MOBILITY4EU - D2.1 - Societal needs and requirements for future transportation and mobility as well as opportunities and challenges of current solutions

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Executive summary

Mobility4EU is a Coordination and Support Action of the European Commission started in January 2016 and lasting for 3 years, until 31 December 2018.

The project will deliver a vision for the European transport system in 2030 and an action plan including a roadmap to implement that vision. The work towards that vision and action plan is based on the identification and assessment of societal challenges that will influence future transport demand and supply and the compilation of a portfolio of promising cross-modal technical and organisational transport solutions. The entire process from studying trends and options for solutions, developing a vision and finally the action plan are organized within a structured participatory approach that focuses on user-centeredness and that aims to engage a broad stakeholder community into the consultation processes. A further goal is to build a European Transport Forum that continues the work beyond the project duration and works on complementing the action plan.

The present document reports on the results of researching trends and societal drivers impacting mobility demands and transport in Europe until 2030.

Societal, political, technological, environmental, legal and economic trends interacting with mobility and logistics

We provide a comprehensive vision of societal drivers having an impact on mobility and freight. Our aim is to establish a basis for the understanding of societal trends, in the broad sense, and an input for the next phases of the project broad stakeholder consultation, especially the scenario needed in the multi-actors multi-criteria analysis (MAMCA) that forms an integral part of this structured stakeholder consultation to be developed in the next work packages of Mobility4EU. The trends we study include societal trends, political trends, economic trends, technological trends and legal trends.

As compared to other comparable exercises in European researches that had a similar scope, our approach is rooted in the study of societal trends, as opposed to a more classical transport demand analysis that mostly separates trends along classical transport modes and transport markets. Within the present project, we go one step beyond by starting the analysis of societal dynamics in a broad sense, and in a second stage identifying those trends that have an interaction with mobility and logistics. Societal trends are for us entry points instead of transport solutions and markets. In addition, our analysis intends to cover all transport modes, all geographical scales and freight as well as passenger transport.

In our approach a trend has an unequivocal impact on mobility. If neighbouring trends have the same impact or the same type of impact on mobility we have merged them. Conversely, if a trend was considered as containing diverging impacts on mobility, we have separated them in two distinct trends.

The list is composed of 29 trends organised in 9 larger trends:

- 3.1 Distribution of wealth and labour market developments

Economic climate and economic conditions play a major role in shaping the demand of mobility. We identify two trends in the economic domain. Firstly the adaptation of Europe's economy in the global context of significant relative decline of GDP is foreseen ("Share of the European economy in world GDP declines"). European GDP and population

should grow but much slower than the rest of the world in average. Direct consequence of the global growth will be an increase in flows, particularly freight, but a possibility has been identified of a reindustrialisation of Europe, which could lead to significantly modified freight flows. At the individual level, economic growth usually converts into more mobility, as illustrated by the growth of tourism.

The second major trend refers to the idea of "Restructuring working arrangements". Telework and part-time work are the two major foreseeable tendencies already happening that should further grow in the future. They have direct and indirect effect on mobility. Home-to-work flows will reduce but may be longer trips due to rising urban sprawl that may even be supported by telework. Less peak hour traffic may be opposed by more trips for other purposes than commuting to work. A likely consequence of the last effect has been identified as a demand for more flexible tickets for public transport.

- 3.2 Inclusive society, personalisation, accessibility

The second large trend we identify refers to societal dynamics that interact with mobility and freight demand. Some of these are actually driven by developments in society (like "Increasing life expectancy of the population" or "Migration trend generating long distance flows"), but others are also supported ("Move towards more active and healthy lifestyles") or even mainly driven ("Trend towards inclusion of vulnerable to exclusion groups" and "European integration facilitating flows") by policies.

"Increasing life expectancy of the population" is an essential dynamic of European societies. The interaction with mobility and logistics are complex though: the population of car drivers is likely to grow, and less active mobility is expected from the disabled "oldest old", but maybe more active mobility will come from for those who will stay or move back in denser urban areas; a need for proximity in goods and services deliveries for the urban elders contrasts with specific and costly mobility demand in ageing rural areas.

"Migration trend generating long distance flows" introduces or develops specific patterns of mobility demand: the foreseen increasing migration in Europe will generate more long distance flows of persons and goods with origin countries.

There is a consensus on the fact that policies are supporting a "Trend towards inclusion of vulnerable to exclusion groups". This trend, addressing societal issues, has direct translation in the transport policy sector with the theme of accessibility for all. In addition to the long-time known vulnerable groups, the digitisation of mobility carries the risk of creating new exclusion, for instance among those who do not own a smartphone.

Forming a part of the explanation of the *peak car* phenomenon, the tendency of "Less car use by younger generations" has been observed in the recent period since the mid-2000. Connecting to the social network, whatever the means, physically based or telecommunication based, seems to have outshined the car ownership dream observed in precedent generations.

Another consequence of the societal awareness for environmental issues is the "Move towards more active and healthy lifestyles". This trend is fuelled by individual awareness and by policies aimed at influencing individual behaviour. Health is likely to become a major concern in the future with direct translation for the policies aimed at orientating mobility behaviour.

There is an emerging consensus among social scientists around the idea of *liquid modernity* introduced by Z. Bauman. In order to characterise the interactions of liquid modernity with mobility and logistics we have established two trends: "Acceleration and flexibility of liquid modern society" and "Personalisation of liquid modern society". The

first trend refers to the ideas of acceleration and flexibility and provides an explanation to the increase of leisure time and its associated mobility patterns. It also entails a requirement of transport users for less need for planning their trips, of immediate and seamless access to information. The second trend of liquid modernity highlights the personalisation aspect. The individualisation process, illustrated among other indicators by the decreasing size of households, favours individual transport modes of cars, but also bike and walk, and also favours models of the type "one-stop-shop" for mobility services.

Essentially driven by policies and political choices "European integration facilitating flows" is still, despite the recent reverse movement by United-Kingdom, an ongoing process. Its impacts on mobility are straightforward through the development of tourism and of freight flows in Europe.

- 3.3 Urbanisation and smart cities

"Rising and expanding urbanisation" is the major trend concerning human settlement. It also affects Europe despite an already high level of urbanisation, which is foreseen to increase from 73 % in 2014 to 84 % in 2050. Cities and city-regions, which are densifying and spatially extending, are more and more the dominant forms of settlement. These trends lead to more intense and longer urban flows, both for passengers and goods.

The emerging model of the *smart city* aims at articulating human and social development with information and communication technologies in cities ("The emergence of Smart cities"). Equipping cities with ICT infrastructure is pushed forward by the introduction of new technologies of mobility (mainly electric vehicles, car sharing, car-pooling) and should lead to new social interactions and to new uses of city spaces, and hence should have significant impacts on mobility behaviour and freight demand.

- 3.4 Environmental protection: climate change, pollution resource and energy efficiency

In the domain of environmental protection we identify four trends. The first three are imposed or encouraged by policies, while the last one refers to the management of the consequences of climate change.

The rising awareness in society for environmental issues leads to the adoption of stricter regulations for environmental protection. Transport, being a significant and not reducing part of the environmental impacts of anthropic activities is concerned with many regulations, and strategic policy goals in the long-term perspective of decarbonisation.

Economy is adapting increasing scarcity of available resources ("Limited resources require more resource efficiency and circular economy in transport"). A "sustainable consumption" culture emerges among citizens and firms tend to conform to social and environmental rules and approaches: corporate responsibility, circular economy, Life Cycle Assessment. All these elements will oblige to reconsider the organisation of logistics. One example is local food consumption that depends on short supply chains.

In the domain of energy, policy goals support a movement to step "Move away from fossil fuels towards energy efficiency and renewable energies", The current dependence on transport on fossil fuels is expected to be replaced by electrification and sustainable biofuels.

Finally, regarding environmental trends, the "Impact of climate change on transport" is direct and significant. Extreme weather events cause damages to transport systems of road, rail and aviation. Global warming could have one positive effect though, to open the North-West passage for freight between Europe and Asia.

- 3.5 Digital society and internet of things

In this section on digital society, we identify two types of trends. Regarding the digital world, technology, as an enabler, exerts a true influence and drives individual and social uses. We identify two technological trends in the supply side. These are Internet of things and big data, and automation. But at the same time, technology is sometimes used for a slightly different purpose than what was foreseen by the designers. In this sense individuals and social groups can be seen as actors of digital society that are able to fuel trends themselves. This is the demand side of digital society.

The technological trends of "Rise of the Internet of Things and big data" is impacting many aspects of the production of goods and services, and particularly in the transport domains. Vehicles, transport infrastructures, ICT devices, parcels will all be able to communicate in real-time. Dealing with the masses of data produced requires new methods, the so called *big data* approaches. Within these technologies lies great potential to improve many transport issues like transport operations planning, traffic management, or safety.

The trend of "More automation" in transport modes is driven by the development of artificial intelligence, sensors and information and communication technologies. This technological dynamic carries ambitious road safety promises, but also raises difficulties expressed in another trend (3.7.2 "The emerging safety issue in complex networks with new vehicles"). Automation is also developing in the air and rail transport domains.

Regarding the demand side of the digital society, the first trend that we identify refers to the "Expectation of customers and digitisation of mobility". Travellers in the digital world expect to be able to connect their mobile devices, and expect to receive accurate and real-time information about their trips. All these expectations are challenging for transport providers. Quite ambivalently, travellers also want more data privacy.

For the most part driven by the development of the digital society, "New uses of travel-time" can be observed. Classically seen as a burden, travel time can become a positive moment for users. This trend is able to influence the transport mode choice in favour of public transport and detrimental to the car, until automation is introduced.

- 3.6 Novel Business models and innovation in transport

The transport sector is witnessing the emergence of new players, new business models interacting with – if not fuelled by – new behaviour. New business models are closely related to the trend of "Rise of the Internet of Things and big data". The main issue regards the challenge over the currently dominating individual vehicle ownership model, described in the first trend 3.6.1 "New models challenging the individual vehicle ownership model". The second trend covers the other cases where new players and new business models emerge, in batteries, in data, in freight 3.6.2 "New players and new business models". The last trend highlights the emergence of the co-development model and its implications for mobility: 3.6.3 "Emerging co-development and co-creation of new systems by users and economic actors".

- 3.7 Safety in transport

Despite significant improvement of the levels of safety, especially in the road transport domain, and encouraging perspectives linked to automation, we perceive no sign that transport safety in general would become less an issue in the future than it is now.

In the perspective of the long term promise of a decrease of road casualty through the introduction of automated cars, a new safety issue emerge with the coexistence of automatic and non-automatic vehicles creating complex networks and environment.

Safety will become a far more complex issue than today with necessary adjustments in insurance and liability.

- 3.8 Security in transport

Terrorism is a growing concern in our societies and for governments. Attacks often target transportation means and hubs, and hence the interaction between this trend and mobility and freight is straightforward. More security is expected which raises the security/accessibility tension: the provision of more security in transport by introducing controls/barriers reduces accessibility.

- 3.9 Legislative framework

The legislative dimension translates societal demand by means of the production of laws and rules by public authorities and also by means of jurisprudence. Nevertheless, beyond the mere role of translation of societal demand, it carries a self-dynamic that enlists it as a societal trend in the broad sense. We identify three trends that exert influence in the domains of mobility and logistics.

We observe in the legislative domain a trend of "Diversifying approaches of governance". More actors are invited to contribute to the governance of transport and mobility. In particular, with the association of citizens in decision processes, more transparency is required in governance models. The innovation at play in the domain of legislation and governance leads to a diversification of governance models.

Secondly, with "Legislative models adapts to new transport solutions and businesses" an interaction occurs between new business models and the legislative framework. The legislative framework has to adapt to new solutions, but newcomers must also make sure their business can sustain in a given and moving legislative framework.

The general trend for "Trend toward harmonisation in legislative frameworks" of the legislative framework in Europe has direct implications for transport, e.g. for interoperability of transport systems. This trend refers also to the fact that legislative adaptations to new models and solutions in a given European country will inspire the other countries' reactions.

Barriers and societal resistance to transport development

Based on our investigation of societal trends, we describe the obstacle to transport solutions developments. Despite the widely acknowledged significance of the social impacts of transport in life and their effects across various segments of society this issue has not been reported and related to the previous outcomes of the current report.

All transportation developments have impacts on a social level. Thus, in order to foresee if a transportation change will be sustainable or not we have to check its social implications and how receptive the society is for this change to occur. Even if the focus at the decision making of new transport developments is on environmental or economic aspects, the societal factor is the most crucial, since if the society resists to the change, the transport solution will never penetrate the market and will, in the end, collapse. That being said, in this Deliverable we have been elaborating the societal resistance in the sense of specific pillars that can be perceived as basic ones in the social sector, namely the "Job related resistance", the "Accessibility aspect", the "Technophobia and personal data protection" and the "Habit aspect", which determine the overall societal framework.

Conclusion

Because of the intrinsically interdependent nature of the societal trends shaping the demand of mobility and logistics, we have to express these interactions. A small group of interactions between trends links societal dynamics to policies aimed at correcting or accompanying them. A large group of interactions includes all the links between societal trends and digital technologies that form the concept of *digital society*.

In addition to these groups of links, three interactions have been identified. Complex interactions link automation and transport safety. The responses to the security threat perception carries the risk of introducing more controls that may be detrimental to the ease of access and use of collective transport systems. Finally, liquid modernity is both a consequence and a source for the observed restructuring working arrangements. Indeed, the acceleration observation is paradoxically based on the growing mobility for non-work purposes, and hence directly related to the idea of growing part-time work described in the restructuring arrangement trend.

1 The project Mobility4EU - Action Plan for the Future of Mobility in Europe

Mobility4EU is a Coordination and Support Action of the European Commission started in January 2016 and lasting for 3 years, until 31 December 2018.

The project will deliver a vision for the European transport system in 2030 and an action plan including a roadmap to implement that vision. Recommendations for tangible measures in research, innovation and implementation targeted towards various stakeholder groups will be derived. The work towards that vision and action plan is based on the identification and assessment of societal challenges that will influence future transport demand and supply, and the compilation of a portfolio of promising cross-modal technical and organisational transport solutions. The entire process from studying trends and options for solutions, developing a vision and finally the action plan are organized within a structured participatory approach that focuses on user-centeredness and that aims to engage a broad stakeholder community into the consultation processes. This will be achieved by the Multi-Actor Multi-Criteria Analysis (MAMCA) and an accompanying story mapping process. Both concepts are explained in more detail in the project website (http://www.mobility4eu.eu/vision/). A further goal is to build a European Transport Forum that continues the work beyond the project duration and works on complementing the action plan.

The seed structure for this broad stakeholder consultation and the focus on user-centeredness is the project consortium that gathers 19 organizations from 11 European countries. Partners cover expertise on all modes from industry and academia. In addition, legal expertise as well as organizations that can provide the perspective of different transport users are present in the consortium. This is further broadened by the inclusion of associated partners that fill gaps in expertise and strengthen significant aspects.

Within the first phase of the project, societal challenges, requirements and needs that will influence the future transport demand and supply have been thoroughly researched and assessed. The results of this phase are reported in this document. Within an interactive workshop further inputs from stakeholders have been collected thereby validating and extending on the research that has been done in the project. This lead to the creation of the context map which is the first part of the story map and which is available on the project website (http://www.mobility4eu.eu/wp-content/uploads/2016/10/context-map-deliverable_colours_vectors.pdf).

2 Introduction: a general understanding of mobility in the context of Mobility4EU

The acknowledgement that mobility is of crucial importance for our societies represents a broad consensus in scientific literature and in policies. And this trend is not seen as losing importance: according to a study by the International Transport Forum in 2011 (Wilson 2011), by 2050 passenger mobility should increase by a staggering 200-300 % and freight activity by as much as 150-250 %.

Society and mobility are so closely linked that some authors proposed to replace the study of society by the study of mobility (Urry 2007). In this spirit we chose not to separate society from mobility and transport but rather consider them in an integrated approach.

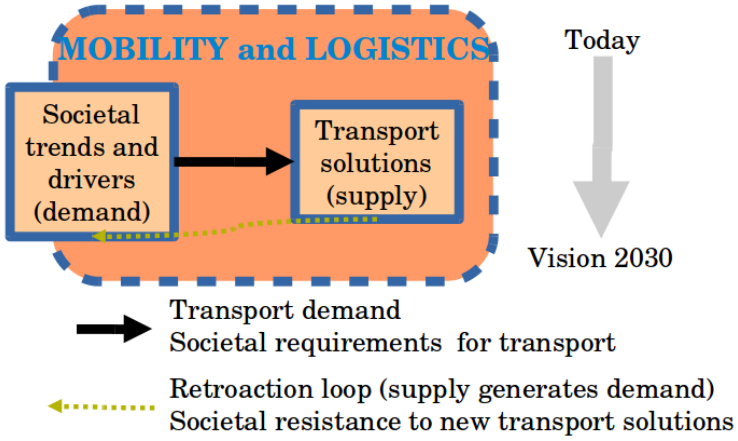

Figure 1: General concept of Mobility4EU project

We propose to define our domain of study as mobility and logistics. Almost all societal trends have effects on mobility and logistics demand and supply. In an economical approach transport is studied as a demand supply paradigm. Nevertheless, a retroactive loop exists where new supply is able to generate a new demand that was not expressed before. In addition, the emphasis on society in our approach allows us to include in the retroaction loop the societal resistance to the implementation of new transport systems. The societal resistance is covered in the last section of the present deliverable (section 4.3 “Societal resistance over new transport solutions“, page 64).

We are developing an analysis of this system in the present situation and with a temporal horizon of 2030, as we committed ourselves in the context of the Mobility4EU project.

In order to organise the cooperation work among partners from different countries in Europe, and to produce a coherent report, we start by introducing a list of shared definitions of key concepts. Some of these concepts can have slightly different meaning in literature, in policy documents or in the common language – for instance whether mobility does include freight transport is in different situations answered differently – which justifies the need for this section.

The definitions that we propose here are relevant for Mobility4EU (not necessarily relevant in a different context), form a coherent set with the minimum ambiguities, and remain easy to grasp (not too long and so as close as possible to the common sense definition).

(1) **Societal trend**: A societal trend is an emerging pattern, movement, evolution in society that leads to change and potentially has implications for mobility and transport (e.g. ageing, social networks). Societal trends impact transport demand and its evolutions. Thus, they can be considered as societal drivers for transport.

(2) **Political trend**: Differing from societal trend, a political trend is an expression of political will that can have implications for mobility and transport (e.g. sustainability).

(3) **Economic trend:** An economic trend is an emerging pattern, movement, evolution in the global or local economy that has an impact on mobility demand and interacts with the societal and policy trends (e.g. globalisation, development of international trade, economic restructuring, employment patterns, etc.)

(4) **Technological trend**: A technological trend occurs in industry and is driven by technological evolution, as opposed to societal trend driven by social change. Technological trend is a key driver of the evolution of transport supply, as highlighted in the retroaction loop presented before.

(5) **Mobility**: Mobility refers to the movement of people. As mobility is a key feature of society in the common academic understanding (Urry 2007; Kellerman 2012), mobility can be seen as encompassing a large and significant part of societal trends. Mobility is realised by the actual use of a transport solution.

(6) **Logistics**: Logistics refers to the organisation of the movement of goods.

(7) **Transport user requirement**: All the aspects (functional and physical) that users take into account to make a choice between transport options are considered user requirements. This includes the cost of the transportation in terms of time and money, the quality of service, the accessibility of the service, etc. User requirements may differ in essence and weight depending on the type of user.

(8) **Transport solution**: A technological solution, an organisational concept or a system of both that contributes to meeting mobility and transport demand is a transport solution.

(9) **Societal resistance**: Societal resistance refers to the societal opposition to different dominant forms of social norms and values. Societal resistance includes also the opposition to governmental political and social actions and policies as well as to the adaptation of new technologies or solutions that may implement and support these actions or policies.

3 Societal, political, technological, environmental, legal and economic trends interacting with mobility and logistics

In this section we provide a comprehensive vision of societal drivers having an impact on mobility and logistics. The definition of societal drivers covers the definitions given in the previous section and includes societal trends, political trends, economic trends, technological trends and legal trends.

This section has for objective to provide a basis for the understanding of societal trends, in the broad sense, and an input for the next phases of the project, especially the scenario needed in the multi-actors multi-criteria analysis (MAMCA) to be developed in the next work packages of Mobility4EU.

In order to achieve this task we have been working from existing scientific sources, cited along the text and shown in the reference list, from past or ongoing European projects[1], and from workshop outputs involving stakeholders of the project.

As compared to exercises in European researches with a similar scope, our approach is rooted in the study of societal trends as opposed to a more classical transport demand analysis as for example in TransForum (Anderton, Åkerman, et al. 2015), in TRANSvisions (Petersen et al. 2009), in FUTRE (Bernardino, Vieira, and Garcia 2013), in RACE2050 (Sena e Silva et al. 2013, 20), in EUTransportGHG (Sessa and Enei 2009) or in ORIGAMI (Lemmerer and Pfaffenbichler 2012). These approaches tend to separate trends along classical transport modes and transport markets, without going one step beyond, in the study of societal trends, as in the present project. As opposed to these approaches we have started by an analysis of societal dynamics in a broad sense, and in a second stage identifying those trends that have an interaction with mobility and logistics. Societal trends are for us entry points instead of transport solutions and markets. Our approach is hence complementary to these projects. In addition, as opposed to more thematic approaches having also studied societal trends like for instance CITYLAB on freight (Dablanc et al. 2016) or TransForum on a few targeted transport sectors (Anderton, Åkerman, et al. 2015), our analysis intends to cover all transport modes, all geographical scales and freight as well as passenger transport.

We are developing an analysis of this system in the present situation and with a temporal horizon of 2030. In consequence, our description of trends aims at capturing the present situation and the dynamics of these trends in the future.

Common structure for the description of trends:

1. Textual description of trend with scientific and policy references
2. Interaction between trend and mobility (through key elements of the transport system: users, infrastructure, vehicles, governance and organisation)
3. Type of trend: Political, Economic, Social, Technological, Legal and Environmental
4. Evidence of trend, sources of evidence

[1] The list of European projects studied is given at the end of the present deliverable page 81.

In this section, and according to the collaborative production process adopted in the Mobility4EU consortium, a trend has an unequivocal impact on mobility. If neighbouring trends have the same impact or the same type of impact on mobility we have decided to merge them. Conversely, if a trend was considered as containing diverging impacts on mobility, we have separated them in two distinct trends.

The result of this process, implemented in the work package 2 of the Mobility4EU project, is the following list. This list can be seen as the shortest possible set of trends that allows describing present and emerging societal factors, in a broad sense, that have impacts on mobility, both for freight and passengers' mobility.

This list will be used as elements for building scenarios in the MAMCA analysis.

The list is composed of 29 trends organised in 9 larger trends.

3.1 Distribution of wealth and labour market developments

Economic climate and economic conditions play a major role in shaping the demand of mobility. We identify two trends in the economic domain. Firstly, the adaptation of Europe's economy in the global context of a significant relative decline of GDP is foreseen. European GDP and population should grow but much slower than the rest of the world in average. Direct consequence of the global growth will be an increase in flows, particularly freight, but a possibility has been identified of a reindustrialisation of Europe, which could lead to significantly modified freight flows. At the individual level, economic growth usually converts into more mobility, as illustrated by the growth of tourism.

The second major trend refers to the restructuring of working arrangements. Telework and part-time work are the two major foreseeable tendencies already at work and that should grow in the future. They have direct and indirect effect on mobility. A reducing quantity of home-to-work flows but that could be longer due the urban sprawl made easier by telework, less peak hour traffic, but also more trips for other purposes. A likely consequence of the last effect has been identified as a demand for more flexible tickets for public transport.

3.1.1 Share of the European economy in world GDP declines

At the global scale it is anticipated that the population will grow to nine billion people by 2050 and that GDP will rise in the same time frame from $72 (€58) trillion (2010) to $380 (€305) trillion (Bassanini and Reviglio 2011). Europe however, is expected to account for just 9 % of global GDP by 2050, down from 28 % in 2010 (Bassanini and Reviglio 2011). As identified in the TRANSFORuM project, the implications of this decline, as more emerging economies begin to exert their influence, may be far-reaching, but it is difficult to predict what they might be. Whether will we see a centralisation and focus on particular industries in Europe, or a general reindustrialisation of the continent, based perhaps on new technologies and innovation – it is impossible to know for sure (Anderton, Åkerman, et al. 2015, 9). The industrial dynamics in the future will also rely on the fact that on-shoring or return of manufacturing from lower cost locations is partly driven by increasing transportation costs, but also by a concern with quality and producing goods closer to the market. Balancing cost control with non-cost elements of product (speed of delivery, customisation) is becoming an important element of manufacturing competitiveness (Bryson, Clark, and Mulhall 2013).

A process of hybridisation between manufacturing and services is also occurring, leading to the production of hybrid products or products containing a complex combination of services and manufactured inputs. These new service facilities will have a different geography of manufacturing plants as some will be required to be located close to market and most will require access to skilled labour (Bryson et al, 2013).

Interaction between trend and mobility: Future growth in world GDP is linked to (more rapid) growth in global trade and changes in freight flows (volumes, origins and destinations, with a shift towards emerging countries as places of origin and destination of goods) ('ITF Transport Outlook' 2015). Freight flows will be impacted. Reindustrialisation means more imported spare parts and materials (which can mean more opportunity for rail and barge transport within Europe). Reindustrialisation can involve shorter distances between production and consumption, and decreased tonne-kilometres across Europe.

However, it is generally understood that world growth will spur increased freight mobility, especially on European roads connecting important gateways (ports, airports, major logistics parks) to consumption markets in large metropolitan areas.

At the individual level, economic growth usually converts into more mobility, as illustrated by the growth of tourism (Dubois et al. 2011).

Type of trend: Economic

Evidence of trend: population and GDP growth figures cited before can be seen as evidences of these global trends. The figure of 1.6 billion international tourist arrivals is predicted by 2020 (Dubois et al. 2011).

3.1.2 Restructuring working arrangements

Restructuring of working arrangements (working time, part-time work, teleworking, self-employment at flexible times) have an impact on travel demand (trip generation, temporal and spatial distribution of trips)

One major substitution that depends on Internet access is telework—work performed at home or from another location close to home that would otherwise be performed at a workplace.

Part-time work is becoming more prevalent across EU countries. Part-time employment is most common at the end of one's working life, with the 65+ age group having the highest percentage of part-time workers (Isusi and Corral 2004). Meanwhile, many EU countries are increasing, or planning to increase, their retirement ages, including the UK, Germany, the Netherlands and Spain (Jagger et al. 2014). This could indicate that there will be an increased number of older, part-time employees in future years.

Interaction between trend and mobility: The number of trips to work generated should drop due to teleworking. Hence, changing travel patterns in time should lead to less peak hour travel, but non-peak travel might increase because teleworkers often make additional vehicle trips to run errands that would otherwise have been made during a commuting trip. Teleworking makes it easier to extend commuting distances therefore more long distance trips can be expected and can also trigger urban sprawl. The evolution of economics, with lower need for labour for production (Jackson and Victor 2011), could lead to more free time for non-work activities and the related mobility, and lower volumes of freight transport (Bernardino, Vieira, and Garcia 2013, 89).

Regarding the increase in older workers in the labour market, and especially part-time older workers, there could be an increased demand for more flexible tickets for public transport (e.g. off-peak tickets, 3 days-a-week tickets).

Type of trend: Economic, Social

Evidence of trend: In the US it was estimated in 2013 that 63 M workers – or 43 % of the workforce- will undertake some kind of work from home by 2016 (Narayanan 2013).

3.2 Inclusive society, personalisation, accessibility

The second large trend we identify refers to societal dynamics that interact with mobility and freight demand. Most of these trends are mainly societal dynamics (like "Increasing life expectancy of the population" or "Migration trend generating long distance flows"), but some of them are also supported ("Move towards more active and healthy lifestyles") or driven ("Trend towards inclusion of vulnerable to exclusion groups" and "European integration facilitating flows") by policies.

"Increasing life expectancy of the population" is an essential dynamic of European societies. The interaction with mobility and logistics are complex though: the population of car drivers is likely to grow, and less active mobility is expected from the disabled "oldest old", but maybe more active mobility will come from those who will stay or move back in denser urban areas; a need for proximity in goods and services deliveries for the urban elders contrasts with specific and costly mobility demand in ageing rural areas.

"Migration trend generating long distance flows" introduces or develops specific patterns of mobility demand: the foreseen increasing migration in Europe will generate more long distance flows of persons and goods with origin countries.

There is a consensus on the fact that policies are supporting a "Trend towards inclusion of vulnerable to exclusion groups". This trend, addressing societal issues, has direct translation in the transport policy sector with the theme of accessibility for all. In addition to the long-time known vulnerable groups, the digitisation of mobility carries the risk of creating new exclusion, for instance among those who do not own a smartphone.

Forming a part of the explanation of the *peak car* phenomenon, the tendency of "Less car use by younger generations" has been observed in the recent period since the mid-2000. Connecting to the social network, whatever the means, physically based or telecommunication based, seems to have outshined the car ownership dream observed in precedent generations.

Another consequence of the societal awareness for environmental issues is the "Move towards more active and healthy lifestyles". This trend is fuelled by individual awareness and by policies aimed at influencing individual behaviour. Health is likely to become a major concern in the future with direct translation for the policies aimed at orientating mobility behaviour.

There is an emerging consensus among social scientists around the idea of *liquid modernity* introduced by Z. Bauman. In order to characterise the interactions of liquid modernity with mobility and logistics we have established two trends: "Acceleration and flexibility of liquid modern society" and "Personalisation of liquid modern society". The first trend refers to the ideas of acceleration and flexibility and provides an explanation to the increase of leisure time and its associated mobility patterns. It also entails a requirement of transport users for less need for planning their trips, of immediate and seamless access to information. The second trend of liquid modernity highlights the personalisation aspect. The individualisation process, illustrated among other indicators

by the decreasing size of households, favours individual transport modes of cars but also bike and walk, and also favours models of the type "one-stop-shop" for mobility services.

Essentially driven by policies and political choices "European integration facilitating flows" is still, despite the recent reverse movement by United-Kingdom, an ongoing process. Its impacts on mobility are straightforward through the development of tourism and of freight flows in Europe.

3.2.1 Increasing life expectancy of the population

Ageing society/"silver society" will reshape the role of elderly people in the society as well as their needs, and activities in all societal dimensions:

The ageing issue will have the strongest implications for the organisation of transport systems. The older European population of the future will have different transport requirements, and current transport and mobility enablers need to adapt to meet these challenges. But different countries are ageing at different rates. In the 20th century it was Western and Northern Europe that had the oldest populations, but by 2060 this will be almost reversed.

Across Europe, the trend is generally that cities attract working-age adults, meaning that the percentage of working age adults in cities tends to be higher than the national average (Eurostat 2015b). Conversely, the population structure in rural areas across many European countries is older than in urban areas, with the percentage of the population who are aged 65+ higher in rural areas than urban areas in every EU country except Belgium and Poland (Eurostat 2015b). This is especially true in Western and Northern European countries, and as economic development continues in Southern and Eastern European countries, this urban/rural divide in terms of age structure could increase in Europe.

Global ageing has a major influence on disability trends. The relationship here is straightforward: there is higher risk of disability at older ages, and national populations are ageing at unprecedented rates (World Health Organization and The World Bank 2011, 34). The growing proportions of older people in national populations and the increased numbers of the "oldest old" most at risk of disability are well documented (World Health Organization and The World Bank 2011, 35). More than a billion people are estimated to live with some form of disability, or about 15 % of the world's population (World Health Organization and The World Bank 2011, 261).

Interaction between trend and mobility: According to the conclusions of the project TRANSFORuM, focusing attention on active mobility (e.g. walking and cycling) may be less plausible for all people within the older sections of society and more compact and smart urban and regional development may be needed, offering more public services in closer proximity to where people live (Anderton, Åkerman, et al. 2015, 7). Access to transport services, including high-speed rail, should account for an older client base, with attention paid to enabling those with decreased mobility to retain or gain access (Anderton, Åkerman, et al. 2015, 7).

The Netherlands experience about bicycle tells about the relationship between ageing and bike use (CROW Fietsberaad 2014). Since 2004, cycling in the Netherlands has increased by 6.5 %. The main reason is the growth of the population and the number of cyclists. The use of e-bikes means people are cycling longer distances. The e-bike is especially popular with the over-65 age group. A quarter of all persons in that category now have an e-bike. Only 1 % of adults up to the age of 40 have an e-bike. The percentage for the 40-

50 category is 5; of those aged between 50 and 65, some 10 % have an e-bike (CROW Fietsberaad 2014).

Future generations will also be entering older age more mobile than ever before. More will be using a car, more will be taking longer trips, and more will be taking trips for leisure, including air travel (European Metropolitan Transport Authorities 2007, 8). A short-term trend will be the increase in older drivers in Europe. Use of a car has previously been increasing in each age cohort in Europe, meaning that people reaching old age in the future will have higher rates of car use; this trend will be particularly apparent in older women (European Metropolitan Transport Authorities 2007, 6).

As the middle-aged population in Europe ages, they will reach older age with higher rates of car ownership than previous older generations. This will see an increase of older drivers, as well as less 'captive users' of public transport (e.g. the older generations of the future will have the choice of driving and using public transport).

Taking a more macro-economic view, an ageing population will, even under conservative estimates, place government budgets under severe pressure. Government expenditure on health, long-term care and state pension provision is predicted to increase across European countries as the proportion of older people increases (European Commission 2015, 140, 162). This could mean that government budgets for transport provision could be reduced in order to meet the health and care needs on an ageing population.

Whilst urbanisation trend happens, rural populations will see an increase in the proportion of older people living in those areas. This means that rural transport provision will have to cater more for the needs of older passengers with mobility issues, and public transport providers may have to adapt their business model to prepare for a higher proportion of passengers using concessionary tickets. Also whilst in high-density urban areas it is easier to make an economic argument for a integrated, smart technological transport systems, it is harder to make an economic argument for the same system in low population-density rural areas, possibly creating a 'digital divide' (Velaga, Beecroft, and Nelson 2012, 1).

Another effect of an ageing population is that consumption patterns may be shifted more towards services, which will to some extent reduce the need for freight transport. This however will also depend on where ageing people choose to live and to what extent policies encourage a shift of the older populations from rural to urban retirement (Anderton, Åkerman, et al. 2015, 8).

Type of trend: Social

Evidence of trend: in 2014 population of EU-28 aged of more than 65 years was estimated to be 18.5 % (Eurostat 2015a, 18). The percentage of Europeans aged over 65 is projected to rise from 16 % in 2010 to 29 % by 2060. The European population aged over 80 is set to rise from 4.1 % in 2010 to 11.5 % in 2060[2]. Europe's population is also growing, with the EU population set to increase by 18 million people by 2050[3].

In the 20th century it was Western and Northern Europe that had the oldest populations, but by 2060 this will be almost reversed, with the oldest populations in Eastern and Southern Europe – in 2010 the country with the highest percentage over 65 years old was Germany (20.7 %), but by 2060 it is predicted it will be highest in Latvia (35.7 %) (Creighton 2014, 5). According to the conclusions of the project TRANSFORuM, the total EU population is projected to be stable over the period 2010 to 2050 (Anderton, Åkerman, et al. 2015, 7). However, the share of people over 65 (dependency ratio) may

[2] According to an assessment of ILC-UK in 2014
[3] According to an assessment of ILC-UK in 2014

increase by 70 % and the share of people over 80 may increase by 146 %. The ratio between the total population and those between 15 and 65 is thus projected to increase from 1.44 in 2010 to around 1.76 in 2050 (Anderton, Åkerman, et al. 2015, 7). The highest dependency ratios by 2060 will be in Slovakia, Portugal, Greece and Poland, which will all have less than two working age adults per non-working age person (Creighton 2014, 7).

3.2.2 Migration trend generating long distance flows

According to the 2011 European white paper on transport, migration already plays the predominant role in population growth today: in many Member States, the size of net migration determines whether the population still grows or has entered a stage of decline. Net migration might add 30 million people to the EU population by 2030 and an additional 20 million by 2050 (European Commission 2011a, 132).

In addition, the mobility of workers within the Union is expected to increase with the gradual removal of administrative and legal barriers and further deepening of the internal market.

Interaction between trend and mobility: Migrants will further intensify Europe's ties with neighbouring regions by creating cultural and economic links with their country of origin. These links could entail more movement of people and goods. Related to this, more cross border rail links are being (re)opened, international travel is made easier. In general, erasing (geographic) borders will increase demand for travel. A demand for multilingual information services will also increase with the development of a multicultural society (Brög, Barta, and Erl 2005; Sena e Silva et al. 2013, 57), which is seen as a trend for the future, for example in the Netherlands (Sena e Silva et al. 2013, 57).

Type of trend: Social

Evidence of trend: a total 3.4 million people immigrated to one of the 28 members states during 2013, while at least 2.8 million emigrants were reported to have left an EU member state according to Eurostat (Eurostat 2016). The most recent data are from asylum seekers: following an upward trend since 2006, the year 2015 has seen close to 1.3 million people as first time applicants ('Asylum Statistics - Statistics Explained' 2016).

In 2008 2.3 % of the total EU population (11.3 million EU citizens) were living on the territory of another EU Member State, according to Eurostat (Vasileva 2009).

3.2.3 Trend towards inclusion of vulnerable to exclusion groups

Issues like accessibility poverty, access inequalities and social segregation are posing new social challenges to transport policy.

The awareness about the necessity and the right of inclusion of vulnerable groups, for instance elderly, has been increasing, but not very fast and there is still a substantial deficit in mobility research on the inclusion of economically disadvantaged urban populations. Some analysis considers that the awareness of *justice oriented* transport policies is rising (Martens 2012).

This trend includes also the engagement on EU level to ensure right to independent living, personal mobility, free movement, education, employment, etc. for persons with disabilities as well as accessibility to transport and its infrastructure and information for

persons with disabilities. Obligations in these fields arise from international human rights conventions, EU Treaty. There are several pieces of EU legislation on passengers' rights in the field of transport, including the rights of passengers with reduced mobility and disability[4]. In December 2015, the EC issued a draft for legislation on 'Accessibility Act' partially covering the field of public transport as well. The act aims at harmonizing accessibility on EU level, and while it does not tackle the physical access to trains or buses, it concerns the field of transport services as well the sales tickets both online and via ticketing machines.

As technology becomes more integral to everyday life, the risks of exclusion increases for certain population groups. The digital divide is defined by the OECD as "the gap between individuals, households, business and geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and to their use of the internet for a wide variety of activities" (OECD 2001). There are a number of 'divides' in Europe; for example, between rural and urban areas in terms of broadband connectivity. There has been progress in this area however, and all EU households can now access basic broadband (Davies 2015, 1). However, there still remains an urban/rural divide in terms of fast-speed broadband provision, with many rural areas with low population density unable to access fast-speed broadband (Davies 2015, 1).

There is also a divide in internet access and use between income groups and age groups. Both EU citizens from 'low educational backgrounds' and older age groups use the internet regularly far less than other population groups (Eurostat 2015b). However, there has been significant progress in both of these areas; the percentage of EU citizens of 'low educational background' regularly using the internet has increased from 23 % in 2005 to 52 % in 2014. Similarly, EU citizens aged 55-74 who regularly use the internet increased from 19 % in 2005 to 50 % in 2014 (European Parliament 2015).

Over 35 % of the EU population is at risk of exclusion from the Digital Single Market if we consider the 80 million Europeans with disabilities, and the 190 million people aged 50+.

EU ratified the UN Convention on the rights of persons with disabilities (UN CRPD) the first human rights treaty to address access to ICTs, which explicitly requires accessibility for information and communication technologies and systems for persons with disabilities. Information used in transport therefore needs to be accessible for persons with disabilities. Guidelines and standards to address accessibility of information and communication are in force (ISO 2016; CEN, CENELEC, and ETSI 2014). Some binding EU legislation stipulating requirements for accessibility of information for persons with disabilities are in draft form[5].

Considering this "digital divide" it should be kept in mind that information as well as all other procedures (booking, reservation, etc.) should also be available in alternative formats via different sensory channels. If for example information on train timetables is available on the website of the transport operator, the timetable information should also be available in print format and audio so that everybody, including persons with sensory impairments, can obtain the information. The same is true for the booking procedure: besides online booking, this should also be offered via a free telephone line, for example.

[4] Prohibition of discrimination based on disability in the field of transport, as well as obligation to provide assistance to persons with disabilities or reduced mobility is included in the set of Passengers' Rights legislation, including Regulations 1107/2006, 1371/2007, 181/2011, and 1177/2010.

[5] Directive on the accessibility of public sector bodies' websites and European Accessibility Act

Interaction between trend and mobility: The restructuring of mobility in urban areas with new sustainable mobility approaches promise a window of opportunity at this point, where dedicated mobility solutions for vulnerable and underprivileged groups can also be embedded in the new mobility landscapes.

A survey in 2013 in Paris region shown that impaired people have a mobility quite similar to that of the non-impaired in terms of number of trips and purposes. The significant difference lies in the use of public transport where impaired people tend to use surface modes of bus and tramway significantly more than underground modes highlighting their more difficult access for the impaired (Meret-Conti, Paulo, and Debrincat 2014).

Technology can make transport and mobility easier and more accessible for many people; for example, Uber can offer relatively low-cost and easy to use taxi services, whilst real-time travel information at bus stops can inform passengers of delays and easiest journey routes. However, this can mean that certain population groups are excluded from these technological developments; mainly rural populations (where the infrastructure is not available) and population groups that do not use the internet or do not own a smartphone (Velaga, Beecroft, and Nelson 2012, 105–6). The European project DECOMOBIL on multimodal mobility highlighted the fact that usability and legibility of information on nomadic devices is a challenge in terms of human centred design, due to the size of the screen and the mode of dialogue (e. g. tactile screen, small keyboard) (Pauzié 2013, 32).

Type of trend: Political

Evidence of trend: 25 of the 28 EU Member States have ratified the United Nations Convention on the Rights of Persons with Disabilities, as well as the EU as a regional body itself. That means that almost all Member States are now obliged to change their legislation and include accessibility as one of the provisions, including in transport legislation.

The digital divide is reducing in Europe, between urban and rural territories, or between age groups as EU citizens aged 55-74 who regularly use the internet increased from 19 % in 2005 to 50 % in 2014 (European Parliament 2015). In the same time the *digitally illiterate* group remain a reality since over 35 % of the EU population is at risk of exclusion from the Digital Single Market if we consider the 80 million Europeans with disabilities, and the 190 million people aged 50+.

3.2.4 Less car use by younger generations

A significant decrease of the use of cars by younger generations has been documented in the USA (Davis, Dutzik, and Baxandall 2012), and this argument forms a part of explanation of the peak car use observed between 2000 and 2010 in many countries and cities (Goodwin 2012; Newman, Kenworthy, and Glazebrook 2013; Metz 2013).

The late modern society (Rosa 2003) adds to the modern individualism and to the post-modern fluidity, the new dimensions of the social networks and the pervasive use of information and communication technologies. The so-called generations Z and Y exemplify these evolutions with a lower use of cars than their predecessors. If a consensus can be found in the scientific literature on this trend, other sources pushes opposite arguments (Xerox and Harris 2016; Autotrader and KBB 2016). Nevertheless, both studies are based on preference surveys and not on observed behaviour, and are funded by industry (Xerox and Harris 2016) or directly by the car industry (Autotrader and KBB 2016), so they should be considered with caution.

Predicting the future evolution of this trend is particularly challenging. As noted in the TRANSFORuM project (Anderton, Åkerman, et al. 2015, 12), as the current younger generations grow older over the next 3 decades, it is unclear whether we will continue to see the recent changes in social norms endure, with respective to private car ownership and driving licence abstinence for a growing number of the young population. Perhaps the current non-drivers will learn to drive in later life, or as urbanisation and densification trends continue, perhaps they will opt out of obtaining driving licenses altogether. The change is very recent and unprecedented over the last century, where driver numbers have continually increased, so only time will tell if this is a short-term trend, or something which will become more societally embedded. It is of course possible that we may also see more of the middle age and older populations give up driving as alternatives, or driver-less cars come to fruition in more urban areas across Europe.

Interaction between trend and mobility: Younger generations use cars less and use public transport and bike more than their predecessors**.** According to a study by Deloitte, the new trend for young generation is the pay per use mobility instead of owing cars. Young adults are gravitating toward a model of personal mobility consumption based on pay-per-use rather than purchase of a capital asset, which fundamentally challenges today's consumption model centred on personal ownership of cars (Deloitte, Corwin, et al. 2015).

Type of trend: Social

Evidence of trend: studies in the USA show that younger generations make significantly less use of cars and more of other modes when compared to their predecessors: for instance in 2009, young drivers took 15 percent fewer trips than young drivers took in 2001 (Davis, Dutzik, and Baxandall 2012, 10). According to German Kraftfahrt-Bundesamt data car ownership among 18- to 29-year old in Germany dropped 44 percent between 2000 and 2010 – from 424 to 239 cars per 1 000 persons in that age group (McKinsey et al. 2012, 9).

3.2.5 Move towards more active and healthy lifestyles

Health can be a driver for individual behaviour, but health is also considered a societal issue with public policies orientated towards the improvement of health with the intention to influence individual behaviour.

Interaction between trend and mobility:

1. Healthy lifestyles are becoming more and more important which has implications on modal split (increasing popularity of active modes)
2. The trend for Public health policies that have or will have direct impact on transport are related to air pollution, and also favouring physical exercise in mobility behaviour
3. e-Health – may have impacts on travel demand?
4. More awareness towards pollution of fine particulates effects speed limits around urban areas and bans for older cars in city centres.

A shift to more sustainable mode of transport, like public transport and E-bikes, would contribute to a more sustainable world.

Type of trend: Social

Evidence of trend: 40 % of the population is exposed to road traffic noise exceeding 55 dB(A) during daytime, and 20 % to levels exceeding 65 dB(A). At night, more than 30 %

are exposed to sound levels that disturb sleep (>55 dB(A)) (European Commission 2011a, 143).

Estimates in 2005 indicated that about 100 000 deaths a year could be linked to ambient air pollution in cities in Europe, shortening life expectancy by an average of a year, even if precisely quantifying transport's contribution to total exposure and its adverse effects are still difficult tasks (Krzyzanowski, Kuna-Dibbert, and Schneider 2005, 200).

3.2.6 Acceleration and flexibility of liquid modern society

There is an emerging consensus among social scientists (Clegg and Baumeler 2010) that a shift towards *liquid modernity* introduced by Z. Bauman (Bauman 2000) exists. Liquid modernity refers to individualisation, to more flexibility but also to an acceleration of social life identified by post-Marxists (Harvey 1990), geographers (Levine 1998) and H. Rosa (Rosa 2003). Individualisation is the topic of a separated trend (3.2.7 Personalisation of liquid modern society page 27) because its interaction with mobility generates different expectations and solutions.

The increase in leisure time, and the apparently contradictory feeling that time pressure increases is one of the key element of the discussion of liquid modernity. This trend is also captured by the opposition between production economy (economy orientated towards exportation products) versus presence economy (economy orientated towards satisfaction of the needs individuals present locally) (Terrier 2006); revenue is earned somewhere and spent elsewhere.

Interaction between trend and mobility: Increasing leisure time, increasing disposable income and competitive prices for air travel and long distances buses, increasing numbers of high speed trains promote tourism within from and to Europe with implications for long-distance and local travel demand.

Acceleration of social life and more flexibility pushes an expectation that using transport systems needs less travel planning, that information is always and immediately available.

By 2025, it is expected that 20 % of retail will happen through online channels. Demand for urban parcel deliveries will increase – shipments to become smaller and frequent (Vidyasekar and Frost & Sullivan 2013a). Consumers' demand towards "instant deliveries" is increasing. In the domain of logistics, as e-commerce has become mainstream, the next evolution is the evolution towards instant delivery or the development of new segments for e-commerce (for example e-grocery). Groceries still belong to the niche in online trading but are expected to grow fast. This has direct impact on mobility and logistics (Vidyasekar and Frost & Sullivan 2013b):

- Road to remain the dominant mode of urban freight transport. Logistics related transport will account for over 35 % of city traffic. Vans will become even more dominant over trucks.
- B2C trips will come to rival the current dominant segment, B2B by 2020 underpinned by growth in e-commerce
- in some markets, average length of haul will decrease as a real estate niche of urban warehouses and delivery spokes will emerge (warehouses moving back to cities).
- Smaller and more fuel-efficient vehicles will be used within cities which are seamlessly integrated with multi-modal functionalities

- Future delivery vans will revolve around driver support, connectivity, fuel efficiency and design. Some new types of vehicles will emerge (cargo cycles). Instant delivery bikers to gain market share in cities.

Type of trend: Social

Evidence of trend: The development of leisure time and mobility at the local and daily scale is shown by studies of travel times in Île-de-France region (Paris) that show a significant increase of travel time devoted to non-work or studies activities, from 40 min in 2001 to 52 min in 2010, while work and studies mobility time budgets slightly decreased (Courel and Gloagen 2016).

Concerning acceleration, Levine proposed a measurement of the *pace of life* based on the three measurements of the speed of pedestrians in streets, the time it takes to buy a stamp in a post-office and the accuracy of public clocks (Levine 1998, 131). These measurements have been criticised but they show a high level of diversity across the planet, linked to cultural differences.

Walking speed of pedestrians is considered as dependant on the size of cities (Bornstein and Bornstein 1976; Bettencourt et al. 2007; Schläpfer et al. 2014). If we follow this rationale, pace of life should increase with the increasing size of cities related to the urbanisation trend (by extension through mobility and by intensification).

A recent survey on 12 000 respondents in 6 developed countries (France, Spain, Germany, USA, Turkey, Japan) shows that 74 % consider that the pace of life is too fast in the current society (Forum Vies Mobiles 2016).

3.2.7 Personalisation of liquid modern society

Individualisation is a key feature of our modern societies, and takes new forms in the *liquid modern* society (Bauman 2000). In addition to acceleration and flexibility devised in the previous trend (3.2.6, Acceleration and flexibility of liquid modern society page 25) liquid modernity emphasises the individual as a player reinforcing his role, over the determinism of social aggregates of all kinds (e. g. family, nation).

Individualisation is in several ways linked to the trend of a decreasing household size. The average household size in the EU-27 is expected to decline from 2.4 persons in 2005 to 2.1 persons in 2030[6]. This is due to a combination of factors including lower marriage and fertility rates, ageing population, rapid urbanisation and rising wealth in emerging markets (Euromonitor 2013). This trend implies a significant increase in the number of households, adding 28.9 million households between 2005 and 2030 in the EU-27, despite stability of total population (Capros et al. 2008).

The personalization of economy stimulates new kinds of jobs, more flexible, that compete with existing jobs and economic structures; effects of the so called *uberisation* on working conditions is significant, especially in the transport (taxi vs uber and the likes) and logistics (delivery) sectors.

Interaction between trend and mobility: The reduction of household size may have implications concerning vehicle ownership and travel behaviour. Car ownership is significantly lower for single households than for multiple person households (Fornells and Arrue 2014, 96). Due to smaller household size more complex mobility is needed to

[6] United Nations: Global Urban Observatory and Statistics Unit of UN-HABITAT (UN Centre for Human Settlements): Human Settlement Statistical Database version 4. Also available at:http://ww2.unhabitat.org/programmes/guo/statistics.asp

establish and maintain social contacts as well as to conduct other activities which then again increase the demand for transportation (Brög, Barta, and Erl 2005).

The individual mobility needs are strengthened by the liberalisation of working hours and conditions, making commuting less regular (Lanzendorf et al. 2005) described in trend 3.1.2 Restructuring working arrangements page 18.

Apart from the expected benefits for the travellers (reduced travel cost, time, flexibility in their mobility), new business models will emerge to host the one-stop-shop services that needs to collaborate with all transport stakeholders (following the example of *Booking.com*, …).

Type of trend: Social

Evidence of trend: In EU-15 the size of households from 2.48 in 1995 is foreseen to decline to 2.17 in 2025 (Laihonen 2003).

Regarding e-grocery, while in 2011 only 4,5 million people in Europe stated that they have been ordering at least once food online, about 15 million stated that in 2014 (Ecommerce Europe 2014). Furthermore, the competition of e-commerce in urban areas is moving to instant delivery with e-retailers proposing one-hour, two-hour, or same-day deliveries. The emergence and burgeoning of *crowd shipping* solutions is an evidence of this trend: TokTokTok, Amazon Flex, Uber Rush.

3.2.8 European integration facilitating flows

The process of European integration is a tendency to lower international borders and facilitate the movement of people and goods.

Interaction between trend and mobility: the European integration has for explicit objective to implement a free space for the circulation of citizens and goods. This objective has direct impacts on facilitating mobility at cross border and European global scales. The European mobility for leisure and tourism purposes is a direct beneficiary of the achievement of a single European space; the most recent events in the UK confirm this trend: British tourism industry expects a rise in British tourism in Britain, at short term driven by the devaluation of the Pound, and in longer term by the expected re-apparition of borders.

Type of trend: Political

Evidence of trend: the continuous extension of the European Union since its creation – until the most recent events of the Great-Britain referendum in 2016 – can be read as an evidence of European integration, the other being the continuous movement of economic and political integration of institutions, for instance reflected in the adoption of Euro.

In 2013 European tourism flows accounted for more than half of global flows, following a long term upward trend of +2.9 % on the period 2005-2013 (Kester 2014).

3.3 Urbanisation and smart cities

Urbanisation is the major trend of human settlement. It also affects Europe despite an already high level of urbanisation, which is foreseen to increase from 73 % in 2014 to 84 % in 2050.

Cities and city-regions, which are densifying and spatially extending, are more and more the dominant forms of settlement. These trends lead to more intense and longer urban flows, both for passengers and goods.

The emerging model of the *smart city* aims at articulating human and social development with information and communication technologies in cities. Equipping cities with ICT infrastructure is pushed forward by the introduction of new technologies of mobility (mainly electric vehicles, car sharing, car-pooling) and should lead to new social interactions and to new uses of city spaces, and hence should have significant impacts on mobility behaviour and freight demand.

3.3.1 Rising and expanding urbanisation

Urban space has become the dominant European geography. As the share of Europeans living in urban areas is expected to increase from 73 % in 2014 to 84 % in 2050, transport movements occur increasingly in an urban context (United Nations 2014, 10). Growing and extending cities lead to the emerging concept of city-regions, which combines several spatial scales and transport modes. Cities expand and become more dense which constitutes a factor for commuting longer distances. Commuting longer distance to work place is due to the difficulties to find a job locally, and to the aspiration to greener place of living and availability of cheaper land in the periphery.

Regarding urban logistics, it should be mentioned that freight is an important traffic component in cities (10 to 15 % of vehicle equivalent miles), load factors for delivery vehicles in cities are very low (e.g. 38 % for vans in London) and urban freight is responsible for 25 % of urban transport related CO_2 emissions and 30 to 50 % of other transport related pollutants. As the number of logistics facilities increases in cities, especially large cities, an urban pattern called "logistics sprawl" brings additional freight vehicle-miles in urban regions. Logistics sprawl is the spatial de-concentration of logistics facilities and distribution centres in metropolitan areas (Dablanc and Ross 2012; Dablanc et al. 2016). It has been a noticeable spatial pattern for the last decades in large cities around the world, especially cities with a strong logistics activity. Logistics sprawl can have impacts on freight mobility within metropolitan areas, increasing vehicle-kilometres to reach points of destinations (urban businesses and households). Logistics sprawl is linked to land costs and the emerging logistics real estate industry.

Interaction between trend and mobility: Growing cities lead to a more intense mobility (denser traffic, longer and larger flows) (Sena e Silva et al. 2013, 58); spatially expanding cities lead to the need to extend public transport in lower density areas weakening their economic case (Bruegmann 2008); urban freight (last mile logistics) will more and more be an issue. As agreed in the TRANSFORuM project conclusions, urban logistics and the last mile of any given freight trip needs to be given more attention in the medium- and long-term future (Anderton, Åkerman, et al. 2015, 12).

Nevertheless, as was noted in the TRANSFORuM Urban Transport Roadmap (Anderton, Brand, et al. 2015), the diversity between cities cannot be ignored; the forms of the interactions between urbanisation trends and mobility will strongly depend on urban contexts.

It has been shown that logistics organisations are also subject to sprawl in large metropolises. This movement generates extra mileage by vehicles and hence extra CO2 emissions (Dablanc and Rakotonarivo 2010).

Cities and regions are competing with each other in order to attract inhabitants, jobs, tourists. This competition is a factor pushing local authorities to implement innovative transport solutions and consider them as instruments for the transformation of “city image”. The city of Montpellier in France is known for having used the introduction new

trams (light rail) as communication instruments to successfully catch attention and attract businesses and new inhabitants.

Type of trend: Economic, Social

Evidence of trend: share of European living in urban areas should grow from 73 % in 2014 to 84 % in 2050 (United Nations 2014, 10); artificial land cover increased by 3.4 % in Europe between 2000 and 2006 (European Environment Agency 2013). At EU-27 level, in 2005, 4 hours per week are spent on commuting (Eurostat 2009, 42).

Recent economic studies found a correlation between diversity and economic performance for European regions (Bellini et al. 2013). More generally, while discussed (Dijkstra, Garcilazo, and McCann 2013) a broad consensus that regions and cities are emerging actors that tend to reinforce their economic and political power (Fujita, Krugman, and Venables 2001) remains.

3.3.2 The emergence of Smart cities

Smart cities aim to meet demands of rapid urbanization and to dynamism and efficiency of societal interaction within large cities.

A Smart City connects human capital, social capital and ICT infrastructure in order to address public issues, achieve a sustainable development and increase the quality of life of its citizens (European Investment Bank Institute EIB 2013). For the definition of Smart Cities, six action fields may be used (Giffinger et al. 2007):

- Smart Governance
- Smart Economy
- Smart Mobility
- Smart Environment
- Smart People
- Smart Living

With the urbanization and mega cities trend resulting in 66 % of the global population expected to be living in cities by 2050 (United Nations 2014), the implementation of smart city technologies will be a critical challenge for governments in both developed and developing regions. In this context Intelligent Transport Systems (ITS) technologies will play a key role in transforming cities into sustainable, efficient, convenient and cooperative places to live. For example, ITS could help reduce the congestion which cost the London economy around £5.4 bn in 2013 ('Traffic Congestion to Cost the UK Economy More Than £300 Billion Over the Next 16 Years' 2016).

Key mobility trends in the smart cities context are related to smart electromobility as well as to integration of (custom) ICT services for citizens, aiming mostly to maximize the use and impact of novel mobility schemes (i.e. (e)car sharing, (e)car-pooling schemes). Targets of all smart city mobility related trends are mobility efficiency (reduced traffic congestion, socially inclusive mobility) and quality of life both, but also energy efficiency (reduced consumption) and sustainable solutions that cost less to society and the citizens and are friendlier to environment.

Interaction between trend and mobility: digitalisation of transport systems and multi-channels interaction between users and transport systems. The trend towards employing smart city solutions creates demand for digitized, intelligent transport solutions that can be embedded into the smart city context of smart governance, smart economy, etc.

Type of trend: Technological

Evidence of trend: Electric vehicles penetration in Europe is increasing. Although global and European sales figures are still small (below 1 % of new car registrations), we see that in some pockets, growth has picked up speed – driven by government support, an improved offering of electric vehicles (EVs) by the automotive industry, and a growing familiarity and willingness to buy on the side of the consumer. In Norway, one such growth pocket, the top-selling car models in September, October, and December of 2013 were battery electric vehicles (BEVs). In November 2013, EVs reached number 1 of sales in Norway (Amsterdam Roundtable Foundation and McKinsey & Company 2014). In this context, more and more car rental companies (i.e. Sixt) are including electric vehicles in their fleets.

The fact that more and more car sharing operators are arising with large and expanding fleets in urban and peri-urban areas, some of them including large shares of electric vehicles in them, i.e. Autolib, is an evidence of smart mobility schemes penetration.

3.4 Environmental protection: climate change, pollution resource and energy efficiency

In the domain of environmental protection we identify four trends. The first three are imposed or encouraged by policies, while the last one refers to the management of the consequences of climate change.

The societal rising awareness for environmental issues leads to the adoption of stricter regulations for environmental protection. Transport, being a significant and not reducing part of the environmental impacts of anthropic activities is concerned with many regulations, and strategic policy goals in the long-term perspective of decarbonisation.

Economy is adapting in the context of more and more limited resources available (Limited resources require more resource efficiency and circular economy in transport). A "sustainable consumption" culture emerges among citizens and firms tend to conform to social and environmental rules and approaches: corporate responsibility, circular economy, Life Cycle Assessment. All these elements will oblige to reconsider the organisation of logistics, as for instance in the case of local food consumption that need short supply chains.

In the domain of energy, policy goals support a movement to step Move away from fossil fuels towards energy efficiency and renewable energies. The current dependence of transport on fossil fuels is expected to be replaced by more electricity and biofuels.

Finally, regarding environmental trends, the Impact of climate change on transport is direct and significant. Extreme weather events cause damages to transport systems of road, rail and aviation. Global warming could have one positive effect though, to open the North-West passage for freight between Europe and Asia.

3.4.1 Stricter regulations for environmental protection

Environmental issues are gaining importance within society. Especially climate change has become a main topic of the public debate. But also air pollution and noise stay in the focus of mobility stakeholders, notably because of their stable or even increasing health impacts in urban centres (see also 3.2.5 Move towards more active and healthy lifestyles page 25).

Transport causes several environmental impacts. In 2013, greenhouse gas (GHG) emissions from transport constituted one fifth of all European emissions, even slightly more than GHG emissions from industry. Moreover, GHG emissions from transport are the only that are still on the rise. The transport sector is also an important source of a wide range of gaseous air pollutants and of suspended particulate matter (PM). While Europe achieved an immense emission reduction in sulfur dioxide (SO2), carbon monoxide (CO) and hydrocarbons (HC), PM and nitrogen oxides (NOx) still remain problems to be solved. Additionally traffic noise is found to affect almost every third person health-wise in the WHO's European Region.

As a reaction to the rising awareness of global and local environment issues, different many policies targeting the environmental impacts of transport are introduced on global, European and national level.

The European white paper of 2011 on transport states that a reduction of at least 60 % of GHGs by 2050 with respect to 1990 is required from the transport sector (European Commission 2011b, 3). According to IPCC, overall, reductions in total transport CO2 emissions of 15–40 % could be achieved in 2050 (Pachauri and Meyer 2014).

A vision of 2050 where the transport sector has been decarbonised is ambitious, as the world's leading scientists predict that 40 % reduction in emissions is a best estimate (Pachauri and Meyer 2014). The project TRANSFORuM has concluded that much more work will be needed up to and beyond 2050 to achieve the goal of 60 % reduction outlined in the White Paper. Indeed, aggressive and sustained mitigation policies are called for (Anderton, Åkerman, et al. 2015, 8).

Interaction between trend and mobility: Main global measures are for instance the Kyoto Protocol or emission and fuel standards for ships and aviation by the respective UN organisations (International Maritime Organization and International Civil Aviation Organization). On the EU Level environmental policies are dealing with monitoring, emission reduction and air quality improvement (e.g. Environmental Noise Directive, National Emission Ceilings Directive, Cleaner Air for Europe Directive, vehicle emission limits and fuel quality). The EU legislation is being transposed on the national level, where especially regional policy decisions on transport have important impact on the decisions of individual mobility stakeholders (e.g. local clean air measures in consequence of the EU Clean Air Programme).

Fuel, vehicle, aircraft and ship building industry will have to adapt these regulations which will very likely become more stringent in the future. **Efficient drivetrains, greener materials and alternative technologies** will play an increasingly important role. **Road infrastructure** will have to accommodate new vehicle and fuel technologies. Noise and air pollution action plans of regions and cities will implement measures like traffic-calmed sectors, the promotion of public transport and/or cycling, urban access regulations or car free zones. That will induce a shift of transport modes away from individual car use towards **greener modes of travel**. **New mobility concepts** with new kinds of vehicles (e.g. E-Bikes or (small) E-Cars), new kinds of vehicle usage (sharing or "use rather than own") and/or a better cross-linking of different transport modes will gain importance, especially in urban areas. Besides more efficiency and cost benefits for users, new mobility concepts also offer new market chances for OEMs and other stakeholders outside the market of mobility services.

Type of trend: Social, Political

Evidence of trend: the environmental policy of the EU has produced an increasingly dense network of legislation over the past four decades, which now extends to all areas of environmental protection (Jordan 2013).

3.4.2 *Limited resources require more resource efficiency and circular economy in transport*

The resources required to sustain current levels of economic growth may not be available over the next decades. Many factors at the individual and firm levels indicate a trend of actors moving towards more energy resource efficiency. For consumers, environmental awareness is reported to rise, while for firms, corporate social responsibility, circular economy, and Life Cycle Assessment are pushers in the same direction.

In the consequence the implementation of the circular economy, where products and resources are reused to extract their maximum value rather than entering the waste stream, is strongly growing in society and industry, as well as reshoring and local sourcing.

Interaction between trend and mobility: Changes in preferred transport options and for demand on freight will be triggered. Emerging "sustainable consumption" culture (Petersen et al. 2009) may change attitude to car ownership (not seen as a status symbol any more), improve the image of public transport and cycling and hence increase demand and reduce long distance trips (Sessa and Enei 2009). Increasing demand for greener consumption has an impact on the development of short supply chains, especially in the food sector but for instance also in the clothing or home electronics areas. Short supply chains – local ones in particular – are often proposed as a possible response to the increase in the distances travelled by products and the adverse environmental impacts of their transport. They are supported and encouraged by a large number of players.

While from the sole standpoint of transport the use of local products is often more sustainable than that of imported products (Bio Intelligence Service 2007; Rizet et al. 2008), several studies show that the results differ markedly from one local supply chain to another (Perez-Zapico 2008; Mundler and Rumpus 2012). Geographical proximity between producers and consumers does not on its own guarantee good environmental efficiency. The work of (Blanke and Burdick 2005; Coley, Howard, and Winter 2009; Meisterling, Samaras, and Schweizer 2009; Kulak et al. 2015; Seidel, Blanquart, and Mareï 2015) has confirmed the need to improve the organization of transport, particularly in the case of very local supply chains.

Potential increase in the use of waste-based biofuels, light-weight and re-manufactured cars and buses, electrification of transport based on renewable energies, more car sharing and better integration of transport modes -including more sustainable public transport like zero emission buses- to promote modal shift towards sustainable modes, better optimised logistics based on new material flows (waste as a raw material). Circular economy means new transport and logistics needs; waste flows require complex logistics schemes with strong impact on transport flows. Logistics optimization is linked to the choice of transport modes and load rate, but also to the location choices for the storage and recycling sites as well to the potential synergies between activities.

Type of trend: Economic, Social

Evidence of trend: corporate social responsibility is a rising trend with significant developments approximately since 2000 (Kerstin Sahlin-Andersson 2006).

The legislative proposals on waste set clear targets for reduction of waste and establish an ambitious and credible long-term path for waste management and recycling. Key elements of the revised waste proposal include:

- A common EU target for recycling 65 % of municipal waste by 2030;
- A common EU target for recycling 75 % of packaging waste by 2030;

- A binding landfill target to reduce landfill to maximum of 10 % of municipal waste by 2030;
- A ban on landfilling of separately collected waste;
- Promotion of economic instruments to discourage landfilling ;
- Simplified and improved definitions and harmonised calculation methods for recycling rates throughout the EU;
- Concrete measures to promote re-use and stimulate industrial symbiosis - turning one industry's by-product into another industry's raw material;
- Economic incentives for producers to put greener products on the market and support recovery and recycling schemes (e.g. for packaging, batteries, electric and electronic equipment, vehicles).

With respect to the progressing electrification of transport circular economy may allow developing viable business cases for manufacturers of electrified vehicles, since it will increase the resale value of used vehicles. This is particularly true for expensive key components such as the batteries. In that context several companies are carrying out pilot projects for improved recycling or second life applications of batteries, such as Umicore and Renault (Renault 2016; Umicore 2016).

3.4.3 Move away from fossil fuels towards energy efficiency and renewable energies

EU transport still depends on oil and oil products for 96 % of its energy needs (European Commission 2011b, 4). In 2010, the oil import bill was around € 210 billion for the EU including transport and other uses (European Commission 2011b, 3). In 2012 this bill equalled €385 Billion, for 4 billion Barrels (Harrison 2013).

Currently (July 2016), crude oil prices are very low and crude *oil products* are extremely cost competitive that may increase the attractiveness of car use. In Europe, *alternative fuels* have entered the market mainly boosted either by incentives or by mandates, not just based on their own merits. Taxation plays a significant role in the context of transport fuels and vehicles. Directive 2003/96/EC on the taxation of energy products and electricity stipulates different minimum levels of taxation for different kinds of motor fuels.

The EU aims until 2020 to have 10 % of the transport fuel of every EU country come from renewable sources. But it is important to ensure that they are produced in a sustainable way and without indirect land use change.

In addition, Directive 2003/96/EC allows Member States to set lower taxes in certain cases, for some fuels or some special applications. E.g., Belgium, Ireland, Luxembourg and the Netherlands have a reduced or no energy tax on LPG and methane fuels in transport. The Member States also have had the possibility to apply for reduced or no taxes on transport biofuels.

Interaction between trend and mobility: The IPCC suggests that until at least 2050 liquid petroleum fuels will continue to dominate the transport sector (Pachauri and Meyer 2014). Low fuel prices (2016) may increase the use of private cars, but on the other hand, interest in electricity and biofuels is increasing. Depending on regulation scenarios, it is expected that in 2030 electric vehicles (including hybrids and range extended electric vehicles) will be between 48 % and 76 % (McKinsey 2014, 18).

Type of trend: Political, Economic, Technological

Evidence of trend: According to the 5th Assessment report of the Intergovernmental Panel on Climate Change (IPCC) the transport sector accounted for 27 % of final energy use and 6.7 GtCO 2 direct emissions in 2010 globally, with baseline CO 2 emissions projected to approximately double by 2050; and potential to more than triple by 2100 (Pachauri and Meyer 2014).

3.4.4 Impact of climate change on transport

According to a recent study by Doll et al. (Doll, Klug, and Enei 2014), in the period 1998-2010, very extreme weather events inflicted some €2.5 billion damages across all transport modes in Europe. The figure is estimated to be 10 times higher when all adverse weather damage is considered and an additional 20 % could be added to include indirect (production losses, cargo damage, business trips cancelled etc.). The road sector currently takes the majority of the impact but it is estimated that by 2050, rail traffic costs, for example, may rise up to 80 % due to increased flooding and unpredictable winter weather (Doll, Klug, and Enei 2014).

Interaction between trend and mobility: A few positive impacts of current environmental changes such as a warming climate might also see new freight routes open up that have implications for long-distance freight transport in Europe. For example shorter transportation distances between Europe and Asia through the opening of the North-West passage for sea transport (Anderton, Åkerman, et al. 2015, 14).

Interaction between adverse weather and air transport safety: Adverse weather is a result of climate change and affects the air transport operations (Impact of convective weather on New York area arrivals https://www.youtube.com/watch?v=2tXWKFBCXwg). The integration of resources, knowledge and advanced technology is required to enable safety and cost-effectiveness within aircraft operations under adverse weather conditions. These conditions are linked to the trends resilient recovery and big data with respect to weather forecasting and live data.

Type of trend: Environmental

Evidence of trend: it was estimated in 2014 that by 2050, rail traffic costs may rise up to 80 % due to increased flooding and unpredictable winter weather (Doll, Klug, and Enei 2014).

3.5 Digital society and internet of things

In this section on digital society, we identify two types of trends. Regarding the digital world, technology, as an enabler, exerts a true influence and drives individual and social uses. We identify two technological trends of Internet of things and big data, and automation. This is the supply side. But at the same time, technology is sometimes used for a slightly different purpose than what was foreseen by the designers. In this sense individuals and social groups can be seen as actors of digital society, and able to fuel trends that are not driven by technologies. This is the demand side of digital society.

The technological trends of “Rise of the Internet of Things and big data“ is impacting many aspects of the production of goods and services, and particularly in the transport domains. Vehicles, transport infrastructures, ICT devices, parcels will all be able to communicate in real-time. Dealing with the masses of data produced require new

methods, the so called big data approaches, but promise to improve many transport issues like transport operations planning, traffic management, or safety.

The trend of "More automation" in transport modes is driven by the development of artificial intelligence, sensors and information and communication technologies. This technological dynamic has ambitious road safety promises, but also raises difficulties expressed in another trend (3.7.2 "The emerging safety issue in complex networks with new vehicles"). Automation is also developing in the air and rail transport domains.

Regarding the demand side of the digital society, the first trend that we identify refers to the "Expectation of customers and digitisation of mobility". Travellers in the digital world expect to be able to connect their mobile devices, and expect to receive accurate and real-time information about their trips. All these expectations are challenging for transport providers. Quite ambivalently, travellers also want more data privacy.

For the most part driven by the development of the digital society, "New uses of travel-time" can be observed. Classically seen as a burden, travel time can become a positive moment for users. This trend is able to influence the transport mode choice in favour of public transport and detrimental to the car, until automation is introduced.

1) Technology driven digitalisation (supply side)

3.5.1 Rise of the Internet of Things and big data

The Internet of Things (IoT) links smart objects to the Internet. It is the driving force behind the digitalization of logistics and is laying the foundations for Industry 4.0 (Löffler and Tschiesner 2016). IoT can benefit the European economy generating economic growth and employment.

It can be hypothesised that the rise of the Internet of Things (IoT) will enable city infrastructure to be designed and operated in a more integrated way.

Today transport and logistics providers manage a massive flow of goods and at the same time create vast data sets. For millions of shipments every day, origin and destination, size, weight, content, and location are all tracked across global delivery networks (Jeske, Grüner, and Weiss 2013). In the field of mobility, the real-time location of travellers and vehicles such as cars, buses and bikes are tracked. Research estimates that organizations effectively utilize less than 5 percent of their available data. Big data is a relatively untapped asset that companies can exploit once they adopt a mind shift and employ experts with domain knowledge and abilities to process the data to offer real-world use cases, revealing what's happening now, and what's likely to happen in the future (Jeske, Grüner, and Weiss 2013). Big data analytics reflect the challenges of data that are too vast, too unstructured, and too fast moving to be managed by traditional methods (Zakir, Seymour, and Berg 2015). Datafication is not just about capturing more data from daily activities, but to use more data in those activities for better decision making, by further understanding the business, realizing the effect of the changes that happen, better planning and forecasting, detecting fraud and outliers and improving efficiency and productivity.

Interaction between trend and mobility: decrease of the need of planning, information always available and no fear of unanticipated circumstance.

Discovering the repeating pattern in the operations leads to better understanding and planning of transport operations which leads to increased efficiency and better capacity utilisation (Agard, Morency, and Trépanier 2006; Morency, Trépanier, and Agard 2007; Kargupta, Gama, and Fan 2010; Vogel, Greiser, and Mattfeld 2011).

Forecasting techniques can be applied to predict traffic, accident and demand which makes traffic management more efficient reducing congestion and increasing efficiency (Öztürk, Kayalıgil, and Özdemirel 2006; Au, Choi, and Yu 2008; Sun et al. 2008; Hofleitner, Herring, and Bayen 2012; C.-S. Li and Chen 2014).

Casualty detection techniques can be used for an early warning and proactive control system to cope with incidents and increase the resiliency of transport systems (Y. Li et al. 2010).

Type of trend: Technological

Evidence of trend: The market value of the IoT in the EU is expected to exceed one trillion Euros in 2020 (IDC et al. 2014). Currently, 99 % of physical objects that may one day be part of this network are still unconnected. It is estimated that by 2020, 200bn objects will be part of the IoT (26 smart objects for every person on earth) ('A Guide to the Internet of Things Infographic' 2016). Additional value-creation and digitization of production, supply chain and distribution through Industry 4.0 should push productivity of the German Industry by 12 % until 2025 (BITKOM 2012).

In a recent study on supply chain trends, sixty percent of the respondents stated that they are planning to invest in Big Data analytics within the next five years (Jeske, Grüner, and Weiss 2013). In a survey by IBM, the respondents were asked to identify their current state of big data activities within their organizations: 28 % have piloted the implementation of big data activities, 47 % were in the stage of defining a roadmap towards big data and 24 % were in the early stages of adopting and understanding the concept (Amsterdam Roundtable Foundation and McKinsey & Company 2014).The Internet of Things (IoT) links smart objects to the Internet. It is the driving force behind the digitalization of logistics and is laying the foundations for Industry 4.0. IoT can benefit the European economy generating economic growth and employment.

3.5.2 More automation

Improved environment perception due to advancements in camera and sensor systems as well as methods of sensor data fusion will enable higher degrees of automation in vehicles. Highly automated functionality, widely applied in aeronautics, is entering the automotive worlds now and will be available in other modes as well, increasing traffic safety and fleet management significantly, and will support the development of traffic control systems. Robotics and automation will also play an increasing role in the delivery of city services, e.g. driverless cars may soon become a commercial reality. A variety of driving assistance systems of Level 0 (no automation), Level 1 (driver assistance) and a smaller number of Level 2 (part automation) technologies are currently available on the market, mainly implemented in passenger cars to support driving on motorways or for parking. Vehicle manufacturers are investing in R&D of more advanced automation systems up to Level 3 (conditional automation), which are expected to further improve the driving safety and comfort of private vehicles. Concurrently, research and testing of higher automated systems (level 4 – high automation and level 5 – full automation) is already underway. The concept of "self-driving vehicle" represents the pinnacle of vehicle automation, although, at the moment, the implementation of fully automated vehicles still requires a considerable amount of research and technological advancement (Frisoni et al. 2016).

Additionally, automated driving is seen as one of the key technologies and major technological advancements influencing and shaping our future mobility and quality of life.

Interaction between trend and mobility: Road safety is expected to significantly improve as automated vehicles should reduce accidents due to human errors. Also, the option to switch to "automated driving mode" will give drivers more freedom in terms of individual mobility. With the market introduction of highly automated vehicles by 2020-2025, drivers will be able to manage their driving times better. At the same time, an automatically controlled vehicle will be even safer thanks to the increased interaction with itself and its environment. Furthermore, the energy management and driving characteristics of the vehicle will be optimized enabling more energy-efficient driving. Highly automated road transport will have a significant impact on our mobility behaviour, road safety and traffic efficiency in interurban (motorway/freeway) and urban applications. Especially in cities, impacts could be very important: improvements in transport reliability and urban centres accessibility would lead to evolving demands and request changes of the business models, requiring private companies and public authorities in charge of transport to assess and anticipate future needs. Nevertheless, the promise of road transport capacity improvement could be undermined by the circulation of empty vehicles (Litman 2014), especially in urban areas. Impacts on traffic and public transport demand will need to be assessed, including unintended risks. The anticipation of future demands will therefore need to be done in an integrated manner, with the private and public sector working together to achieve common goals for automation technologies deployment.

Additional to road transport, flight controls as well as air traffic management systems are affected by automation. The trend of automation is rated as a game changer for air transport safety.

Type of trend: Technological

Evidence of trend: Automated Driving could have a remarkable economic impact and therefore play a decisive role in global competitiveness and EU's strategy (Europe 2020) on re-industrialisation of Europe (i.e. increase the contribution made by manufacturing to European GDP from 16 % to 20 % by 2020).

Various studies revealed the outstanding economic impact projected for automated driving for the years to come ranging up to €71bn in 2030 (KPMG 2015; Boston Consulting Group 2015). The estimated global market for automated vehicles is expected to reach 44 million vehicles by 2030 (Navigant research 2013).

Regarding automation and air transport safety, the trend is also supported by the outcomes of Workshop at EASA-OPTICS Conference, Cologne, 12th-13th April 2016 (Verstraeten and Kirwan 2014).

2) Societal trends regarding digitalisation (demand side)

3.5.3 Expectation of customers and digitisation of mobility

Digital society entails complex interaction with mobility, particularly during the trips, but also in the situation of substituting trips in the case of logistics.

Customers' expectations will grow towards digital information sources (the connected traveller), for usual travels and in case of events and disturbances, while awareness of privacy issues is recognised by users.

Surveys conducted in the European project Instant Mobility in 4 cities (Roma, Istanbul, Nice, Trondheim), showed that there is a high demand for information while travelling; in the context of road transport, the customized services that are expected by the users are information while travelling in case of events (accident, road works ...), optimized itinerary matching preferences, duration of the trip, arrival time, mean of transport and, far after, security or price (Pauzié 2013, 30).

Interaction between trend and mobility: The growing use of internet has the potential to affect mobility in several ways. It might substitute shopping trip (for example, the shopping trip to purchase a book could be replaced by the downloading of an e-book) (Zmud et al. 2013). This shift from personal travel to freight transportation depends on the type of goods. Regarding e-commerce, as consumers' perception of time and space has changed due to the use of internet and smart phones (m-commerce), super/hypermarkets have to develop new models in order to attract a larger extent of consumer groups outside their traditional catchment areas (for example, from resident to office, less served areas) (Heitz et al. 2011).

As people become increasingly familiar with real-time information in their hands, this places expectations on transport operators to deliver accurate and timely information in a consistent approach (Deloitte, Goodall, et al. 2015, 8).

Type of trend: Social

Evidence of trend: in 2015 54 % of European adults owned a smartphone, and 87 % are internet users (Poushter 2016).

Online consumers worldwide will grow to 1.623 billion in 2018 from 1.079 billion in 2013 (+50 %). The countries with the highest e-commerce readiness are Luxembourg (91.7), Norway (88.3) and Finland (88.1) (United Nations Conference on Trade and Development 2015).

Regarding the demand for privacy of data, surveys conducted in the European project Instant Mobility in 4 cities (Roma, Istanbul, Nice, Trondheim), showed that 50 % of persons if confronted to real-time location and trip recording transport solutions would require anonymous recording and good preservation rules (Pauzié 2013, 30). The survey showed that for respondents personal preferences recording, more than 50 % record them today, more than 90 % would record them in the future and more than 70 % would require easy management of their data (modify, remove, share, ...).

3.5.4 New uses of travel-time

Travel time is often conceived as a burden, but under certain conditions can become a positive moment. ICT through the concept of *equipped time* (Jain and Lyons 2008) can contribute to make this moment positive. The spread of smart ICT devices changes the way travellers spend their travel time. There are more opportunities for productive activities (working, studying, communication) and leisure (gaming, videos, social media). This has an impact on the value of travel time. This trend affects primarily public transport users and has an interaction with the level of comfort available in the vehicle: in a crowded train or a fast moving bus the experience is less positive for the user than if he/she is seating.

But in the future, beyond public transport, automated driving should make it possible for car drivers as well to spend their travel time with useful activities.

Interaction between trend and mobility: this evolution has the potential to change the perception of transport time, and will have a very different impact on the choice of

transport modes, following the comfort and the possibility to avoid driving (as in the case of the car driver). For now, until the time when automated car driving is introduced, this trend has the potential to favour the use of public transport instead of car (Russell 2012, 251).

Type of trend: Social

Evidence of trend: Lyons et al. (2013) compared results from the UK National Rail Passenger Surveys of 2004 and 2010. They noticed a two-fold increase in listening to music, a 63 % increase in texting and phoning for personal purposes, and an 83 % increase doing so for work. The regular surveys of Schwieterman and Battaglia (2014) about the use of ICT devices on buses, trains and airplanes in the USA show an increase in the use of ICT devices. The percentage of passengers using personal electronic technology increased by 17.8 percentage points to 52.2 % on Amtrak trains, by 28.8 percentage points to 54.4 % on commuter rail and by 26.2 percentage points to 44.1 % on conventional buses between 2010 and 2014.

3.6 Novel Business models and innovation in transport

The transport sector is witnessing the emergence of new players, new business models interacting with – if not fuelled by – new behaviour. New business models are closely related to the previously mentioned trend of Rise of the Internet of Things and big data page 35. The main issue regards the challenge over the currently dominating individual vehicle ownership model, described in the first trend 3.6.1 "New models challenging the individual vehicle ownership model". The second trend covers the other cases where new players and new business models emerge, in batteries, in data, in freight 3.6.2 "New players and new business models". The last trend highlights the emergence of the co-development model and its implications for mobility: 3.6.3 "Emerging co-development and co-creation of new systems by users and economic actors".

3.6.1 New models challenging the individual vehicle ownership model

Current/previous vehicle ownership or rent models are challenged by new societal trends (for young adults owning a car is not a dream any more) and economic trends. Ubiquity of mobile devices has enabled contextual, real-time services that were previously not possible. New solutions for delivering services such as peer-to-peer transport of people and goods (e.g. Uber) imply new business models as well as need for revising legislation (Cirstea 2015).

Sharing economy needs to be investigated specifically regarding implications for Europe where the public transport system is comparably good and different framework conditions than in US apply**.** Beyond these differences, surveys conducted in the European project Instant Mobility showed that a majority of persons favour having their own vehicle, and have a very low ride-sharing activity (Pauzié 2013, 29).

Interaction between trend and mobility: Car-sharing may be organized on per-use level or through affinity groups, large employers, transit operators, neighborhood groups, or large car-sharing businesses. Besides station-based car sharing, recently free-floating car sharing services emerged in many cities that make it possible for users to leave the vehicles anywhere in the services area and pay on a minute basis.

Car-sharing provides users with a large range of vehicles, fewer ownership responsibilities, and less cost (if vehicles are not used intensively). Societal benefits

include less demand for parking space and the indirect benefits resulting from costs being more directly tied to actual usage and vehicles being matched to trip purpose (Shaheen, Sperling, and Wagner 2001). An analysis by the Massachusetts Institute of Technology (MIT) suggests significant direct and indirect increases in social utility to consumers and society through ride-sourcing. Compared to regular taxi trips the pre- and post-journey time is reduced because the arrival of the car is forecast by the minute. The average time reduction in the overall total journey time is estimated between 20 to 30 percent (Hardesty 2014).

Ride-sourcing serves demand that was previously unmet by other services. The users of taxis and ride-sourcing services are different. Ride-sourcing users are characterised by a younger age, lower vehicle ownership and more frequent trips with companions. Ride-sourcing may substitute longer public transport trips, but it also acts complementary to public transport. The overall impact on traffic and congestion is still not known (Rayle et al. 2014).

Uber CEO was expecting, through the development of his business in 2015 in Europe, to reduce the number of cars by 400 000 units and to create 50 000 new jobs (*Wall Street Journal* 2015).

A study by McKinsey indicates that the development of car-sharing should not entail a decrease of the mileage of travel by car in the future (McKinsey et al. 2012, 15). The argument considers among the car-sharers the 48 % that had not had a car before, the 26 % that will abandon their car and the 26 % that will keep their own car.

Type of trend: Economic, Social

Evidence of trend: According to a recent report on circular economy in Europe, sharing could continue to grow and account for as much as 30 percent of overall passenger-kilometres covered by cars by 2050, but would likely not penetrate towns and some urban areas. Vehicle-sharing would likely grow at varying rates in different European markets. Relatively supportive markets include Germany, where the number of people sharing cars has increased 50 percent a year since 2010 and reached one million at the end of 2014 (The Ellen MacArthur Foundation, McKinsey Center for Business and Environment, and SUN 2015).

A survey by McKinsey conducted in Germany in 2011 shown that 38 percent of all young Germans (18- to 39-year old) living in cities with more than 100,000 inhabitants indicate that in ten years “[they] will use car sharing more,” and 26 percent of those 40 and older agree (McKinsey et al. 2012, 12).

3.6.2 New players and new business models

Beyond the key issue of the challenge to the individual car ownership model, the new business models are also applied to other contexts of mobility.

Besides moving technological value from engines to batteries by using electric power transmission, a key aspect in the business model of Tesla is the ability to update the software systems of the vehicle. Rather than launching a new model with upgraded features, the upgrade can be software delivered over the air to provide new features or improve existing ones (e.g. updates to software controlling the power train) (Forbes 2015).

Increasingly available data and emerging Internet of Things with connected devices and infrastructure make generation, aggregation and analysis of data an important part of value creation. It changes service architectures and crosses industry boundaries. New

business is being developed from finding new ways to utilise data, whether it is used for creating new value added services, improving efficiency and monitoring of existing systems, or selling the data itself (Leminen et al. 2015). Data has been essential in the development of models described in the previous trend on alternatives to the individual vehicle model, but can play a significant role in the context of car ownership or freight as we will see.

Interaction between trend and mobility: Services and technologies have largely been deployed as vertically integrated closed solutions, which has restricted the diffusion of services, making it difficult to scale them across markets. As value creation moves more and more towards software and data, hardware becomes more interchangeable. Using open and interoperable systems that allow customers to easily switch between service providers rather than isolated platforms changes the competitive environment. It reduces the risk of vendor lock-in for customers while also creating larger markets as services can be delivered to customers independent from hardware. The multi-service approach where normally fragmented services are interoperable and can be aggregated increases the importance of business models for more complex value networks (Rantasila et al. 2014; Casey and Valovirta 2016). This also closely relates to the trend of innovation systems and embracing a collaborative culture of development and testing.

An emerging trend is the appearance of independent bikers for instant deliveries in the food delivery market, from restaurants to consumers (e.g. Foodora and Deliveroo).

Type of trend: Economic

Evidence of trend: the service of Uber was first tested in New-York in 2010 and in 2014 has expanded to 45 countries and more than 200 cities (Bond 2015).

3.6.3 Emerging co-development and co-creation of new systems by users and economic actors

Innovation culture is developing in the industry sector with new innovation systems including workers, users etc. In addition, cheap prototyping, with 3d-printing has further facilitated innovation. Innovation is becoming feasible also for individuals, as illustrated by the *makers movement*. A milieu of innovation emerges with innovation hubs, start-up camps, open innovation.

New products and business opportunities arise from technological and services innovations as well as combinations of such existing innovations; different mixtures of technology-fusion, technology-servitization, enabling technologies and service integration (Chang and Yen 2012). The fusion of different competences implies cooperation. The innovation process can be supported through networks and common, standard technologies (e.g. European Technology Platforms) enabling rapid development cycles as businesses can focus on their core activities.

Enabling development activities and fast testing of solutions – a culture of experimentation – can support faster take-up and scale-up of new solutions and enable innovation and business opportunities, and is therefore of important for the public sector as well (Finnish Prime Minister's Office 2015). Platforms that serve as a development and test environments enable validating and developing solutions together with users, helps create references and promote products and facilitates collaboration among different actors, creating new value chains and networks (Kostiainen, Aapaoja, and Hautala 2016).

Interaction between trend and mobility: The firm "Local Motors" allowing individuals to design and produce vehicles is a representative example of this trend.

Type of trend: Economic

Evidence of trend: the model of the FabLab was invented by the MIT in the USA, in 2001 (Lhoste and Barbier 2016). FabLab, for *fabrication laboratory*, is a platform for the rapid prototyping of physical objects. In the USA the term *makerspace* is more popularly used for the same concept, while in Europe the term FabLab is used. 45 FabLabs over the world existed in 2010, and 547 in 2015 according to the Fabfoundation (Troxler and Wolf 2010).

3.7 Safety in transport

Despite significant improvement of the levels of safety, especially in the road transport domain, and encouraging perspectives, linked to automation, we perceive no sign that transport safety in general would become less an issue in the future than it is now.

In the perspective of the long term promise of a decrease of road casualty through the introduction of automated cars, a new safety issue emerge with the coexistence of automatic and non-automatic vehicles creating complex networks and environment. Safety will become a far more complex issue than today with insurance and liability necessary adjustment.

3.7.1 The persisting issue of transport safety

No transport mode is exempt of safety and security issues and many public policies aim at addressing this problem. Road is mainly concerned with traffic safety; despite a continuous reduction of road fatalities, still 26 000 people died from road accidents in 2013 in the EU, which makes it a major societal issue. We perceive no sign that road safety would become less an issue in the future than it is now.

In any development of the rail mode, maintaining the level of current safety is always a requisite, as shown for instance in the SMART-RAIL European project (Oslakovic, Tan, and Gavin 2014). The latest available statistics for rail safety by the European Railway Agency show a trend of 5 % reduction in accident rates per year since the 1990 until the mid-2000, but the analysis of the most recent data suggests a stagnation of the level of railway safety since 2004 in Europe (European Railway Agency 2014, 10).

With respect to the air transport mode, which is the safest transport mode in terms of fatalities per passenger-kilometres (European Railway Agency 2014, 13), airline accident statistics reveal a decreasing trend of accident fatalities, especially between 1985 and today (Ranter 2016) despite the increasing number of annual flights. But safety is a mandatory requirement for global aviation which is expected to be fulfilled by 100 percent.

Interaction between trend and mobility: The slowdown marking the last three years certainly has several contributing factors. Some of them are evident, based on statistics (European Commission 2016): a higher interaction between unprotected and motorised road users in our cities, and an ever growing number of elderly people in road traffic. Some other causes commonly referred to are: urbanisation with a growing number of vulnerable road users; an increase of traffic during milder winters in Europe; less resources dedicated to road maintenance and vehicles following the economic crises; and last but not least the appearance of new trends in users' behaviour, such as distraction mainly by mobile phones ('European Commission Press Release - 2015 Road Safety Statistics: What Is behind the Figures?' 2016).

Even though air travel is the safest mode for long-distance travel, novel energy sources for propulsion, for example lithium batteries, as well as complete new and emerging risks in aviation, like the airplane crash intentionally caused by the culpability of one of the pilots in the case of Germanwings flight 9525 in 2015, affect, especially, the perceived safety of mobility with respect to the aviation (IATA 2016).

Type of trend: Social, Political

Evidence of trend: Over the last decades, the EU has made great progress in reducing road fatalities. Between 2001 and 2010, Europe cut the number of road deaths by 43 % in spite of the increased traffic volumes, and reduced it by another 17 % since 2010. Furthermore, with 51.5 road fatalities per one million inhabitants, Europe has the lowest fatality rate for any region in the world. This ratio amounts to 106 in the United States and to 174 globally ('WHO | Global Status Report on Road Safety 2015' 2015). However, the progress rate has lately clearly slowed down: change in fatality figures was close to 0 from 2013 to 2014, and 2015 repeated the same pattern. The current slowdown means that efforts must be stepped up, especially at national level, if the strategic target of halving the number of road death by 2020 is to be reached ('European Commission Press Release - 2015 Road Safety Statistics: What Is behind the Figures?' 2016).

In 2015, aviation has faced an accident rate of equivalently one major accident for every 3.1 million flights, a 30 % improvement compared to the average rate of the previous five years of one major accident for every 2.2 million flights (IATA 2016). But the past has shown that also new challenges. The Germanwings 9525 accident was not included in the statistics to fatalities since this event did not fit in the existing criteria of the Safety Report from IATA, the International Air Transport Association. This Association has also developed a six-point safety strategy in 2013 with four key pillars, improved technology, regulatory harmonization, training and awareness. The six safety strategies include the reduction of operational risk, the enhancement of quality and compliance, the endorsement for improved aviation infrastructure, the support of the consistent implementation of SMS (Safety Management Systems), the support of the effective recruitment and training and the identification and addressing of emerging safety issues. (IATA Safety Report 2015 (2016).

3.7.2 The emerging safety issue in complex networks with new vehicles

Safety issue will be a crucial issue with the gradual introduction of automated vehicles in cities. The difficulty resides in mixing automated, non-automated vehicles, pedestrians, cyclists and other users in urban traffic.

The EXCROSS project highlighted the need for developing a *safety culture* in different transport modes. From this perspective the most mature safety culture modes air and maritime sectors are opposed to rail and even more road transport systems which is the less advanced (Lazakis 2014, 42).

Road safety is expected to improve with vehicle automation. But this effect remains untested at a large scale and may not be immediate or linear. Most crashes involve human error. If greater autonomous operation reduces or eliminates these errors, then benefits for road safety may be substantial. However, most driving involves no crashes. The real safety test for autonomous cars will be how well they can replicate the crash-free performance of human drivers. While results from early prototypes sound promising, new types of crashes may emerge as autonomous technologies become more common – for

instance crashes resulting from the car handing control back to the driver or from mixing autonomous and conventional vehicles.

Interaction between trend and mobility: Incrementally shifting the driving task from humans to machines will require changes in insurance. Liability remains an important barrier for the manufacturers and designers of autonomous vehicles. Expanding public insurance and facilitating greater private insurance could provide sufficient compensation to those injured by an automated vehicle while relieving pressure on the tort system to provide such a remedy. Enhanced vehicle insurance requirements by manufacturers, especially if combined with greater flexibility in the administration of this insurance, could also provide a third-party check on the safety of automated systems. As automation increases, liability could gradually shift from drivers to manufacturers and Original Equipment Manufacturers (OEMs). However, the allocation of liability among these parties remains challenging and adjudication methods have yet to be developed (Smith and Svensson 2015).

Type of trend: Social, Legal

Evidence of trend: The estimated global market for automated vehicles is expected to reach 44 million vehicles by 2030[7]. The 2016 Tesla accident involving the death of the driver, who had activated the self-drive mode, represents a direct illustration of the issue.

3.8 Security in transport

Terrorism is a growing concern in our societies and for governments. Attacks often target transportation means and hubs, and hence the interaction between this trend and mobility and freight is straightforward. More security is expected which raises the security/accessibility tension: the provision of more security in transport by introducing controls/barriers reduces accessibility.

3.8.1 Growing concern over security threats

The growing concerns of governments, based upon the "Threat Perceptions in the OSCE Area" report, about security threats are mainly referred to terrorism, migration and cyber threats (Zellner 2014).

Transportation means, hubs and stations are targets of terrorist attacks, because of the easy access and escape for the terrorists and the fact that congregations of strangers guarantee anonymity, but also because crowds in contained environments are vulnerable to conventional explosives and unconventional weapons.

The specific needs of the most vulnerable users, such as elderly, disabled and children, need to be integrated into any disaster mitigation system from its design phase and, furthermore, their specific behaviour and movement speed and limitations to be included in any human behaviour model for it (SAVE ME project, fp7-saveme.com).

Public transport users are more aware of potential threads just after an attack took place. As showed by Transport Focus in the UK 'public fear' about terrorism and personal security on railway dissipated quite quickly after 7/7 2005 (Irwin 2015). Concerns on personal security are not an issue in preventing train travel. Travellers asked for reasons for worry about their personal security named only terrorism around 5 % of the times. Anti-social behaviour by other people on stations is influencing personal security

[7] Autonomous Vehicles, Navigant Research, Aug/13

concerns far more (up to 61 %). On train anti-social behaviour is even more influencing concerns on personal security (72 %). Lack of visible staff and others' anti-social behaviour dominates passengers' concern. Usage implies that passengers assume rail is 'safe'; rapid recovery from 'incidents'. This is also showed by ridership numbers of international trains to Brussels. The same ridership level was reached just after one month the attacks in Brussels (corrected for the closed railway station of Brussels Airport).

Interaction between trend and mobility: Attacks cause alarm and major disruption in transport systems. The security/accessibility tension: provide more security in transport by introducing controls/barriers that reduce accessibility.

Type of trend: Social

Evidence of trend: Past and recent attacks have caused the death of many people. The following list shows recent (since 2003) terrorism attacks in transportation means and hubs in various cities (Jenkins 2007):

- Stavropol –December 5, 2003 (42 killed)
- Moscow –February 6, 2004 (40 killed)
- Madrid –March 11, 2004 (191 killed)
- Russia –August 31, 2004 (10 killed)
- London –July 7, 2005 (52 killed)
- Mumbai –July 11, 2006 (207 killed)
- Diwana –February 18, 2007 (66 killed)
- Brussels – March 22, 2016 (32 killed)

Among the attacks, highly selected targets are subways/trains and other public terminals, but also bridges and tunnels, namely (Jenkins 2007):

- Buses (32 %), tourist and school buses (8 %) and *bus terminals* (7 %) = 47 %.
- *Subways and trains* (26 %), stations (12 %), and rails (8 %) = 46 %.
- Bridges and *tunnels* (5 %) and other (2 %) = 7 %.

3.9 Legislative framework

The legislative dimension translates societal demand by means of the production of laws and rules by public authorities and also by means of jurisprudence. Nevertheless, beyond the mere role of translation of societal demand, it carries a self-dynamic that enlists it as a societal trend in the broad sense. We identify three trends that exert influence in the domains of mobility and logistics.

We observe in the legislative domain a trend of "Diversifying approaches of governance". More actors are invited to contribute to the governance of transport and mobility. In particular, with the association of citizens in decision processes, more transparency is required in governance models. The innovation at play in the domain of legislation and governance, leads to a diversification of governance models.

Secondly, with "Legislative models adapts to new transport solutions and businesses" an interaction occurs between new business models and the legislative framework. The

legislative framework has to adapt to new solutions, but new comers must also make sure their business can sustain in a given and moving legislative framework.

The general trend for "Trend toward harmonisation in legislative frameworks" of the legislative framework in Europe has direct implications for transport, in the aims of interoperability of transport systems. This trend refers also to the fact that legislative adaptations to new models and solutions in a given European country will inspire the other countries reactions.

3.9.1 Diversifying approaches of governance

Acknowledging the complex nature of issues, in particular mobility, leads to diversifying approaches of governance: more coordination, involvement of business and civil society (European Environment Agency 2015, 156) Trends in legislative framework for local planning and governance are decentralisation and "de-siloing" of policies. The belief that mobility should be solely regulated by a single actor, commonly the local authority, has been challenged (Tosics 2011).

Tackling mobility necessarily implies to find a sustainable and coherent balance between the necessity to develop an efficient network and the difficulty to preserve the surrounding environment against all sort of nuisance of all kind: pollution, noise, deterioration of the network, public disturbance, etc.

We see massive public sector investment in intelligent streets and digital railways as a result of the widening recognition that the "information everywhere" world will disrupt the transportation status quo (Deloitte, Goodall, et al. 2015). Also, the growing importance of energy sources alternative to oil and of the importance given to the issue of climate change leads to the creation of subsidies to allow their development.

Different approaches are in place to deal with tolling. Not all major cities use a car entrance toll for diesels, e.g. Milan/London do, while Brussels doesn't. Belgium introduced toll for trucks, a move in its interest as the centre of Europe and given the constant flow of trucks from e.g. UK to Germany, Netherlands to Spain, etc. This caused huge congestion, thus pollution and economic damages issues. Yet, as soon as it was implemented, other countries tried to attack it before the European Commission.

Also, a new methodology referred to as "transformative practices" is introduced (Albrechts 2010). It focuses on new concepts and new ways of thinking that change the way resources are used, (re)distributed and allocated, and the way the regulatory powers are exercised. Transformative practices take decision-makers, planners, institutions and citizens out of their comfort zones and compel them to confront their key beliefs, to challenge conventional wisdom, and to look at the prospects of new ideas and "breaking out of the box".

Interaction between trend and mobility: spread of a specific type or category of transport due to public funds allocated for it. Also, public and private innovation processes will work together, especially through PPPs. Different interaction between users and policy-makers in the decision-making process related to transport. Development of user-centred mobility services where the user has more information.

Type of trend: Political, Legal

Evidence of trend: The European Commission has always looked from input from stakeholders in its decision-making process. It initiated the Transparency Register in 2008, together with the European Parliament, and wants now make it mandatory. Besides, all stakeholders, even citizens, can access the workshops organised by the Commission

while it's preparing a new legislative package. Also, the consultation process allows everybody's voice to be heard at EU level.

3.9.2 Legislative models adapts to new transport solutions and businesses

Recent technological developments obliged the legislator to review and sometimes reform classical business schemes in place. The said reforms have been both a reaction and a trigger to changes in the transport sector. Example of novel transport means is the well-known Uber (Azevedo and Maciejewski 2015), together with the growing systems of sharing economy, leading to novelties in labour law, issues of insurance law and to new forms of self-employment. Also linked to the same legislative changes is the introduction of automated vehicles ('ERTRAC -Automated Driving Roadmap' 2015).

Also innovative design, like the 3D printing used in bridges ('MX3D Bridge' 2016), have an impact-reaction on the legislative development, especially on standards imposed in construction. Always linked to design innovation is the imposition of privacy-by-design products.

Another topic to touch is that of freight, the whole legislative framework concerning delivery services is changing with the introduction of drones (Di Tella and Hirsh 2015) and connected systems like platooning (Fornells and Arrue 2014), liability rules will change.

A general reform of commercial law due to the spread of digital business and thus of e-commerce will lead to a digitalisation ('Press Release - A Digital Single Market for Europe: Commission Sets out 16 Initiatives to Make It Happen' 2015) of the transport services as well. A similar result will be obtained thanks to the development of online payment services, not forgetting the recent EU proposal on parcel delivery services ('EUR-Lex - 52016PC0285 - EN - EUR-Lex' 2016).

The reaction to recent terrorist attacks will most probably trigger the issuance of security rules and standards, maybe pushing towards the imposition of secure-by-design services.

Interaction between trend and mobility: many recent technological and organisational innovations in the domain of transport have necessitated the reform of the legislative context where business models evolve. The most significant situations are Uber and other similar services, the introduction of automated vehicles, drones for freight and e-commerce.

Type of trend: Legal

Evidence of trend: The European Commission issued the Digital Single Market Initiative in May 2015 and the Circular Economy Package in December 2015, so demonstrating it will to seize the potential of green companies active in the digital world to drive the European economy. In November 2016 the European Parliament issued a resolution on "New opportunities for small transport businesses", including collaborative business models (P8_TA-PROV(2016)0455).

3.9.3 Trend toward harmonisation in legislative frameworks

The European Union has demonstrated a will to harmonise transport legislation. A recent example is the initiative ('Road Transport: Harmonisation of Legislation | EU Fact Sheets | European Parliament' 2016) put in place by the European Parliament to work on the

harmonisation of legislation in the road transport sector. Harmonisation, though, doesn't deal only with legislation. New business models, like car hire, led to the need for harmonisation of standards among different countries, e.g. plugs for e-cars. The cross-border nature of transport means pushes both the industry and the legislator towards the implementation of interoperable, thus compatible, standards to allow, on one hand, businesses to expand and, on the other, users to benefit from the service. Both parties know that this target can be reached by working on harmonization ('Rail System: Interoperability - European Commission' 2016). Also, disruptive concepts entering the market of one country push the others to get ready for them, and their reactions can create precedents, potential inspiration for governments.

Interaction between trend and mobility: The more transport means are interoperable, the more users are able to benefit from them wherever they are.

Type of trend: Legal

Evidence of trend: the existence of interoperability European directives concerning the rail transport system constitutes an evidence of the trend as a policy goal of Europe.

4 Barriers and societal resistance to transport development

In this section we have the aim to describe the obstacle to transport solutions developments. We start with an analysis of a set of good practices in the management of transport needs with a focus on barriers to their widespread implementation. We provide a synthesis of this analysis in the following section.

Finally, we introduce an analysis of the societal resistance to new transport solutions, based on literature and experts' analysis.

4.1 Good practices in managing transport needs: a focus on barriers

This section provides a list of good practices in addressing and managing transport needs. Transport needs are derived from the understanding of societal trends described in the previous section.

This section has for aim to **highlight societal resistance** to a wider implementation of good practices and solutions. In consequence the list has not the ambition to be comprehensive, as opposed to the previous list of trends, but rather provide a first overview of the barriers to widespread diffusion of existing solutions.

Good practices are implemented transport solutions or policies, as opposed to transport solutions implemented or to be implemented that will be covered in the respective deliverable. This section includes generic principles and policies and also implemented solution in specific European territories.

The structure of the list follows these indications:

1 **Title** of good practice

2 **Geographical scale** of good practice: international, EU, state, region, city level

3 **Societal trend(s)** addressed by the good practice (refer to the previous list of societal trends)

4 **Why** the good practice was applied in first place (briefly describe the challenge /need/ problem the good practice came to address)?

5 **Description** of the good practice. Describe the content, the measures, the scope, the operational part, duration of implementation, the actors being involved, the role of authorities, etc.

6 **Results/impact** Please refer in short to the key results/impacts of the good practice (in all aspects, i.e. end-users acceptance, transport modal shift, new business models, energy saving, emissions reduction, mobility improvement, road safety, traffic efficiency, new technologies/vehicles penetration like electric vehicles, changes in travel/mobility behaviour patterns, social inclusion, travel time and cost, ...). Please refer to both the key positive and negative results.

7 **Barriers and shortcomings** for a wider implementation, highlighting the societal resistance, specificities in economy, geography, legislative framework, etc.

4.1.1 Sustainable Urban Mobility Plans (SUMP)

Geographical scale: urban agglomeration scale

Societal trends addressed:

- 3.3.1 **Rising and expanding urbanisation**

Why: recognising the unsustainability of urban transport systems, mainly based on automobile, SUMPs aim at developing more sustainable transport modes.

Description: SUMPs are a planning practice where strategic priorities are defined in the domain of mobility at urban agglomeration scale. SUMPs comprise a diagnostic of the current situation, often using mobility surveys, strategic objectives for the period to come, and a strategic vision of a transport organisation to be set up.

Results/impact: SUMPs are credited with providing the framework conditions and the impetus for setting up major public transport transit projects in many European cities. For instance in France the numerous new tram and metro projects since the late 1980 are all associated with SUMP that planned them.

Barriers and shortcomings: when cities expand spatially, because of automobile driven urban sprawl, SUMPs perimeters have to enlarge which weakens the case for public transport, more suitable in denser areas. A relevant diagnostic for mobility needs a costly mobility survey usually conducted every ten years.

The EltisPlus European project identified a series of barriers in the implementation of SUMPS as: Existing car-infrastructure orientation within the community (including strong lobbies); Lack of engagement and resistance from established planning and engineering officials, and a lack of joint working between sectors, particularly transport and land use; Lack of relevant knowledge among officials; Lack of funds for the preparation of SUMPs and increasingly for infrastructure itself; Lack of coordination between different levels of government; The greater requirements for public participation compared to conventional transport plans; Adverse responses to EC-led initiatives; Political conservatism (Rupprecht consult 2012, 19). Hence, many legal issues, already highlighted in the trends section of this document (3.9 Legislative framework page 45), are involved in SUMP approaches.

One more barrier/shortcoming is that the SUMP usually covers the administrative legal limits of the city, however the SUMP often includes a high number of actions to implement where the city has no competence (for example, improve suburban rail network). Therefore, there are many SUMPs where the rate of actions implemented is not very high because of this. In this sense, the SUMPs at more metropolitan/regional level become more strategic and convenient to ensure that the administrations who have the real competences are included within the SUMP.

4.1.2 Stedenbaan plus project, a Transit Oriented Development (TOD)

Geographical scale: urban/regional scale in the Rotterdam and Den Haag region (Netherlands)

Societal trends addressed:

- 3.3.1 **Rising and expanding urbanisation**

Why: The Stedenbaan plus project has been motivated by the fact that the new high-speed rail line was completely avoiding Den Haag region, and raised to threat of territorial relegation. A rail network de-classed by HST with available capacity and a region that fears being left out of the development trends and that proposes an ambitious plan.

Description: TOD is a compact urban development organised around transit stops, lines and networks. The soft governed project links 3 regions, 2 major cities, 8 transport authorities, 3 transport firms. The aim is to "improve the accessibility of the south-wing of the Randstad region by public transport in combination with spatial development".

Results/impact: Aims have been fixed in terms of concentrating new housing and offices built around railway stations; these objectives have been attained of extend to higher targets for the period 2010-2020. New stations have been built and train usage have grown close to levels that have been determined to trigger frequency improvements (4 to 6 trains per hour) on main corridors.

Barriers and shortcomings: TOD are difficult to implement for a series of reasons listed in the literature (Tan 2013): the interface nature of TOD entails that we don't know who is in charge; transit culture is missing; lack of money is a symptom of deeper issues with formal institutional barriers (fragmentation and complexity) and informal institutional barriers (indifference, lack of urgency).

4.1.3 Mobility Legislation without a proper financial framework (as in Catalonia)

Geographical scale: urban, metropolitan/regional or national

Societal trend(s)

- 3.9 Legislative framework
- 3.6 **Novel Business models and innovation in transport**

Why/Description Many cities or regions have developed legislation to establish a coherent mobility framework to improve the planning process, which is a very positive aspect. However many of the issues related on how to implement and finance the mobility system and the new plans have not been included.

Results/impact The new legislation has a very positive impact related to the mobility planning, but there is a lack of definition of financial instruments to implement it.

Barriers and shortcomings The planning framework is well established but not the financial framework. For example, in the case of the Government of Catalonia, the Mobility Law was approved by the Parliament in 2003 and it included the development of a Financial Law which has not been approved by the Parliament until 2015.

4.1.4 Smartcities or too many technologies implemented? (Barcelona)

Geographical scale: urban, metropolitan/regional

Societal trend(s)

- 3.3.2 **The emergence of Smart cities**

Why/Description Smartcities have become a fashion and many cities and metropolitan areas want to be considered as 'Smartcity'. Therefore, there is sometimes a tendency to implement too many technological gadgets without a coherent strategy and without integration with other cities.

Results/impact In the end, there has been an important technology implementation (sensors, etc.) but the big questions are: what do we get from them? What is the main objective?

Barriers and shortcomings Define properly the goals. Afterwards decide what the best technology is to implement in an efficient way. Technology is only an instrument.

For example, there are many cities within the Metropolitan Area of Barcelona (AMB) which have implemented a lot of technologies and are considered smartcities. However, sometimes the city itself is not enough and there is need to integrate and interconnect all of them at metropolitan and regional level. In this sense, on the one hand, the AMB is trying to find synergies between these cities and on the other hand, the Metropolitan Transport Authority of Barcelona is planning a global strategy which has been included within its Mobility Director Plan 2013-2018.

4.1.5 Co-creation including citizens versus cultural issues

Geographical scale: urban, metropolitan/regional

Societal trend(s)

- 3.5.3 **Expectation of customers and digitisation of mobility**

Why/Description There is currently the positive tendency to have more the citizens involved in the definition of mobility issues, and it has had great success in cities and countries where there is a great tradition of citizens' participation. However, in those countries where there is not such tradition, the citizens' participation is very low and the results of the process might not represent the majority of the society.

Results/impact Very good results in countries with tradition of citizens' participation.

Barriers and shortcomings Make sure that the process results represent the interests of the majority of the society in those areas where the levels of participation is very low.

4.1.6 Road user charging in Stockholm and Gothenburg

Geographical scale: City (Stockholm and Gothenburg)

S**ocietal trends addressed**:

- 3.4.4 Impact of climate change on transport
- 3.6.2 **New players and new business models**

Why: Congestion, traffic-related noise and air pollution in city centres are mainly caused by road traffic. Congestion charging, in combination with other measures such as the development of public transport and cycling infrastructure is an effective measure to reduce road traffic.

Description: A congestion charge was implemented in the city centre of Stockholm in 2006. The charge varies by time of the day (higher in peak hours). The charge is collected based on automatic number plate recognition and automatic processing of payments.

In the city of Gothenburg, a similar scheme was introduced in 2013. The scheme was, however, rejected in a referendum after 1.5 years of operation. In spite of the results of the referendum the city council decided to keep the charging system.

Results/impact: After the introduction of the charging scheme in Stockholm, the number of vehicles entering the charging area decreased by 22 % in the long term. Particulate Matter (PM10) levels significantly decreased by 18 %. After a 7-month trial a referendum was held which confirmed the continuation of the scheme. Public support in Stockholm rose from 36 % to 74 % after implementation.

In Gothenburg, peak hour traffic dropped by 20 % in the first month of the charge, but after 10 months traffic levels were only 8 % to 11 % lower than before the charge introduction. Some displacement of traffic into adjacent areas was also detected.

Barriers and shortcomings:

Road user charging is a very sensitive issue and public opposition is usually the strongest justification why it has not been introduced in more cities. The scheme is successful in cities where alternatives to car driving have been improved (public transport capacity and quality, improved cycling conditions) and the problems that the charging scheme addresses are serious (high level of air pollution, congestion). The interests of businesses located within the charging zone have to be taken into account (parking, compensation of visitors). The way revenues from the scheme are used can also make the system more acceptable. In Stockholm and London the revenues are explicitly used to improve mobility.

More generally than these tow cases, the monetary benefits from the implementation of actions to reduce the use of car (such as, parking regulation or tolls) can't sometimes be used to implement sustainable mobility projects because the money is not in the same administration or it might be in the same administration but not in the same department. There might be an insufficient legislative definition and coordination between administrations

In Gothenburg the level of traffic congestion was lower than in Stockholm and the charge was promoted as a tax to finance large infrastructure projects rather than a tool to increase liveability of the city centre. This probably led to the negative result of the referendum.

Sources: (EPOMM 2015; Franklin et al. 2016)

4.1.7 Micro platforms for urban goods distribution in European cities

Geographical scale: urban

Societal trend(s)

- 3.3.2 The emergence of Smart cities
- 3.4.1 Stricter regulations for environmental protection
- 3.6.2 **New players and new business models**

Why During the last years a large number of microplatforms for urban goods distribution have been implemented around Europe, including free emissions vehicles for the last mile distribution. A lot of them have been included within European projects.

Description The main goal has been to improve the environmental and efficiency of urban goods distributions in central areas and avoid the entrance of lorries.

Results/impact During the pilot tests, the results are positive considering the environmental aspects.

Barriers and shortcomings The main barriers to overcome that are not still completely solved are: the business model once the European subsidy has finished, who manages the microplatform (which stakeholder is best suited to do it in a professional way)? How to secure the effective participation of all the shops and business within the area to cover? How to negotiate with all the providers that will have to go to the microplatform?

4.1.8 Mobile Depot in Brussels

Geographical scale: City (Brussels)

Societal trends addressed:

- 3.2.6 Acceleration and flexibility of liquid modern society
- 3.3.1 Rising and expanding urbanisation
- 3.4.4 Impact of climate change on transport
- 3.4.1 Stricter regulations for environmental protection
- 3.4.2 **Limited resources require more resource efficiency and circular economy in transport**

Why: Urban areas face particular challenges for freight transport, both in terms of logistics performance and environmental impact. The high share of diesel combustion engines in urban freight transport leads to pollution from exhaust emissions which include among others Carbon Monoxide (CO), Carbon Dioxide (CO_2), Nitrogen Oxides (NOx) and Particulate Matter (PM).

Description: A Mobile Depot (MD) is a trailer fitted with a loading dock, warehousing facilities and an office. Courier, express and parcel (CEP) service providers can use such a trailer as a mobile inner city base to do their last-mile deliveries and first-mile pick-ups with electrically supported cycle cargos.

TNT Express tested the MD concept in Brussels for a period of three months in 2013 at 40 % of its capacity to avoid any falls in service levels.

Results/impact: TNT Express succeeded in integrating the MD in their operational structure. Even though punctuality dropped from 95 % to 88 %, there were no complaints by senders or receivers about this new way of working.

Emissions of pollutants dropped significantly, from 24 % for CO2 up to 99 % for PM2.5 emissions. The number of diesel kilometres decreased from 1291 van kilometres per week to 141 weekly truck kilometres. The MD was, however, twice as expensive compared to the initial situation with vans.

Barriers and shortcomings:

The test showed that using an MD for last-mile deliveries would be beneficial for society by reducing emissions and kilometres driven by combustion engine vehicles. The main barrier for implementing the solution is the increased operational cost for the CEP service provider. Further analysis showed that using the MD to its full capacity and increasing drop density would allow meeting the viability of investment and profitability of operations criteria of TNT Express. Another possibility would be to compensate the CEP service provider for the benefits he is creating for society by internalising external costs, for example. A second and smaller barrier for this solution is the need for (public)

centrally located space to park the MD while drivers load parcels from the MD into their cargo-bikes. In Brussels, local authorities provided such a public space but this might not be possible in every city.

Sources: (Wulfhorst et al. 2014)

4.1.9 Mobility Robots in Japan

Small robotic single passenger vehicles have been developed by Japanese firm Hitachi ('News Releases : March 12, 2013 : Hitachi Global' 2016).

Geographical scale: These were invented by Hitachi in Tokyo, Japan.

Societal Trends Addressed:

- 3.2.1 Increasing life expectancy of the population
- 3.4.4 **Impact of climate change on transport**

Why: The use of Ropits helps to increase mobility for an ageing population. They are also low carbon emission vehicles.

Description: The Hitachi Ropits are used for autonomous locomotion on footpaths. They come equipped with a "specified arbitrary point autonomous pick-up and drop-off function" that can autonomously navigate to a point specified by a portable information terminal.

This can aid people who find it difficult to walk and navigate busy streets etc.

Results / Impact: Through pilot tests conducted on real-world footpaths, research has been conducted to improve usability and convenience as a transport support service, reliability in autonomous travel, as well as compatibility surveys with actual pedestrians.

Barriers and Shortcomings: Ropits have to navigate past obstacles placed on the footpaths.

4.1.10 Ride-sourcing and ride-sharing by Uber and others

Geographical scale: City

S**ocietal trends addressed**:

- 3.2.7 Personalisation of liquid modern society
- 3.6.1 **New models challenging the individual vehicle ownership model**

Why: In our accelerated society city dwellers would like more flexibility, better customer service and lower cost for their urban journeys. Ride-sourcing and ride-sharing services such as UBER and Lyft offer flexibility, transparency, low cost and easy ordering and payment procedures.

Description: Uber and other similar services offer ride-sourcing (the equivalent of taxies) and ride-sharing (sharing a car with other passengers travelling in the same direction) services through a mobile app. Uber drivers use their own cars. Uber controls the booking, fare setting, tracking, payment and brand communications with a minimum of staff. Users can track the vehicles, they are never overcharged and they can rate the drivers.

Results/impact: An analysis by the Massachusetts Institute of Technology (MIT) suggests significant direct and indirect increases in social utility to consumers and society through

ride-sourcing. Compared to regular taxi trips the pre- and post-journey time is reduced because the arrival of the car is forecast by the minute. The average time reduction in the overall total journey time is estimated between 20 to 30 percent (Hardesty 2014).

Ride-sourcing serves demand that was previously unmet by other services. The users of taxis and ride-sourcing services are different. Ride-sourcing users are characterised by a younger age, lower vehicle ownership and more frequent trips with companions. Ride-sourcing may substitute longer public transport trips, but it also acts complementary to public transport. The overall impact on traffic and congestion is still not known (Rayle et al. 2014).

Barriers and shortcomings:

UBER is the subject of ongoing protests and legal actions from governments and taxi companies in the regions they operate in.

The opponents of Uber mostly cite the disruption caused to the existing taxicab owners, operators, and drivers who will face new competition from an unregulated competitors. They allege Uber represents unfair competition, because their cost structure differs from the regulated taxicab industry. Uber drivers can flout the rules and restrictions that regulate the professionals, since they do not pay licensing fees or taxes. Another discussion point is that the company uses drivers who are not licensed, insured or trained to drive taxicabs, which is unsafe and illegal. The only requirement for driving Uber is having the appropriate age, health, ability to drive and passing a background check.

Therefore Uber and other similar services are subject to unclear government regulation or an official ban in many countries, which makes their operation uncertain.

4.1.11 Intelligent transportation systems in Greater Montreal

Geographical scale: Intelligent Transportation systems have been implemented by Xerox in the Greater Montreal area.

Societal Trends addressed:

- 3.5.1 **Rise of the Internet of Things and big data**

Why: Intelligent Transport systems use big data to integrate ticketing systems, fare collection, open payment systems and real-time fleet management. This can lead to more efficient, reliable and cost effective transport solutions.

Description: The integrated ticketing systems mean that the same card can be used to pay across different modes. It would also be possible to incorporate assistance cards for older people as recommended by the ILC Future of Transport Report page 17. ITS can also be used for real-time fleet management. This allows you to dynamically receive transport updates ('Public Transport Management Services - Xerox' 2016).

Results / Impacts: ITS have worked effectively across Europe and the USA. Once installed ITS has less operational costs and lower time costs than the older technology. ITS has also been proven to lead to a reduction in road traffic accidents. The Intelligent Transportation System elements implementation at toll plaza has a positive impact on the ecological situation. In case of Intelligent Transportation System elements implementation the emissions will decrease by 239 thousand tons.

Barriers: There are large initial start-up costs which can present a barrier. Other common barriers can be a lack of understanding on the part of the various stakeholders. Finally

with a big data project of this scale privacy can provide to be an issue (Plaksin et al. 2015).

4.1.12 Dementia Training in London

Geographical scale: In London transport providers such as Transport for London and First Group offer their staff dementia training.

Societal trends addressed:

- 3.2.1 **Increasing life expectancy of the population**

Why: A lack of awareness, among both passengers and transport staff, of the issues surrounding dementia can make transport difficult. In an ageing society where dementia is becoming more prevalent it is important for transport staff to better understand dementia. Public Transport can be difficult for people with dementia as it can increase disorientation and also the can exhibit uninhibited behaviour. Dementia is a recognised disability in the UK so is protected under the Equalities Act ('House of Commons - Transport Committee: Written Evidence from the Alzheimer's Society (DAT 16)' 2016).

Description: Some transport providers, such as First Group and Transport for London, already run dementia training for their staff to enable them to better understand the needs of passengers with dementia. Staffs are taught to be alert to passengers who are lost or confused. Furthermore it is possible for transport staff to mistake some symptoms for confusion and agitation (Holley-Moore and Creighton 2015).

They are developing a new training module component on dementia for their Driver Certificate of Professional Competence. They are also developing their safe journey cards for passengers with dementia. This means that First Group staff will be aware of people with dementia using their buses and can ensure that they can use the bus service safely and get to their destination ('The Prime Minister's Challenge on Dementia: Annual Report of Progress - Publications - GOV.UK' 2015).

Results / Impacts: First Bus, one of Britain's largest bus operators, has scooped one of the top prizes at the inaugural Dementia Friendly Awards, organised by Alzheimer's Society. First Bus won the 'Business Award' at the central London event on May 20, thanks to the company's development of a training module designed to raise awareness of dementia, which currently affects 800,000 people in the UK. First's 13,500 drivers across the country are learning how to provide assistance, if needed, to customers who have dementia ('First Bus Scoops Prestigious Prize at Alzheimer's Society's Dementia Friendly Awards – FirstGroup Plc' 2016).

Barriers and Shortcomings: There are no obvious barriers or shortcomings to this policy.

4.1.13 Demand Responsive Transport (DRT) in Lincolnshire

Geographical scale: Flexible bus routes have been employed successfully in Lincolnshire which is a rural part of England.

Societal trends addressed:

- 3.2.1 Increasing life expectancy of the population
- 3.2.7 **Personalisation of liquid modern society**

Why: Demand Responsive Transport is an advanced, user-oriented form of public transport characterised by flexible routing and scheduling of small/medium vehicles operating in shared-ride mode between pick-up and drop-off locations according to passenger's needs. (Synopsis of DRT European Commission Directorate-General for Energy and Transport). Allowing greater flexibility with routes in rural locations can help mobility. This helps with ageing and longevity as proportionally older people reside in rural locations.

Description: Increasing the frequency of services, providing more and better information regarding community transport services in order to increase take-up, using smaller accessible buses instead of double-deckers, and reducing restrictions on where buses may set down passengers in rural locations.

Results / Impacts: The uptake of the Lincolnshire approach to DRT provision by other rural areas suggests that the County provides an example of good practice for other rural areas (Wang et al. 2015).

The main benefits that DRT brings to its users in communities around the UK:

· Flexibility in scale

· Services can be targeted to specific zones or areas

· Quick and easy to change or adjust operating times

· High frequency on-demand services

· Wider network coverage can be obtained with given resources

· Can help to serve the 7-20 % of the population who are outside the Authority's minimum distance and frequency criteria relating to their subsidised services. (Activeage 2008)

Barriers and Shortcomings: The core problem here was due to there being such a complex array of stakeholders and regimes relating to operators, routes, vehicles and drivers in terms of licensing, tax, and insurance that many potential operators (particularly taxi firms) are put off investigating new DRT markets. There can also be a high cost per trip (Activeage 2008).

4.1.14 The Transport Code in Finland

The public consultation of the Transport Code in Finland was completed in the end on May 2016.

Geographical scale: Member state

Societal trend(s) addressed by the good practice:

- 3.5.1 Rise of the Internet of Things and big data
- 3.5.2 More automation
- 3.5.3 Expectation of customers and digitisation of mobility
- 3.6.1 New models challenging the individual vehicle ownership model
- 3.6.2 **New players and new business models**

Why Currently the regulation related to transport services is dispersed under several regulations and acts, which hinders the free development of transport markets and emergence of new digital services.

Description In the Transport Code, transport market regulations will be brought together under one act in Finland. The Code aims to make room for new business models and to better meet the needs of users by promoting introduction of new technologies, digitalisation and innovative business concepts. It aims at enabling provisions, removing unnecessary norms and alleviating the administrative burden. Open data and the better use of data resources are hoped to generate new business ideas. The preparations for the Transport Code have been carried out in interaction with stakeholders.

Results/impact The Transport Code aims at new innovative digital transport solutions, improvements in services, the promotion of individual initiative and entrepreneurship, and the strengthening of regional and local decision-making and cooperation by utilising citizen-driven operational practices. The actual impacts will be concretised within a couple of years' time in case the Code will be accepted.

Barriers and shortcomings: Resistance of quite many stakeholders (e.g. taxi drivers, transport and Logistics associations, local public transport providers) due to lock-inns in the current practices, technologies and habits. Also the general public is uncertain on the impacts of this kind of large reform to their daily lives. The stakeholder process has been carried out, but maybe with a too tight schedule and without clear vision on the ultimate target and the big picture. Also impact assessments carried out during the process have been quite modest.

4.1.15 High speed magnetic levitation train

Geographical scale: Regional, national

S**ocietal trends addressed**:

- 3.4.4 Impact of climate change on transport
- 3.2.6 Acceleration and flexibility of liquid modern society
- 3.2.3 Trend towards inclusion of vulnerable to exclusion groups
- 3.4.3 **Move away from fossil fuels towards energy efficiency and renewable energies**

Why: Increased security measures in aviation, more congested airspace and the aim to reduce CO_2 emissions propelled the development of high-speed surface transport solutions that can provide connections between city centres at speeds competing with that of the aircraft using sustainable energy sources.

Description: Maglev trains are capable of running at 600 km/h using magnetic levitation without touching the ground. The train uses dedicated guideways. Magnets create lift and propulsion minimising friction that allows for very high speeds.

Results/impact: Operational and maintenance costs are estimated to be lower than for conventional high-speed rail while operational reliability is high, noise pollution is very low, energy consumption is 30 % lower than conventional rail and local emissions are zero.

Technical readiness of the Transrapid, the German high-speed maglev train was reached in 1991 but apart from a test track in Germany no other applications were built in Europe. The only high-speed system has been operational in Shanghai, China on a 30 km line since 2004. A new system is currently under planning in Japan to be completed by 2027. In Europe the only test track in Germany has been dismantled and previous plans to deploy the system have been abandoned.

Barriers and shortcomings: The technology is ready for deployment. Nevertheless the high construction costs, and the need to build a completely new alignment for the guideways (existing railway tracks cannot be used), which is difficult in densely built areas have prevented the technology from wide-scale deployment. (see Hyperloop).

4.2 Lessons learned from good practice analysis: barriers to widespread implementation

This part provides a synthesis on societal trends and good practices, highlighting the opportunities and challenges in view of a wider implementation of transport solutions.

Two social trends related to urbanisation and smart cities are related to the urban space and the land cover and how this is advancing in the European Countries. According to trend 3.3.2 The emergence of Smart cities (see page 29), the urbanisation has become the dominant European geography, with the cities expanding and becoming denser, as the share of Europeans living in urban areas is expected to increase from 73 % in 2014 to 84 % in 2050 (United Nations 2014, 10). Additionally, the artificial land cover in Europe increased by 3.4 %, between 2000 and 2006 (European Environment Agency 2013), while the 50- years lasting car based urban sprawl is more and more seen as an issue by urban and regional planners because of the associated externalities (land consumption, energy, traffic congestion) with proposed alternatives like urban intensification, compact development, Transit Oriented Development (TOD), and to some extent, smart cities.

Thus, spatially expanding cities lead to a more intense mobility (denser traffic, longer and larger flows) (Sena e Silva et al. 2013, 58) and to the need to extend public transport in lower density areas weakening their economic case (Bruegmann 2008). Nevertheless, according to the TRANSFORuM Urban Transport Roadmap (Anderton, Brand, et al. 2015), the diversity between cities cannot be ignored; there is no 'one size fits all' approach to sustainable urban planning as the needs, context and aspirations of each city will be different.

Recognising the aforementioned trends as a reason behind unsustainability of the urban transport systems, local policies in Europe are implementing Sustainable Urban Mobility Plans (SUMP) aiming at improving the accessibility of urban areas and providing high-quality and sustainable mobility and transport to, through and within the urban area (http://www.eltis.org/mobility-plans/sump-concept). The Sustainable Urban Mobility Plans are supporting public transport and other alternatives to the car. SUMPs are credited with providing the framework conditions and the impetus for setting up major public transport transit projects in many European cities, they have a deep impact in particular on the development of public transport and they are proposed as an opportunity to solve many of the unsustainability issues that may be raised.

On the other hand, the challenging part of the implementation of SUMPs is that when cities expand spatially, SUMPs perimeters have to be enlarged, fact that weakens the case for public transport being more suitable in denser areas. One more barrier/ shortcoming is that the SUMP usually covers the administrative legal limits of the city, however the SUMP often includes a high number of actions to implement where the city has no competence (for example, improve suburban rail network). Therefore, there are many SUMPs where the rate of actions implemented is not very high because of this. In this sense, the SUMPs at more metropolitan/regional level become more strategic and convenient to ensure that the administrations who have the real competences are included within the SUMP. Additional barriers of the SUMPs implementation, according to EltisPlus European project, include the existing car-infrastructure orientation within the

community (including strong lobbies), the resistance from established planning and engineering officials, and the lack of joint working between sectors, particularly transport and land use, the lack of relevant knowledge among officials, the lack of funds for the preparation of SUMPs and increasingly for infrastructure itself, the lack of coordination between different levels of government, the greater requirements for public participation compared to conventional transport plans and the adverse responses to EC-led initiatives (Rupprecht consult 2012, 19).

A good practice of a SUMP implementation is the Transit Oriented Development (TOD) developed by the Stedenbaan plus project. TOD is a compact urban development organised around transit stops, lines and networks, which links 3 regions, 2 major cities, 8 transport authorities and 3 transport firms. The aim is to "improve the accessibility of the south-wing of the Randstad region by public transport in combination with spatial development". Thus, the plan of the TOD was to concentrate new housing and offices built around railway stations. New stations have been built and train usage has grown close to levels that have been determined to trigger frequency improvements (4 to 6 trains per hour) on main corridors.

These kinds of combined transport and land use plans could be realised and implemented in many metropolitan regions in Europe who are already big and they keep expanding. Nevertheless, the implementation of TOD in any region is challenging, since, the interface nature of TOD entails that we don't know who is in charge, the transit culture in many regions is missing and there is lack of money for its implementation (Tan 2013). Additionally, such practices despite the fact that they are very promising, they need lot of time to be planned and even longer to be implemented. Thus, we are talking about long-term solutions, which deeply affect the urban sprawl and its development.

Another SUMP good practice is the Transport Code in Finland, which public consultation was completed in the end on May 2016. The Transport Code aims at new innovative digital transport solutions, improvements in services, the promotion of individual initiative and entrepreneurship, and the strengthening of regional and local decision-making and cooperation by utilising citizen-driven operational practices. The actual impacts will be concretised within a couple of years' time in case the Code will be accepted.

Of course the barriers in this case are also varying, but kept at the aforementioned pillars, including the resistance of many stakeholders (e.g. taxi drivers, transport and Logistics associations, local public transport providers) due to lock-inns in the current practices, technologies and habits, the uncertainty of the general public on the impacts of this kind of large reform to their daily lives.

The aforementioned good practices may provide potential solution to the trends mentioned in the beginning of this section, but they also encompass other trends related to "Smart integration" of transport modes for mobility users, global environmental trends (climate change), Internet of Things and big data, automation and Expectation of customers and digitisation of mobility.

Moving forward from the SUMPs and the policies related issues, another topic that seems to gather concerns is the one related to the financing of the solutions and their implementation. Financing schemes developed and implement, as well as, new business models on vehicle (car, bike, etc.) ownership are trend to be tackled. Public procurement is more and more emphasising internationally interoperable and open systems and services rather than custom made solutions, and this opens up competition and affects the business models of service providers (3.6.2 New players and new business models page 40). Additionally, current/ previous vehicle ownership or vehicle rent models are

challenged by new societal (for young adults owning a car is not a dream anymore see 3.2.4 Less car use by younger generations page 24) and economic (high price of electric batteries incites to lease/rent them) trends. Thus, the financial aspect is something that should be also taken into account both legally and in practice, especially since, many cities or regions have developed legislation to establish a coherent mobility framework to improve the planning but not financing process.

A good practice related to the new business models about vehicle ownership is the bike and the car sharing systems, like UBER, Car2go or Blablacar etc., that already exist in many cities and are another way of tackling the emerging transportation unsustainability issues in the urban areas. Vehicle-sharing would likely grow at varying rates in different European markets. Relatively supportive markets include Germany, where the number of people sharing cars has increased 50 % a year since 2010 and reached one million at the end of 2014 (The Ellen MacArthur Foundation, McKinsey Center for Business and Environment, and SUN 2015). A survey by McKinsey conducted in Germany in 2011 shown that 38 % of all young Germans (18- to 39-year old) living in cities with more than 100,000 inhabitants indicate that in ten years "[they] will use car sharing more," (McKinsey et al. 2012, 12). The figure below supports this, depicting the car sharing Market from 2006-2014 (Frost and Sullivan (2014) Strategic Insight of the Global Car sharing Market. Report #ND90-18, June 2014).

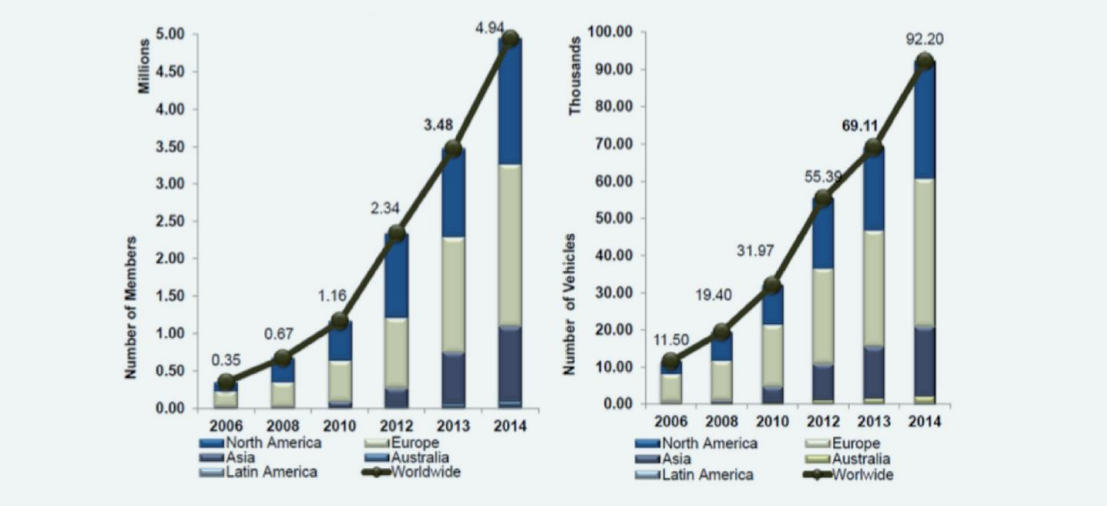

Figure 2: Carsharing Market, Number of Members and Vehicles, 2006-2014

Nevertheless, the financial framework under which the car sharing services interact with the public sector is unfamiliar for carmakers (SAG report, 2014) and this is a great challenge. For example, car sharing services require privileged access to on-street parking space, which is typically managed by municipalities. Another example comes from UBER, which is the subject of ongoing protests and legal actions from governments and taxi companies. Additionally, car sharing goes against the up-to-now status that was related to the car ownership. Even if this status tends to fade, taking into consideration also the trend towards green movement (biking and walking), it still remains a issue of prestige.

On the other hand, car sharing provides also lots of opportunities. The fulfilment of car access (especially to young generations), the great potential improvement of the urban transport issues, the air pollution concerns and the enhancement of the clean vehicle promotion is just a set of the various potential possible opportunities provided by its implantation (EMBARQ report in Car sharing).

Additionally, another good practice that is implemented in various cities is the road user charge in the city centre. More specific, a congestion charge was implemented in the city centre of Stockholm in 2006 with varying charge depending on time of the day (higher in peak hours), collected based on automatic number plate recognition and automatic processing of payments. After the introduction of the charging scheme in Stockholm, the number of vehicles entering the charging area decreased by 22 % in the long term, while the public transport usage rose from 36 % to 74 %.

Road user charging is a very sensitive issue and public opposition is usually the strongest justification why it has not been introduced in more cities. The scheme is successful in cities where alternatives to car driving have been improved (public transport capacity and quality, improved cycling conditions) and the problems that the charging scheme addresses are serious (high level of air pollution, congestion). The interests of businesses located within the charging zone have to be taken into account (parking, compensation of visitors). The way revenues from the scheme are used can also make the system more acceptable. In Stockholm and London the revenues are explicitly used to improve mobility.

Another critical issue, which is indirectly related to lots of trends too, is the increase of the ageing population and mostly the active ageing population. The ageing issue will have the strongest implications for the organisation of transport systems, since the percentage of Europeans aged over 65 is projected to rise from 16 % in 2010 to 29 % by 2060 and the European population aged over 80 is set to rise from 4.1 % in 2010 to 11.5 % in 2060. Across Europe, the trend is generally that cities attract working-age adults, meaning that the percentage of working age adults in cities tends to be higher than the national average (Eurostat 2015b). The older European population of the future will have different transport requirements, and current transport and mobility enablers need to adapt to meet these challenges. Access to transport services, including high-speed rail, should account for an older client base, with attention paid to enabling those with decreased mobility to retain or gain access (Anderton, Åkerman, et al. 2015, 7).

A good practice related to ageing population is the Demand Responsive Transport (DRT) implemented in Lincolnshire. Demand Responsive Transport is an advanced, user-oriented form of public transport characterised by flexible routing and scheduling of small/medium vehicles operating in shared-ride mode between pick-up and drop-off locations according to passenger's needs.

The main benefits that DRT brings to its users in communities around the UK is the flexibility, the services targeted to specific zones or areas, the quick and easy change of operating times, the high frequency on-demand services and the wider network coverage (Active Age, An introduction to Demand Responsive Transport as a Mobility Solution in an Ageing Society, November 2008). On the other hand, there are barriers related to the complex array of stakeholders and regimes related to operators, routes, vehicles and drivers in terms of licencing, tax, and insurance that many potential operators (particularly taxi firms) are put off investigating new DRT markets.

A good practice that comes from Japan and could be implemented also in Europe is the mobility robots, which are small robotic single passenger vehicles ('News Releases : March 12, 2013 : Hitachi Global' 2016). The use of Ropits helps to increase mobility for an ageing population, while they are also low carbon emission vehicles. They come equipped with a "specified arbitrary point autonomous pick-up and drop-off function" that can autonomously navigate to a point specified by a portable information terminal, so they may also be combined with the aforementioned DRT.

While the barriers of the Ropits implementation are various and related to a number of legal, privacy, financial, behavioural and technical issues, research has proved that they improve usability and convenience as a transport support service, reliability in autonomous travel, as well as compatibility surveys with actual pedestrians.

Similar to Ropits, Google is testing the autonomous car technology, with a sticky front-end, on the streets of Austin, California, Phoenix and Washington (Calpito 2016). This has further benefits in the context of an ageing population, where older people are more likely to be killed or seriously injured by car accidents but can improve road traffic safety by reducing fatalities from car accidents.

Finally, one additional issue that enhances the problems of the increase of ageing population is the lack of awareness, among both passengers and transport staff, of the issues surrounding disabilities. A good practice on this is the dementia training, which transport providers in London, such as Transport for London and First Group, offer their staff. Dementia is a recognised disability in the UK so is protected under the Equalities Act ('House of Commons - Transport Committee: Written Evidence from the Alzheimer's Society (DAT 16)' 2016) and public transport can be difficult for people with dementia as it can increase disorientation and also the can exhibit uninhibited behaviour. Staff is taught to be alert to passengers who are lost or confused. Furthermore it is possible for transport staff to mistake some symptoms for confusion and agitation (Holley-Moore and Creighton 2015). Training of the staff in issues related to dementia and accessibility in general can be a very assistive measure in enhancing the movement of people with disabilities and the elderly population being also a low cost measure.

Another trend that should be taken into account but expands in many domains is the smart cities. Smart cities aim to meet demands of rapid urbanization and to dynamism and efficiency of societal interaction within large cities. A Smart City connects human capital, social capital and ICT infrastructure in order to address public issues, achieve a sustainable development and increase the quality of life of its citizens (European Investment Bank Institute EIB 2013). With the urbanization and mega cities trend resulting in 70 % of the global population expected to be living in cities by 2050, the implementation of smart city technologies will be a critical challenge for governments in both developed and developing regions. In this context Intelligent Transport Systems (ITS) technologies will play a key role in transforming cities into sustainable, efficient, convenient and cooperative places to live.

A good practice of the ITS technologies implementation is their implementation in the Greater Montreal area by Xerox. ITS Montreal uses big data to integrate ticketing systems, fare collection, open payment systems and real-time fleet management. Once installed, ITS have less operational costs and lower time costs than the older technology, they have also been proven to lead to a reduction in road traffic accidents and the environmental pollution.

Of course, there are also barriers in the implementation of ITS, the greatest of them being the large initial start-up costs and the lack of understanding on the part of the various stakeholders. Finally with a big data project of this scale privacy can provide to be an issue (Plaksin et al. 2015).

In addition to passenger transport there are also good practices that can be implemented in EU cities related to freight transport. One practice implemented around Europe during the last years is the microplatforms for urban goods distribution, including free emissions vehicles for the last mile distribution. The main goal has been to improve the environmental impact and the efficiency of urban goods distributions in central areas and avoid the entrance of trucks to them.

Even if this practice is not implemented that long to have palpable evidence of its results, pilot tests prove that it can positively enhance environmental aspects. The main barriers to overcome are the business model to follow once the European subsidy has finished, and some administrative issues like who manages the microplatform (which stakeholder is best suited to do it in a professional way), and what is the real participation of all the shops and business within the area to cover.

Staying in the freight issue the last good practice comes from Brussels and it is the mobile depot. A Mobile Depot (MD) is a trailer fitted with a loading dock, warehousing facilities and an office. Courier, express and parcel (CEP) service providers can use such a trailer as a mobile inner city base to do their last-mile deliveries and first-mile pick-ups with electrically supported cycle cargos. TNT Express tested the MD concept in Brussels for a period of three months in 2013 at 40 % of its capacity to avoid any falls in service levels and found that even though punctuality dropped from 95 % to 88 %, there were no complaints by senders or receivers about this new way of working. Also, emissions of pollutants dropped significantly, from 24 % for CO2 up to 99 % for PM2.5 emissions. The number of diesel kilometres decreased from 1291 van kilometres per week to 141 weekly truck kilometres. The MD was, however, twice as expensive compared to the initial situation with vans. This cost might be a barrier to take into account.

4.3 Societal resistance over new transport solutions

Since the publication of the 'Brundtland report' in 1987, there is a consensus that sustainable development is built around 3 axes: environment, economy and society. In transport developments, the environmental and economic aspects have been broadly viewed and been researched. In contrast, the social impacts of sustainable transport are often neglected and remain under-examined in comparison to economic and environmental impacts. Thus, the social ramifications of transport developments are not clearly described and understood and the social/psychological factors supporting unsustainable instead of sustainable transport are often forgotten.

Defining social impacts is not an easy task, since there are a lot of diverse, overlapping and competing ones (Geurs, Boon, and Van Wee 2009). Since the social impacts of transport have been vigorously neglected, or only been poorly taken into account, the knowledge about the reaction of society to the transport solutions that are proposed and implemented is vague. Thus, sometimes the implemented solutions might merge with the social norms and some other times they might be rejected, since the society cannot incorporate them and resists to its use. In our view, this societal resistance to the changes in transport is built upon four specific pillars: job loss resistance, affordability of technology, technophobia and habits. All but one of these resistance factors, namely habits, have been identified in the previous section on trends.

4.3.1 Job loss resistance

New transportation trends are emerging and new innovative models are implemented to meet the needs of the society. We have identified these needs through the description of the trends 3.2.6 "Acceleration and flexibility of liquid modern society" and 3.2.7 "Personalisation of liquid modern society" where acceleration, flexibility and personalisation are seen as a important trends in societal developments shaping transport demand. These transport models always affect in a way the life of the people that live in the area where they are implemented. The bigger the change, the greater the resistance; especially in the beginnings of the implementation. One of the biggest

challenges of all occurs if fear exists that this new transport solution threatens job and especially the own job in any manner.

According to related studies, most unemployed people want full-time employment, even when they disliked the job they previously held (Coffield 1983). Thus, feeling threatened from a change at their working routine would make them unwilling to accept this solution. One example of this is the resistance of the society and specifically the taxi drivers to accept Uber (car sharing model). Of course Uber and all the other vehicle-sharing models have the potential to greatly benefit economy (people would buy fewer cars), environment (converting parking spaces to new and environmentally sound uses) and safety (reduce drunk driving and other accidents), but the societal resistance due to the fear of loss of the current employment in some countries, lead to major resistance with social movements and legislation by the authorities.

4.3.2 Affordability of technology

Mobility and accessibility should actually be the same, since mobility is the access of people to goods and services. Thus, any new transportation solution should bear in mind to enhance the accessibility of all the people that is targeting to serve. The accessibility features do not only restrain to the physical accessibility, but also expand to accessibility of the design. For example there are lots of bus lines that have been designed and implemented, but neither the vehicles are accessible (without bus ramps), nor the information given (no verbal feedback on the bus stops).

But when referring to accessibility, we do not restrict ourselves only to people with disability or the elderly, but also those with limited economic resources available. One of the solutions with the highest market penetration (Shende and Singh 2015) is the Advanced Diver Assistance Systems (ADAS). According to most recent reports (Chisult Insight 2015), in 2014 the largest penetration rates of ADAS market was still in Europe, with a penetration rate of around 9.86 %. This solution though excludes most of the car drivers since ADAS are mainly implemented in upper class vehicles, which the average car buyer cannot afford.

This issue is related to the economic trends that we describe in the section 3.1 “Distribution of wealth and labour market developments“.

4.3.3 Technophobia and personal data protection

New transportation technologies are emerging, to meet the transportation challenges of our times, including connected and autonomous vehicles, keyless fleet management, local zoning, new technology for on-road communications, real-time traffic management, etc. It is clear now that ITS is poised to transform transportation, but as Adams said in 1999 (Adams 1999) “even if the harmful environmental consequences of current and projected levels of mobility could be eliminated by technological advances, significant social problems would remain”. And this problem is twofold. On the one hand there are people who are do not know how to use technology (they are afraid to use it - technophobia) and on the other hand there are people who don’t want to use it because despite its impact at the quality of life, it also creates all kinds of problems, including distress, confusion, pathology, and conflict. An example of resistance to technology is the RFID ticketing or the mobile ticketing. This solution has great benefits to the average people, but lacks of benefit to the people who do not possess smart mobile phones or they don’t know how to use these specific functionalities. This problem is identified in the societal trend 3.2.3 “Trend towards inclusion of vulnerable to exclusion groups“.

A consequence of the technology is also the great amount of data gathering in our times. This big data gathering and their treatment is an additional barrier for many. People do not like their personal information to be collected in any way or saved to a Cloud, that most people are not aware of its meaning or existence. We identify this resistance in the trend 3.5.3 “Expectation of customers and digitisation of mobility“.

4.3.4 The force of habits

Habit is one of the most persistent human characteristics; the force of habit, also called routines, explains a large part of social patterns. Habit and routines are well described in transport behaviour (Ettema and Timmermans 1997; Van Acker, Van Wee, and Witlox 2010). Once people create a habit over a form of travel behaviour or of organisation, they tend to stick to it. Habits or patterns of behaviour, of either individuals or group of people, are slow to change since, once established, they are extremely resistant to change precisely because of their self-reinforcing loop.

When changing a habit is required, energy consumption is needed and with no extreme extraneous impetus (legislation, death of a friend in a road accident, etc.), it is unlikely that someone who has a strongly developed pattern of car-driving for example, will change behaviour, even if presented with alternatives which are more appealing in terms of cost and more friendly to the environment. This explains heavily the resistance of some people to change, in relation to transportation mode use and this is the most difficult societal resistance bone to break since it is difficult to make counterbalance with specific incentives either economic, or environmental or even societal.

5 Conclusion

This deliverable focuses primarily on the identification and description of societal trends shaping the demand of mobility and logistics. This task represents the starting point of the whole Mobility4EU project. In a second step, we have conducted an analysis of the barriers and societal resistance to the development of new transport solutions.

In our work, it has proven difficult to dissociate clearly societal trends from political trends – for instance in the environmental domain, aspirations by citizens and legislation are tightly combined as driving forces – and also to dissociate societal trends from technological trends – as expressed in the concept of *digital society*. In order to deal with this difficulty we have chosen to integrate in our analysis of the societal trends having an impact on transport, five domains of investigation: we encompass societal, political, technological, environmental, legal and economic trends.

In this conclusion we present the main interrelations between these trends. Even if we have tended to identifying and isolating individual factors interacting with mobility in an unequivocal sense, we are aware of the intrinsically interdependent nature of our material.

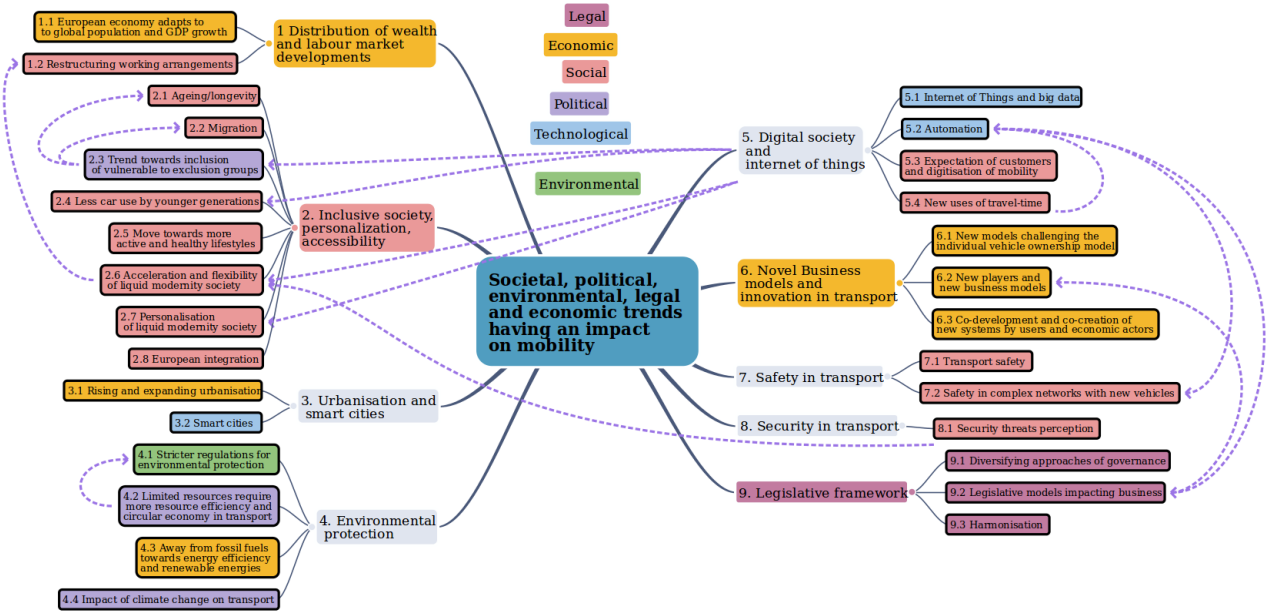

Figure 3: Interrelations between societal trends shaping the demand of mobility and logistics

In figure 3, we have materialised with dashed lines the main interactions between trends. These interrelations form three groups. A small group of interrelations links societal dynamics and policies aimed at correcting or accompanying them: trend 3.2.3 “Trend towards inclusion of vulnerable to exclusion groups“ addresses issues identified in trends 3.2.1 “Increasing life expectancy of the population“ and 3.2.2 “Migration trend generating long distance flows“. A large group includes all the links between societal trends and digital technologies. Finally, a few remaining interrelations are identified beyond these two categories.

The first group of interrelations has already been mentioned: the links between policies and societal trends. Several emerging trends in transport demand are pushed by policies but can also be seen as expressing or translating a societal demand by means of

jurisprudence. This is the case in the environmental protection domain where a sustainable consumption culture interacts with extensive sets of policies dedicated to environment protection. Hence, our analysis mixes societal trends, like ageing, and political responses to identified issues like policies aiming at inclusion.

The second group of interrelations links society and digital technologies.

The liquid modern society described by Bauman and object of a consensus among social scientists is intimately shaped by digital technologies of information and communication mainly. There is, hence, clearly a strong link between the two trends of liquid modernity and the four trends of the digital society. The current and future digital society would not exist without the technology developments in communication and information, but the uses by individuals and social groups, not always envisaged by the creators of services, contribute significantly to shaping the digital society. In this sense digital society is shaped by technology and by societal factors. As is well known in the domain of transport infrastructure, a new supply generates a demand that was not expressed before: this is the so called induced demand. Digital society is rooted in the societal trends of liquid modernity, but also influences the transport demand, the expectation of the customer having a specific dynamic in the digital world, and the digital society does not limit to transport user requirement, but has deep interactions with mobility in general, including avoiding mobility.

The observed less car use by younger generations has been seen by several analysts as linked to a change in values. The possession of a car tends to be replaced by the idea of connecting to the social network; this points to the use of ICT, and hence to several trends we have identified in the digital society section.

We have identified a trend towards the inclusion of vulnerable groups. But in the emerging digital society new forms of exclusion arise; these forms are particularly of concern in the transport and mobility sectors. Here a clear issue lies at the intersection of public policies towards inclusion and the development of new transport services making use of ICT.

We have identified a trend of new uses of travel time, mainly by means of ICT, that currently favours public transport. But, in the future, car automation should erase this comparative advantage. We have here a complex interaction of trends with evolving developments over time.

Beyond the two categories of interrelations, we have identified three other linkages.

Complex interactions link automation and transport safety. Automation comes with the promise of significant improvement of the levels of safety in transport, but also introduces new kinds of safety problems: we consider as an illustration the self-driven Tesla car casualty accident in 2016, a new type of accident raising significant liability and insurance issues most likely to impact the legislative and regulatory frameworks.

The responses to the security threat perception, as noted, carries the risk of introducing more controls that may be detrimental to the ease of access and use of collective transport systems. This trend that we underlined with the idea of a security/accessibility tension is clearly contrary to the fluidity, acceleration and flexibility, features of the *liquid modern* society.

Liquid modernity is both a consequence or a symptom and a source for the observed restructuring working arrangements. Indeed, the acceleration observation is paradoxically based on the growing mobility for non-work purposes, and hence directly related to the idea of growing part-time work described in the restructuring arrangement trend. We have here an example of the links between economy and society.

This review of linkages was necessary to reveal the complexity of the system of trends that we identified. This review also contributes to validating our list of trends, by distinguishing as many factors for the understanding of the present and future dynamics between society and transport.

During the following stages of the Mobility4EU project, the trends will be extensively used in the Multi-Actor Multi-Criteria Analysis (MAMCA) approach, the methodology employed for the structured stakeholder consultation. The trends form the basis for scenario building for the future European mobility and logistics. Within the first round of assessments by stakeholders within the MAMCA process, the trends with the strongest impact and bearing the most uncertainty have been identified to be 3.2 Inclusive society, personalisation, accessibility and 3.9 Legislative framework. These two groups of trends are used to distinguish the various scenarios, as we can consider them as probably the most significant for the future of mobility and logistics in Europe.

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Figure 3: Interrelations between societal trends shaping the demand of mobility and logistics 67

8 List of European projects used for describing societal trends

AutoNet2030
CITYLAB
CIPTEC ciptec.eu/
CityMobil2
COMPANION http://www.companion-project.eu/
COMPASS http://www.fp7-compass.eu/deliverables
Compass4D
DECOMOBIL
Eltis
EurWORK
EUTransportGHG
EXCROSS
FLAGSHIP
FUTRE http://www.futre.eu
MINDSET http://www.mind-sets.eu
OPTICS
ORIGAMI
PASHMINA
RACE2050
SAVE ME http://fp7-saveme.com
SMART-RAIL http://www.smartrail-project.eu/
TRANSFORuM
TRANSvisions
V-Charge
VOYAGER