STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
Advanced fare management and beacon-based ticketing	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political	European Commission initiative to promote standardisation, including smart ticketing	EC Mandate M/546 requested standards organisations to draft new European standards for urban ITS including multimodal information and smart ticketing. International and open standards facilitate interoperable systems, which in turn encourage the market and support cost-effective solutions.	Agreements for co-operation between the various operators and authorities are needed	This is particularly important where more than one transport operator is involved. Involving all relevant stakeholders in an interactive planning process has been found to be a key factor to success.
Economic	European Commission transport policy	Promotion of sustainable multimodal passenger transport across Europe as an alternative to private modes	Lack of consensus on an appropriate business model	An appropriate business model is needed to support a European journey planner and the cooperation between organisations that is needed to implement it
			High cost of introducing new ticketing systems	However the benefits have been shown to outweigh these costs
			Arrangements for sharing of costs and revenues are needed that to ensure fair treatment of operators	Different levels of cooperation can be arranged between operators, ranging from mutual acceptance of tickets on the same route or network to integrated fares and fare management agencies. Mutual acceptance of tickets on the same route or network is more difficult if the share of services or revenues are not equally shared between operators; in this case compensation payment arrangements are needed.
			A high volume of passengers is needed before intermodal ticketing can be financially viable	In the case of air-rail and rail-rail intermodal journeys, a stakeholder survey has indicated that the potential market for integrated ticketing is small. The reasons given are different for air-rail (limited number of airports with high speed rail connections) and rail-rail (competition with airlines for journeys over 4 hours).
Societal	Widespread adoption of smartphones	Culture of multifunctional device in people's pockets increases opportunities for take up of advanced fare management systems	Well established car use habits	Habitual car users do not routinely come into contact with information that would enable them to try out other modes of travel
Technological	Increased adoption of Near Field Communications (NFC) technology	For example to support smartphone ticketing applications. This enables different services to be integrated.	Stand-alone systems run by individual operators may not be standardised or interoperable	Issues with hardware and software, as well as problems with availability of real time data, can hinder integrated ticketing.
Legal			Data protection in payment systems	Personal data held in payment systems must be protected to ensure confidentiality and prevent of mis-use of data. Not only does this incur costs for the organisations involved, but it also risks damage to customer relationships if users cannot be confident that their data is secure.
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
Traffic management systems	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political	European Commission initiatives to promote standardisation and define specif	Establishing compatible standards and data formats, open and practical interfa	Conflicts between road authorities	Agreements between neighbouring road authorities are necessary in order to manage the traffic without creating conflicts (e.g. in case a traffic diversion is required)
	EC policy objectives to support improved transport efficiency, backed up by fu	EC part funding of R&D and implementation projects on the Trans-European n		
Economic	Reducing costs of technologies	Facilitate investment by road operators	No clear return on investment for the stakeholders	Developing new systems requires investments whose outcome is not clearly predictable both at a monetary and at a societal level.
Societal			Privacy concerns	Users could hesitate to consent to the use of their personal data, fearing privacy leaks or misuse.
			Intelligent Transport Systems are not uniformly present in all countries.	Regional differences in the stage of development of the system hampers the implementation of an efficient international transport system
Technological	High level of penetration of navigation devices in vehicles	Facilitate the implementation of TMS		
	Spread of in-vehicle communication systems	These can provide data and support communication between vehicles and bet	Lack of Security Infrastructure for Cooperative Vehicle Data	A Public Key Infrastructure, with the defined hierachy of Certification Authorities (CA) and the corresponding business models needs to be in place in order to ensure data integrity and privacy.
	Open data initiatives	Support and stimulate development of new services	Mobile network coverage	The accuracy and availability of services that rely on cellular networks for communication depends on the availability and quality of the mobile network coverage.
	Open mapping initiatives - e.g. EC	Support and stimulate development of integrated services and cooperation ac	Interoperability	There are gaps in the existing standards for interfacing vehicles and service providers across regions and national borders that hinder the development and availability of seamless services between operators and across administrative boundaries
			Different service providers use different network maps	This represents an obstacle to the exchange of traffic information between operators and areas. Open and shared location data could remedy this.
Legal			Lack of clarity over who owns the data and who guarantees data quality	Minimum quality requirements for the data to be reliable are essential; therefore, prior agreements on the standards to apply and on who is in charge of assuring they are met are necessary.
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
Electric vehicles	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political	Phase-out of fossil-fuelled cars	e.g. UK, France, Sweden	Lack of standards for the installation of residential charging stations	The absence of clear guidelines, and consequently costs, for the upgrade of the infrastructure at a residential location make this option over complicated and therefore unattractive.
	Government policy and regulations/ legislation to promote charging infrastructure deployment and standardisation	A link has been observed between the density of public charging stations and the uptake of EV, so it is expected that coordinating and planning the deployment of public charging infrastructure would encourage growth in EV ownership and use. Likewise, facilitating the deployment of private charging points would widen the pool of potential EV buyers. Furthermore, setting EU-wide harmonised standards for charging points would enable drivers to cross borders without fear of being unable to charge their vehicles, thus removing a potential barrier to EV use.	Urban planning and road traffic regulations	Regulations are needed to support local authorities in planning the deployment of public charging points. These should include appropriate parking schemes for an efficient use of the spaces and to prevent their misuse (for instance, would be a traditional vehicle be allowed to park on a space intended for EVs if the number of EVs parking spaces is greater than the demand and no other spots are avaialable?)
	Government policy on taxes and incentives for purchase and running of EVs	A variety of policies exist to influence upfront vehicle costs by adjusting tax regimes, introducing subsidies or other incentives. Similarly, interventions aimed at influencing the relative running costs of different types of vehicle (for example through fuel duty rates, congestion charging, etc.), are expected to promote the take up of EVs.	Pollution concerns	Concerns about the environmental harm caused by the vehicle and battery manufacturing and end-of-life, plus the emissions caused by electricity production.
	Government trategy for long term carbon reduction in transport	Such strategies can support and drive the mass adoption of EVs		
	Government information and awareness campaigns to promote EVs	These could play an important role in forming drivers' opinions and influencing their decisions to choose EVs.		
	Green parking tariff for hybrid and electric vehicles by agreement between stakeholders (car concessionaires, car park operators, hotels, etc.)	Promote use of low emission vehicles by reducing associated parking charges		
	Measures to reduce air pollution in densely populated areas	Increasing the number of vehicles with zero tailpipe emissions at the expenses of internal combustion engines vehicles would significantly improve the air quality of high traffic areas, such as urban environments.		
Economic	Potential of EV s to provide balancing services to the electricity grid	Enhancing the function of EVs from vehicle only to vehicle & service tool would add value to the technology and provide an incentive for stakeholders with an interest in loading of the electricity grid to promote uptake of EVs.	Battery cost	This contributes to the high upfront cost of vehicles
	Battery cost reduction	Falling costs of batteries will have a significant impact on the cost of EVs, making them more affordable		
Societal	Integration of EVs with public transport (electric buses, shared electric cars and bicycles)	This could contribute to improving consumers' perception of EVs	Inaccurate perceptions and information among consumers about EVs	Often EVs are still perceived as slow and cumbersome vehicles whose battery capacity is not enough to cover the required range. In reality a fully charged battery is sufficient for most journeys (90%). Sometimes ongoing costs are not properly assessed and therefore the consumer is not aware of the potential savings in fuel costs and maintenance costs. Many consumers do not actually have an updated knowledge about the technology in order to make an informed decision.
			E-bikes: lack of bicycle lanes	The absence of dedicated infrastructure and the risks of cycling in traffic discourage the use of bicycles
Technological	Battery improvement	Increasing the energy storage capacity increases the vehicle's driving range between charging the battery will reduce 'range anxiety' among drivers and would make EVs more attractive to use.	Battery range	The energy density of fossil fuels, as petrol and diesel, is higher than what current batteries can store; therefore, the range is typically shorter for EVs than for ICE vehicles.
	General vehicle lightweighting/efficiency	Reducing the ongoing costs contributes to the advantages of the EVs and therefore their attractiveness		
	Smart charging technologies	The vehicle remains connected to the grid when not in use and exchanges energy with the grid according to needs. The battery is charged when the best market prices are available (for example during low demand times on the grid) and it can sell power back to the grid during peak times. Drivers would save money and the flexibility of the grid to respond to fluctuations in demand would increase.	Charging times	The time required for charging a battery at a standard station or at a fast charging point spans from several hours to half an hour; this is not a convenient option for on-route charging. Super-fast technologies, which allow charging times comparable to the traditional refuelling times, are under development; however, at present they are still expensive and the process is not efficient. Besides, the battery life is shortened by the procedure.
	Fast/Ultra fast charging stations and batteries	Reducing the time necessary to recharge the battery is of paramount importance for mass adoption of EVs, since this is one of the factors currently hindering uptake. Having a network of efficient fast/ultra fast charging stations and batteries which do not have their lifetime reduced by the charging process would make EVs more competitive with traditional fuel vehicles and contribute to reducing range anxiety among drivers.		
Legal				
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
V2X	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political	Political/regulatory mandates	Some analysts believe that a mandate that certain capabilities be included in all cars is likely to kick-start a market that is then self-perpetuating	Differences in mandates between countries/regions.	Some countries (e.g. the U.S.) seem likely to set requirements for technologies, while other countries (e.g. EU MS) are leaning towards standards/specifications and no mandate. This could lead to a fragmented market that develops slower than otherwise.
Economic	Network effects	The value of V2X increases exponentially as more vehicles use it	First-mover disadvantage	First movers bear the cost of the technology installation without a guarantee of maximizing returns
	Synergistic benefits	V2X technologies will probably create value in unforeseen ways as communication capabilities are exploited		
Societal			Acceptance of automated safety mechanisms	Building user acceptance for automated safety functions related to V2X will take time.
Technological	5G mobile	Broader band network may make low-latency communications possible without dependency on a dedicate channel/ infrastructure.	Carmaker resistance to dependency on others	V2i and cloud-based solutions create safety/liability risks for carmakers
Legal				
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
Open Data	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political	Environmental objectives supporting public transport generally	Open data is envisioned as part of a broad effort to expand use of public transport.		
Economic	The development of MaaS business models	Mobility-as-a-Service is the long-term dominant driver of the movement to open transport data.	Organisational barriers within current data 'owners'	Organisational silos and legacy data systems can create resistance to decisions to 'open' data and a lack of clarity regarding accountability for its quality upon end use.
			Uncertain value capture for data 'owners'	Benefits to (for example) transport authorities may be indirect or difficult to measure, while app and service providers may capture the bulk of financial returns
Societal				
Technological	Widespread adoption of smartphones and fast app development	App development and use creates value from Open Data		
Legal			Contractual regulations	In many areas there are limitations on how providers of tickets for public transport can set prices. This creates challenges for people wanting to build multi-modal services based on Open Data
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
HD Maps	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political				
Economic			Costs of frequent/live updating	Recording and delivering updates about accidents, closures, live updates could be costly, especially for the public sector.
Societal			Different speed of development in different geographies	Maps need to be able to offer seamless content for drivers across multiple geographies.
Technological	Vehicle automation	Needs of automated vehicles will be the determinant of what functionality HD Maps and road databases need to deliver	High-performance live updates will challenge bandwidth	
Legal			Lack of clarity about responsibility/liability for accuracy	
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
Voice recognition	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political				
Economic				
Societal			Different progress in different countries hinders 'seamless' experience for travellers	Smaller and more complex languages are naturally less attractive targets for voice recognition. This reinforces English and other large languages in their dominant position and slows universal adoption
			Low levels of trust based on earlier, more primitive versions of technology	
Technological	Increasing usage in smartphone apps	Comfort via other smartphone apps will encourage users to try voice recognition in a transport context		
	Increasing use in other context accelerates devleopment	Learning from internet applications (e.g. Youtube subtitling) is delivering rapid improvements to algorithms.		
	Increasing adoption of wearables	Voice recognition is expected to be a primary interface for wearable technology		
Legal				
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
Augmented Reality	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political				
Economic				
Societal	Pokemon GO and similar mobile games	These games introduce the basic nature of AR interaction to users.	Local content means different development speeds	Dependency on local surroundings for content means that it is difficult to leverage development across geographies
Technological	Synergies with Virtual Reality	Development of VR experiences (games and otherwise) will benefit development of AR as well		
Legal				
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
Wearable tech	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political	Potential for some wearables to be required by law	E.g. inflatable helmets, devices that communicate to first responders etc.		
Economic			Existing business models in textile/fashion industry	Scale economies and current profitability limit 'physical' innovation
Societal	Increasing awareness of health and welness issues	Technologies can build on and reinforce trends towards individual wellness and healthy lifestyles	Cultural limitiation to use, especially wearables that exploit 'emotional' zones (e.g. face).	
	Role of social media	Ability to share personal health/wellbeing achiements makes devices more popular		
Technological	Miniaturization/Moore's Law	Decreasing physical size required for computing supports wearability.	Lack of interoperability	Probably a short-term problem.
	AI/Machine learning	Overall progress in artificial intelligence will benefit wearables		
Legal				
Environmental				
Other				

STTRIDE D3.1: PESTLE matrix of potential barriers and drivers				
Powering smart infrastructure	**Drivers**	**Explanation**	**Barriers**	**Explanation**
Political				
Economic			Business cases for smart infrastructure are underdeveloped	Without clarity on the revenue side, unclear how cheap/flexible powering solutions must be
Societal				
Technological	Continuing progress in solar pv, battery tech	Rapidly declining costs for solar and battery technologies offer hope that these may continue to be usable for low-power infrastructure applications		
Legal				
Environmental				
Other				