rural area, as well as widen the geographical extension[133]. Therefore carpooling can be considered at 8th- Proof scalability level of the Market Readiness Level.
Market positioning
Carpooling is an existing market. The market concentration rate of carpooling is high. Though there are many emerging players in Global, the leading brands occupy large market share. Top 5 took up more than 74% of the global market in 2017[134]. Didi Chuxing, Dida Chuxing, Uber, Via Transportation, Lyft Line, Waze Carpool, Zimride , Carma, Scoop Technologies, Splitting Fares, Wunder Carpool, BlaBlaCar, Karos, Grab, Ryde, Ola , Cabs, SRide, Meru Carpool are the main suppliers in the global carpooling market. The high value of the average distance traveled with carpooling (e.g. 263 kilometres for BlaBlaCar) proves that carpooling in urban area is more difficult to arrange but it has a big potential considering the fact that world's population is increasingly city-based[135]. According to a study of the National Academy of Sciences, carpooling could potentially replace all of the taxis in New York City: 14,000 New York cabs could be replaced by a fleet of 3,000 four-person vehicles[136].
Market maturity

[132] Galizzi M.M., The Economics of Car-Pooling: A Survey for Europe, 2004

[133] https://drive.google.com/file/d/1exHoqlVa3NROt8B92Rulv-BtXbcZaebp/view

[134] https://www.marketwatch.com/press-release/at-152-cagr-carpooling-market-size-will-reach-11400-million-us-by-2025-2019-04-11

[135] Carpooling: facts and new trends, Chiara Bresciani, Alberto Colorni, Francesca Costa Alessandro Luè Politecnico di Milano

[136] On-demand high-capacity ride-sharing via dynamic trip-vehicle assignment Javier Alonso-Mora, Samitha Samaranayake, Alex Wallar, Emilio Frazzoli, and Daniela Rus PNAS January 17, 2017 114 (3) 462-467

According to Shaheen, Cohen, Bayen[137] after driving alone, carpooling is the second most common travel mode for getting to work in USA though the total percentage have declined in recent decades. When it comes at the perception of Europeans citizens on incentives for car-pooling, according to the Special Eurobarometer 406[138] a quarter of Europeans believe that incentives could travel within cities. This 25% share differs country by country, as incentives for car-pooling is deemed as a valuable solution in country as France, being on the contrary less popular in the Czech Republic and Latvia. Furthermore some[139] argue that the use of autonomous vehicles could also help public and private transport to become two integrated businesses.

Cybersecurity
Not relevant
Data
Privacy issues related to data treatment when combining several sources and especially when dealing with carpooling (as this would include personal data and potentially also bank details) must be considered. Linked to privacy issues, significant investment might be required to ensure the risks of cyber-crime and terrorism are minimised.
Safety
Trust in the organizational structure is very important. This can be obtained through the size of the community and the frequency of use (so basically the number of options). The matching time is of importance as well, this really can't take too long. But users don't just need to trust the platform; they must trust the other users as well. For this, safety precautions are important: data privacy, insurances and control over users' profiles (to guarantee reliability and prevent malpractice). The possibility of gender-segregated carpooling can be a plus for some users. Connection to social media allows carpoolers to use their own community to realize a shared ride. Trust related to the organization includes size of community, reputation of the operator (link with local authority or public transport could support this), frequency of use, privacy policy, verification of user profiles, information on website, experience and reports, communication with organization via contact forms, or direct. Trust related to the peer-to-peer experience includes gender segregation, personalization of user profiles (picture, link with social media, music, smoking, social media profile), user evaluation by ratings or open textual evaluation and social relationship with other users (i.e. common friends on Facebook, etc.)
Ethics
Ethical issues concern the level of information that carpooling platforms should acquire in order to ensure the safety of their users and legality. For example, on December 23, 2018, a woman in Russia offered a ride through Bla Bla Car platform to a former soldier with various

[137] https://escholarship.org/uc/item/7jx6z631
[138] https://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_406_en.pdf
[139] Carpooling: facts and new trends, Chiara Bresciani, Alberto Colorni, Francesca Costa Alessandro Luè Politecnico di Milano
Milan, Italy 2018

rapes and robberies records. During the journey, the former soldier attacked, raped and killed her. In August 2018, an Italian man living in France carried an Ivorian woman and a Moroccan man from France to Italy with his car. The two had been contacted via the BlaBlaCar car pooling portal. But at the border of the Mont Blanc tunnel the two passengers were found to be irregular in Italy and the driver was arrested because he was considered a passeur. The driver was sentenced to 9 months of imprisonment and 24,000 euros fine. These recent events cast doubt on trust that the platforms have in the user rating system, which appears to be insufficient, especially for new users.

Example
In Brussels, Taxistop provides carpooling services assisting customer find carpool partners. Matching preferences, route frequencies and itineraries, it allows to formulate very precise requests and to find appropriate matches. In addition to the traditional carpooling services, it also offers companies the possibility of organizing the service tailored to their employees raising their awareness on alternatives to individual cars. Furthermore it provides some additional services such as a benefits calculator, a list of carpool parkings, information on user’s fiscal benefit and “Real Time” service which enables users to find partners at the last minute.

7.4.2 Bike sharing

Technological
Self-service bikes allow users to access a means of travel for short trips (mostly urban) that is faster than using public transport and greener than using a car. It is a collaborative mobility practice because the bikes are used by several users. They belong either to private operators or to public operators. Today, we can differentiate three services that use different technology. The first is the self-service bike, in a station provided for this purpose. The operation is unlocking the bike by paying at a terminal, and then being charged once the bike is locked again at a station (which can be a different station from the first one). The second is similar, but the self-service bike is available anywhere in a predefined perimeter and geolocatable via a smartphone ("free-floating"). The third is the "semi free-floating" option, which requires users to leave their bike in places that are provided for this purpose (parking, bike racks, etc.). They are also generally better secured (with a chain) to try to prevent damage and theft. There are also electric bikes, which have no technological differences in the use of the service. Three obstacles to cycling are eliminated thanks to this service: parking at home, theft and maintenance.
Social and behavioural
This service gives the greatest number of people access to a bike to get around town at a reduced price and encourages exercise. Electric assistance can further increase the number of users by allowing less sporty people to opt for cycling (especially for hilly roads). The improvement of this service could lead to an almost exclusive use of bikes in cities, with both

social (accessibility, health) and environmental benefits (however we would still need to pay attention to pollution and the recycling of abandoned bikes). Degradation and theft would still be a major problem.
Operational
User Services: - "Overflow": system, allowing people to deposit their bikes even if the station is full. - USB socket to charge laptops. - Lighting for night use. Operating costs cover theft (renewal of the bike fleet), damage (maintenance), the installation of the stations (maintenance and new stations) and changing batteries for electric bikes.
Business
Revenue: - Daily, weekly, monthly or yearly subscription – the ride is free for the first 30 minutes, and when this time has been exceeded, the user is charged from the time the bike was unlocked; The user is charged from the time when the bike was unlocked if they don't have a subscription.
Future scenario
- Optional battery on the bike (removable); - Complementarity of the offer with stations and "free-floating"; - Improvement of practicality and safety; - Technologies to reduce theft and damage to 0% (alarm, antitheft, etc.); - Improved bike mass and battery; - Improved battery life; - Regulations to avoid the abusive occupation of public space; - Better use of recovered data. There is still the question of the economic viability of these services, which are far from profitable and have forced many start-ups to close down.

Market readiness
6 or 7
Market positioning
B – New market
Market maturity
I - Development

Cybersecurity
Bike sharing business and operational model relies on collecting and processing huge amounts of personal data. Especially, bike-sharing app gather together location data, rendering possible to exactly detect the position of users. Furthermore, the criticality of cybersecurity increase as a relevant number of companies offering bike-sharing services do operate in countries having lax legislation on cybersecurity and data protection. Thus, measures to control the destiny of these data shall be implemented.

Data
The self-service bikes are connected using an on-board electronic box which means they can be geolocated in real time (useful in the event of loss or theft) and they display on the user's smartphone screen (thanks to Bluetooth) the time of rental, the distance travelled during the journey and, in the long term, traffic indications (roadworks, traffic jams, etc.). The use of big data can then allow a better management of the flows and supply of the stations. Predictions of availability in the departure station and free places in the arrival station are then possible.
Safety
Non-mandatory recommendations (e.g. wearing a helmet). Maximum speed.
Ethics
As in the case of MaaS, the major ethical issue in bike-sharing services is the use of personal data. Companies providing bike-sharing services collect huge amounts of personal data, including those on the consumer habits. Moreover, in some cases the main revenue for bike-sharing companies comes from very selling these data to other companies for commercial purposes. Uncivilized behaviours, especially parking, is a further relevant ethical issue. In this regard a proper sanctions system shall be accompanied by nudges, the latter meant to sensitize users to a proper bike use.

Example
Different operators target one or more cities in one or more countries: - Free-floating: Gobee.bike, Ofo, Bluegogo, Bicycle, Mobike, O'bike (discontinued due to damage and theft), Pony, etc. - Semi free-floating: Titibike, Uber Jump, Oribiky, Indigo Weel, etc. With stations: Vélib'2 (Paris), etc. More examples here.

7.4.3 E-scooter sharing/ Micromobility

Technological
Electric scooters give users access to a means of travel for short trips (mostly urban) that is faster than using public transport and greener than using a car. It is a collaborative mobility practice because scooters are used by several users. They belong to private operators. The technological operation is similar to the "free-floating" bike, available anywhere within a predefined perimeter and geolocatable via a smartphone. Three obstacles to soft mobility are eliminated through this service: parking at home, theft and maintenance.
Social and behavioural
This service lets as many people as possible to move around the city in a flexible way at a low price. The improvement of this service could reduce car ownership with the use of this soft mobility solution, which is accessible to all, electric, leading to environmental benefits such as reduced GHG emissions (however, we would still need to pay attention to pollution and the recycling of abandoned scooters).

Degradation and theft would still be a major problem. Electric scooters have a lifespan of only three months. The intensive use, rough handling and vandalism considerably reduce the durability of these machines. In addition, regarding urban management, eScooters could be a nuisance, blocking pavements and public spaces, leading to strong regulations and fines for companies proposing this service.
Operational
BCG calculated that the average price of a journey was \$ 3.50. The operator, after deducting operating costs, then takes a profit of 65 cents, which means \$ 3.25 per day for five daily errands. BCG has found that it takes 115 days - nearly 4 months - to amortize a scooter acquisition cost, which is longer than its average lifespan. The main cost (50% of the total cost), and therefore the main problem, comes from the "juicers" - the employees who, every night, recover, repair and redistribute scooters abandoned. Hence the question of the robustness and autonomy of scooters, to do without as many of these workers as possible. BCG estimates that, if the scooters last at least six months, the scooters could generate a profit.
Business
Price at the time of unlocking the scooter.
Future scenario
- Complementarity with the public transport offer; - Improved practicality, robustness and security; - Technologies to reduce theft and damage to 0% (alarm, antitheft devices, etc.); - Improved battery life - Regulations to avoid the abusive occupation of public space; - Adaptation to bad weather and mountainous areas; - Attention to investment in private scooters by users; - Better use of recovered data. There is still the question of the economic viability of these services, which are far from being profitable (world market at 1.5 billion dollars today could reach between 40 and 50 billion dollars by 2025 according to BCG). The current strong competition will lead to an erosion of the number of operators, where only those with a real strategy will survive. As one of the possible avenues for the survival of scooter operators, the issue of partnership with other mobility actors seems paramount. Since electric scooter rides can complement other modes of transportation, it would be more practical and advantageous to group services in a single application. The user would then have a single source to visit to get from point A to point B: a one-stop shop for planning, booking and paying for their journey.

Market readiness
6 or 7
Market positioning
B – New market
Market maturity
I - Development

Cybersecurity
N/a
Data
Electric scooters are connected using an on-board electronic box which allows them to be geolocated in real time (useful in the event of loss or theft) and they display on the user's smartphone screen (thanks to Bluetooth) the rental time, distance travelled during the journey and, in the long term, traffic indications (roadworks, traffic jams, etc.). The use of big data can then allow a better management of flows and supply of strategic locations.
Safety
Non-mandatory recommendations (wearing a helmet for example). In France, future regulations will rule the use of eScooters[140] (maximum speed, allowed paths, etc.). In Paris, parking will be setup for flee-foating eScooters[141].
Ethics
N/a

Example
Different operators target one or more cities in one or more countries. For example, there are 12 of them in Paris: Bolt, Wind, Hive, Ufo, Tier and Voi stopped for several days (early July 2019); Lime, Bird, Dott, Circ (formerly Flash), Jump (Uber subsidiary) and B-Mobility (sponsored by Usain Bolt).

7.4.4 Ride-hailing and TNC

Technological
These emerging platforms in the mobility market evolved from the concept of carpooling, which as such has already existed for a while in the form of online platforms such as Blablacar for example. The main difference is that ride-hailing apps offer transport on demand, meaning that the ride is not planned in advance. The journey is requested and only taken because of this request. Most of the time, destinations are not shared between passengers, making the trip more individualized than with car-pooling. With carpooling the ride would have been done anyway but not with ride-selling. Some resemblance to taxi services can be identified, by offering a ride in exchange for a fare. For ride hailing platforms though, anyone with a driving license and a private car who fulfils the specific criteria set up by the company can sign up as a driver to chauffeur people around, meaning the companies behind the ride-selling application do not own a fleet of cars. This allows these companies to expand rapidly.
Social and behavioural
Ride-hailing and TNC, and "traditional" taxis are living strong competition.

[140] https://www.service-public.fr/particuliers/vosdroits/F308
[141] https://www.le-lab.org/spots/rguler-les-trottinettes-lectriques-en-libre-service

The disruptive ride-hailing/TNC present some competitive advantages: • Quality of service: attentions for customers (bottle of water, sweets…); • Ease of use: a smartphone app allows the customers to book the journey, knows exactly the price in advance and manages payment; • Lower cost than taxis. However, some drawbacks can be highlighted, due mostly to lack of regulation of this service: • Poor wage/social protection for the drivers, who are on their own, in a position of insecurity, if they experience unforeseen events that could prevent them from working (vehicle stopped, disease, etc.). • No dedicated paths for TNC drivers, which are allocated to taxis and buses, which can result to time loss for the journey.
Operational
Transactional platforms for ride hailing work match passengers who need a ride with drivers who want to offer a seat in their vehicle through mobile applications. Some of these trips can also be shared with customers that are looking for rides with similar destinations. For every ride sold, the platform gets a commission. As a first step, a smart phone, a valid credit card and registration of customers is required. Customers can then use the app via their smart phone to request a ride, by setting their pickup location and entering their destination. A fare quote will be given to them. They can then track registered vehicles in their area and request a ride, waiting for the driver to accept. Once accepted, the passenger will receive information on the driver and the car and is able to track the car on the map. The passenger is notified on their smartphone of the imminent arrival of their driver. After pickup, the app will show the driver the route, using GPS navigation. Payments are handled through the service provider directly by billing the rider's credit card that is linked to the app. A rating system asking the driver to rate the rider and vice-versa is in place, with the aim to ensure a form of reliability. After the ride, the passenger immediately receives an invoice on their smartphone stating the exact route, distance and time travelled.
Business
Price *per* trip depends on distance, time and location, and are fixed before taking the customer. Nonetheless, in Paris, on New Year's Eve 2014-2015, several users complained about rates multiplied by more than 10, as the company had inflated its rates. Pricing is flexible, and ride selling companies usually increase the fares during peak hour services or special events or whenever demand is high (surge-pricing). A fare quote is shown to the user by the app, calculating the approximate amount based on the expected time and distance. Most ride-selling apps also allow splitting the fare with a co-passenger, further reducing the cost for the passengers.
Future scenario
As with many other companies, the future is in the autonomous vehicle and therefore in the driverless autonomous taxi for this sector.

Market readiness
7 or 8
Market positioning

B – New market
Market maturity
II - Growth

Cybersecurity
N/a
Data
Apps retrieve users' personal data. Data protection is more or less well provided depending on the service.
Safety
Measures to grant passenger safety in ride-hailing services are mainly undertaken by the very providers. One example is the GPS tracking adopted by Uber, allowing to control passenger journeys. Another measure implemented is the Watchdog Network[142], namely the reporting of rider inappropriate behaviour of a on the app. Also, another potential measure, implemented by public authority, could be to mandatory install dash-cam within the vehicle.
Ethics
N/a

Example
Fares are determined by an algorithm, which takes into account the type of service used, and increases with the demand for transport. These pricing practices have given rise to several controversies. At the time of the Sydney hostage situation, Uber had increased its fares by an average of four times, for those wishing to leave the hostage-taking area, before backtracking in the face of outraged reactions. According to the company's business model, the 80% of the customer's fare is redistributed to the driver, with the remaining 20% going to Uber as a commission. On December 8, 2016, Uber unilaterally decided to increase its commission from 20% to 25%, and at the same time to increase customer rates by 8%. Dissatisfied with this fare policy, Uber drivers are starting a social movement accompanied by blocking access to Paris airports. In some areas, Uber charges its users a waiting fee and even a cancellation fee. Even if this is not necessarily legitimate, there are drivers who say that they were rated badly and that overnight, the platform disconnected them.

7.4.5 On-demand ridesharing

Technological

[142] https://reader.elsevier.com/reader/sd/pii/S1877050918305088?token=86D361A414F91EBE052A18C7C9D0FC2CB8436EE712C7AF7EDBB30379DE68FF5336974A7A87D9B1987B67A65E010A0A00

On-Demand Ridesharing involves a system that matches riders and drivers in order to share transportation at random times and locations. Whereas On-Demand Ridesharing is a service in which members give rides to other member mainly behind profit, carpooling is a service in which 2 or more people who have to make the same journey do share the ride, with the aim to reduce costs. This system makes use of recent technological advances such as GPS navigation devices to determine a driver's route and arrange the shared ride, Smartphones for a traveller to request a ride from wherever they happen to be, Social networks to establish trust and accountability between drivers and passengers and E-payments systems. These elements are coordinated through a network service, which can instantaneously handle the driver payments and match rides using an optimization algorithm. On-Demand Ridesharing involves a diverse set of phenomena, involving vehicles such as cars of different sizes, bicycles and others, last-minute as well as first-minute demand, set pick-up and drop-off points. Implementation of this type of systems faces multiple barriers related to low flexibility in adaptation to local conditions of density and transport network, belief that private cars bring convenience and flexibility and lack of good urban public and complementary transport to ease first mile travel. At the same time On-Demand Ridesharing is enabled by its advantages such as lower prices, shorter waiting times and higher safety. Passengers using ride-sourcing and ride-sharing services also mention quality elements such as drivers' courtesy and vehicles condition, as a reason for their preference. Finally multiple systems operating in the same locality can adopt data sharing protocols among platforms that help improve the service.
Social and behavioural
Success of On-Demand Ridesharing as an innovation that fulfils a precise social need that stems for increased population density, the ongoing change of users regarding car ownership. In this context On-Demand Ridesharing offers lower costs in comparison to existing transport provides such as taxis, transparent fares. In a non-regulated market for transpiration services, improvements of public transport infrastructure and facilitating local government policies it can improve the level of satisfaction of transport needs in many cases of the individuals and households that would not be in position to use transport services otherwise. At the same time implementation of these systems leads to reduction of vehicle usage, ownership and vehicle miles travelled, rise of environmental awareness and postponement of car purchase and selling
Operational
Three main innovative practiced identified with ridesharing are the improved use of public stations infrastructure, increased mobility for non-car owning individuals and households and general lowering emission. A 2010 survey at the University of California, Berkeley found 20% of respondents willing to use real-time ridesharing at least once a week; and real-time ridesharing was more popular among current drive-alone commuters (30%) than transit or non-motorized commuters.[9] The top obstacles to using real-time ridesharing were short trip lengths and the added time of ride logistics.[9] As for the companies that set up ridesharing systems, their operation can be impeded by high initial expenses to set up service related to vehicle fleet and insurance and lack of public infrastructure
Business
The revenue model is based on cost recovery. Riders pay drivers proportionally to cover journey expenses.
Future scenario

In the future we can expect multi-modality, that is a significant trait of on demand ride sharing to develop, which will allow users to choose transportation mode by purpose, that will regularly include more modes than it is the case today. In combination with emergence of autonomous vehicles and the electrification of the fleet, the expansion of on-demand ride sharing is expected to force passengers' fares down. In parallel, the trends to retain older cars is expected to develop. The automotive industry might adapt to this transformation by adopting a compartment focus in order to allow people sharing a car to feel like they're in their own space. Finally ride-hail and ride-share services won't necessarily be limited to urban centres or even places with strong public transportation, while competitors more willing to localize their service will thrive by developing services specifically adapted to particular locations.

Market readiness
- 7 or 8
Market positioning
- B – New market
Market maturity
- II - Growth

Cybersecurity
Data safety and integrity, has been a problem for on demand ride sharing service. In the case of Uber issues have emerged regarding tracking their riders' location long after the ride had been completed, to specifically tracking politicians and celebrities, to hiding vehicles from government regulators in order to skirt regulation
Data
On demand ride sharing opens is based on innovative data collection practice that opens up further opportunities. For example, collection data on the usage of individual shared modes as part of the unified travel survey. Further more a requirement for private sector to engage in data sharing (protected repository) as a condition for operating on public rights-of-way. Finally developing a a state-wide repository for public and private sector transportation data and exempt personal traveller data from release under the California Public Records Act to protect privacy and proprietary data.
Safety
Lack of driver background checks has been controversial in the past as it has led to cases of violence. Ideally the community building aspect of these systems is supposed to overcome the problem, but regulators have also been asking for a stronger background checks in order for this not to happen. Also the safety of the service providers is generally lower than that of employees of taxi companies and provisioning emergency support has been demanded in order to ensure it.
Ethics
On demand ridesharing companies differ in their positions regarding important ethical questions regarding the quality of work. These questions have to do with both consumers and providers of services. In order to provide more equitable service some companies have set the

price instead of allowing the algorithm to correct it depending on the present level of demand. On the other hand, the service providers are not treated as hired workers and thus they rarely receive any of the benefits that taxi drivers receive for example. Finally as the ride sharing industry is disruptive the ethical question of how to perform the transition without damaging the existing taxi drivers has often been central concern of the regulators.

Example
As of November 2017, San Francisco-based Uber had 7 million drivers in 600 different cities worldwide. Uber's pricing is fairly competitive on most days of the year with a diverse set of services tailored for different customers. Uber provides a discounted carpooling option called uberPOOL to make the expense a little more palatable. If you are willing to wait, Uber is currently testing a low-fare option if you leave during certain times. Uber also accommodates for larger groups, by letting customers split the fare among passengers in Uber's large sedan (uberXL), SUV (UberSUV), luxury car (Lux), and/or multiple mid-level cars. Finally, Uber is one of the few on-demand services offering a disabled access option called UberASSIST.

7.4.6 Crowd shipping

Technological
Crowdshipping, also known as crowdsourced delivery, is an emerging method that uses free capacity available in various transport modes leveraging on non-professional couriers to perform freight delivery. While it is now a common practice in grocery delivery, this model is arousing interest also in other retailers who are interested in cutting delivery costs and maximizing supply chain efficiency[143]. Crowdshipping involves "not necessarily an additional trip but a trip that leverages the typical travel patterns of the courier. The selected courier may be the closest to the delivery route, offer the cheapest delivery fee, or have the best reputation in the system"[144]. In order to enable such a system, deregulation of delivery markets and the definition of laws that protect crowdshippers' labour, liability and insurance are needed. However there are some downsides that cannot be overlooked such as the risk that the package is stolen, lost or damage or, unbeknownst to the crowdshipper, illegal. Crowdsourcing is an app-based platform and one of the greatest strengths of this freight delivery system is precisely being tech-heavy and asset-light. Therefore, one of the biggest success factors of crowd shipping relies on the effectiveness of the application in managing offer and demand. The use of apps offer customers the possibility to select a time slot and GPS track their order in their smartphones or choose to receive an alert SMS, to identify the nearest available courier and companies to meet costumers' demands for instant gratification with the certainty that the package arrives at its destination when someone is at home or in other defined places (e.g.

[143] Shelagh Dolan, Business Insider, Crowdsourced delivery explained: making same day shipping cheaper through local couriers, May 21, 2018

[144] Le, T., Ukkusuri, S., Review of crowd-shipping services for last mile delivery: current business model, challenges, and opportunities. Submitted to the Transportation Research Part E. 2018.

areas daily frequented by commuters), thus avoiding unsuccessful loss of time and money delivery[145]. Another technological enabler toward a widespread adoption of the system is the use of Automated Parcel Lockers (APLs); the customers receives an alert message and the unique code of the parcel as soon as the courier drop-off it to the locker.
Social and behavioural
An exploratory investigation aimed to identify conditions under which crowdshippers will produce the service and customers buy it. 200 students were surveyed in the city of Rome and the results show that, on the offer side, while 87% of students declared themselves willing to operate as crowdshippers, the percentage decreases as the size of the order to be transported increases and with the decrease in remuneration. Furthermore, the study shows that the maximum deviation accepted compared to the usual route is 1.5 km if the crowdshipper uses a non-motorized transport mode and 3.1 km if using a private mode of transport. As for the demand, 93% would accept to receive goods delivered with crowdshipping but the percentage decreases if the customer cannot directly contact the crowdshipping company or the crowdshipper or if it is not possible to trace the order[146].
Operational
Walmart is studying the possibility of involving its in-store customers to deliver items that online customers order in exchange for discounts, using company drivers just to deliver occasional unforeseen orders. However, from the point of view of city logistics, this system could increase the number of freight movements, making coordination and consolidation of direct-to-consumer deliveries less efficient[147]. More interesting applications of crowdsourcing are those that use APLs, because they allow to minimize the deviations of the shippers from their original path since they are positioned in areas daily frequented by commuters, such as metro, train and bus stations. In particular, the metro stations are the most strategic points as the higher train frequency makes an additional stop / deviation more acceptable[148]. A study conducted on the Rome underground based on the hypothetical scenario in which packages can be picked-up / dropped-off in APL, shows that the positioning of APLs is even more relevant factor than remuneration. The article also investigated how e-commerce users might be willing to accept the crowdshipping service to receive their orders. It emerged that the most relevant factor would be the possibility of planning the date and time of delivery[149]. Another important issue is linked to the achievement of a critical mass. Certainly a certain number of couriers are needed to provide a flexible and efficient service, but, on the other hand, a certain number of customers is also required to attract couriers. This is why companies have

[145] Shelagh Dolan, Business Insider, Crowdsourced delivery explained: making same day shipping cheaper through local couriers, May 21, 2018

[146] Marcucci, E., Gatta, V., Le Pira, M., Carrocci, C. S., Pieralice, E., 2017d. Connected shared mobility for passengers and freight: Investigating the potentialof crowdshipping in urban areas, 5th IEEE international conferenceon models and Technologies for Intelligent Transportation Systems, MT-ITS 2017 - Proceedings 8005629, pp. 839–843

[147] Martin Savelsbergh1 and Tom Van Woensel, City Logistics: Challenges and Opportunities, H. Milton Stewart School of Industrial & Systems Engineering, Georgia Institute of Technology, U.S.A., School of Industrial Engineering, Eindhoven University of Technology, The Netherlands, February 7, 2016

[148] Gatta et al. European Transport Research Review https://doi.org/10.1186/s12544-019-0352-x , 2019

[149] Gatta et al, Public Transport-Based Crowdshipping for Sustainable City Logistics: Assessing Economic and Environmental Impacts, Sustainability 2019, 11

implemented numerous strategies such as hiring a team of professional couriers to start the service, or partnering with high-volume retailers in order to ensure critical volume to attract courier[150].

Business

Five types of business models can be identified in the crowdsourced delivery industry[151]

Name	Clients	Offer	Couriers
Courier	B2C	Deliver an order from a shop, restaurant, pharmacy, etc. intra urban	Professional or non-professional Dedicated couriers
Interdant	B2C	An order is placed on the platform. It is the courier who purchases the article from a shop and delivers the article to the customer. Intra urban	Professional or non-professional Dedicated couriers
Intra-urban	P2P or B2B	Deliver a parcel. Intra urban	Professional or non-professional Dedicated couriers, Commuters
National	P2P or B2B	Deliver a parcel. Intra urban/National	Travelers
Social delivery	P2P or B2B or network	An order is placed on the platform. The courier proceeds to purchase and then to delivery. National/International	Travelers

Table 5: Crowd shipping business models

Future scenario

Some argue that crowdsourcing may not have significant role in instant delivery in the future, especially due to quality and reliability issues. As crowdshippers often sign up with multiple crowd sourcing platforms, it can sometimes be difficult to ensure adequate service quality levels in peak periods. An expert opinion survey conducted by the International Transport Forum reveals that only 25% of respondents believe that crowdshipping will be likely to be present by 2030.

Market readiness

Several delivery services (grocery, food delivery, and all non-hazardous items) with crowdshipping are already operational. Roadie, which raised more than $ 37 million in series C funding in February, is strengthening its partnerships with MSP to expand the service therefore carpooling can be considered at 8th- Proof scalability level of the Market Readiness Level.

Market positioning

With the growth of demand for delivery determined by e-commerce, numerous crowdshipping companies have been founded. To date there are many crowdshipping platforms that are already providing the service (Postmates, Zipments, Deliv, Roadie in the USA, PostRope in Australia, Renren Kuaidi in China, Nimber in Norway, Trunkrs in Netherlands, PiggyBaggy in Finland just to name a few) and big companies such as Amazon, Walmart, DHL, and Uber are conducted city - level pilots projects. Therefore the crowshipping service can now be considered an existing market. To date the Amazon "Amazon Flex" crowdshipping service is

[150] Rougès, J-F Montreuil, B. (2014) Crowdsourcing delivery: Ner interconnected business models to reinvent delivery

[151] Rougès, J., Montreuil, B., 2014. Crowdsourcing delivery: New interconnected business models to reinvent delivery. In: 1st Int. Phys. Internet Conf., pp. 1–19.

available in nearly 80 cities in the US alone[152]. In 2016 Alan McKinnon, in his "crowdshipping white paper" pointed out that crowdshipping platforms are essentially intermediaries, Amazon is one of the world's biggest sources of packages and main users of last mile delivery services. Therefore, "Amazon's entry into the crowdshipping market could prove a game-changer, so long as it is able to entice sufficient numbers of self-employed 'partners' into its Flex operation". On the other side smaller retailers rely on crowdshipping platforms to guarantee fast delivery services to compete with large e-commerce companies[153].
Market maturity
Given that different companies already provide the service, crowdshipping can be considered in the growth phase compared to the market lifecycle. Le and Ukkusuri[154], point out that there are still few behavioral studies on crowdshipping to date, but various questions are emerging regarding the exploitation of couriers, their discontent and the consequent quality of the delivery service[155]. Ultimately, according to McKinnon, the scalability of crowdshipping will depend on three-way inter-dependence in the growth of supplier, courier and customer numbers.

Cybersecurity
Risks concerning cybersecurity are typical of the On Demand Mobility platforms. Please refer to previous sections.
Data
There are also concerns about privacy and the possibility that retailers can exchange customer information such as home addresses, shopping habits etc. Others highlight the problems of trust, as it is easier to trust an employee of a well-known LSP company than a stranger. In addition, the platform rely on the same kind of solution for the sharing economy: secure payment, "log-in with Facebook", ratings and feedbacks etc[156]. Regarding the reliability and privacy issues, a study reveals that the use of Social Networks for crowdshipping delivery can significantly limit these issues if a model is implemented that only allows people over a certain level of personal knowledge of the customer (e.g. a small circle of friends of facebook) to perform the delivery[157].
Safety

[152] https://amazonflexbusiness.com/flex-cities

[153] https://www.businessinsider.com/amazon-flex-hitch-deliv-crowdsource-shipping?IR=T

[154] T.V. Le and S.V. Ukkusuri, CROWD-SHIPPING SERVICES FOR LAST MILE DELIVERY: ANALYSIS FROM AMERICAN SURVEY DATA, , https://doi.org/10.1016/j.triptlc.2019.100008

[155] https://www.businessinsider.com/amazon-delivery-drivers-reveal-claims-of-disturbing-work-conditions-2018-8?IR=T

[156] Rougès, J., Montreuil, B., 2014. Crowdsourcing delivery: New interconnected business models to reinvent delivery. In: 1st Int. Phys. Internet Conf., pp. 1–19

[157] Devari, A. Crowdsourced last mile delivery using social network. Master thesis. State University of New York at Buffalo. 2016

Many safety problems have emerged, such as theft, damage, transport of illegal objects etc. but also liability concerns, as different regulations have not yet settled the questions concerning the identification of the person responsible in case of problems[158].
Ethics
There is the possibility for the couriers of being exploited if they under-value their time and, in case they use their own car, if tend under-estimate the full vehicle operating cost. Some B2C companies, such as Deliveroo and Hermes leveraging on casual workforce of self-employed drivers have been criticized for exploitative practices[159].

Example
Roadie is a delivery network connecting people with goods to send with drivers already heading in the same direction, whether local or long haul. Using Roadie's mobile app, anyone can enter his daily routes and road-trip plans or choose deliveries that fit into his schedule with the possibility of knowing in advance remuneration, pickup and delivery location and item (the company has an "Open Box Policy" that allows couriers to open the box in order to avoid the risk of carrying illegal or dangerous items). Personal senders, small business and enterprises can use the service. Delivery signatures and photo let the sender know the courier picked up and delivered the item allowing to show its condition at every point of the process. Roadie in-app navigation connects the shipper with Waze or Google Maps to direct him from pickup to drop off. To ensure reliability, roadie has set up a rating system that allows both senders and couriers to evaluate each other. Currently, the company is working to use predictive analytics to coordinate the everyday habits of drivers with the needs of shippers[160].

[158] Lam, T., and Li, C. Crowdsourced delivery https://fbicgropup.com/sites/default/files/crowdsourced%20Delivery-SEP.2015.pdf

[159] [159] Alan C McKinnon, Crowdshipping: A communal approach to reducing urban traffic levels? Logistics White Paper 1/2016

[160] https://www.roadie.com/

8 KNOWLEDGE BANK

The main result of 'WP1 Technological, operational, business and social trends and innovations' and 'WP2 Regulatory and governance frameworks' is the creation of the GECKO Knowledge Bank about new mobility, services, technologies, business models, regulatory frameworks and governance models. The Knowledge Bank will also offer evaluation criteria from 'WP3 Impact assessment and prospects for regulatory schemes' about the new mobility services and technologies that are currently available in the market or will be in the future.

From WP1 and WP 2 it offers information about business models and the value proposition of current and future new mobility services. The analysis of market readiness, positioning and maturity will enable the clustering and selection of innovation cases for the impact assessment. The end-users mobility needs and social and behavioural trends in the use of new technologies and mobility services will feed the demand side dimension of the Knowledge Bank.

From the Knowledge Bank a significant range of newly emerging disruptive innovation cases will be selected for the impact assessment exercise undertaken in 'WP3 Impact assessment and prospects for regulatory schemes'.

The Knowledge Bank will feed the development of the remaining tools such as the Regulatory Frameworks Dashboard and Compliance Map. It will be a database available as a PDF on the GECKO website. It will be launched after the first year and a final update will be produced at the end of the project. After the completion of the project it will be available on the websites of the project partners.

The Knowledge Bank will be structured as follows for each disruptive innovation case study described in Chapter 8:

Case study
Future scenario
Example
Market Analysis
End-users' perspectives
Business model
Regulatory responses
Evaluation criteria

Table 6: Knowledge Bank structure per disruptive innovation case study

GECKO CONSORTIUM

The consortium of GECKO consists of 10 partners with multidisciplinary and complementary competencies. This includes leading universities, networks and industry sector specialists.

@H2020GECKO
#H2020GECKO

https://www.linkedin.com/groups/8744013/

For further information please visit **www.H2020-gecko.eu**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824273.