Institute of Transport Economics
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Summary

Transport technologies in a Norwegian context

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Transition processes in the Norwegian transport sector are extensive and characterized by complexity, dilemmas and counter trends. Complexity emerges when looking at the diverse image of actors and interests involved in the transition process. Possible dilemmas may occur in view of the central importance of data driven solutions and privacy and cyber-security issues. It is also a complex image related to the development and phasing-in of transport-related technologies where both national and international players and solutions compete against each other. Counter trends may develop because new technologies do not necessarily lead to a reduction in car traffic. Overall, there will also be a considerable research need in the future to understand this complexity.

Summary

This report has been written as part of the Norwegian Research Councils (NRC) work with the strategy process Transport21. The main aim of the report is to give input to the participants of the strategy process facilitated by NRC. The work at hand constitutes part 1 of a broader analysis for Transport21 and will be followed by another analysis with focus on transport related business sectors in Norway. The report presents input from informant interviews in the Norwegian transport sector. In total 13 interviews have been conducted and a total number of 17 informants participated during these interviews. The interviews focused on participants from the transport related business community (9), the public sector (4) and Norwegian transport research (5). The informants were asked to reflect current developments in Norwegian transport, to identify complexity during transition processes and possible dilemmas. With this report the NRC asks for a better understanding of the global mobility trends in Norwegian context.

The main chapter of this report (chapter 5: perspectives from sector representatives) is focussing on presenting statements from informants. Those statements are presented as single perspectives, but are also integrated in a broader analytical perspective. In chapter 2 we give an introduction into innovation and transition theories and we there outline possible complexities and dilemmas in transport transitions. In chapter 3 we present current technology trends in global transport. Consider that this report excludes electrification and maritime transport and that the main focus in chapter 3 will be on digitization. In chapter 4 we discuss broader societal trends that will have an impact on transport related transitions in Norway. As mentioned above, in chapter 5 we discuss the main findings from the interviews that have been conducted for this project. Findings from interviews are integrated and summarised on the basis of innovation theories, on definitions of technology trends and on the main socio-economic trends in Norway.

Summary of chapter 2: Complexities and dilemmas of transport transitions

Initially, the concept of innovation is mapped. Innovations can be incremental (stepwise development) or radical disruptive (replacing existing solutions). A broader set of both forms of innovation and at a higher macro level can lead to major conversion processes, which in the innovation literature are referred to as transition. Today's digital transformation of the transport sector is considered to be a transition process that initiates a new historical paradigm. The chapter then presents four theoretical insights from innovation research that help explain the complexities and dilemmas of major transition processes.

Table S1: Complexity and dilemma

1	Actor-network	Transition processes are run by many different (competing) players, from R&D, business and government, as well as the complex image of national and international market players.
2	Institutions and culture	It is possible to outline the context of an innovation based on different subjects such as geography and topography, cultural aspects such as language and tradition, and not least political regulation, legislation and regulations. Such delimitations are considered institutionalized.
3	Co-evolution	The term co-evolution describes dependencies in the parallel interaction between transition processes in different sectors and between different spheres in society.
4	Path dependence and lock-in	The term path dependence describes historical emerging conditions that characterize innovation. There are earlier developments in a given context, which currently provides framework (scope and limitations) for restructuring in the transport sector. Previous decisions in transport may today limit the scope for transition (lock-in).

Summary of chapter 3: technological trends

In chapter 3 we go through current technology trends that drive the transformation in the transport sector, with special focus on digitization. As mentioned initially, the technology trend electrification is not included in this report as electrification is organized under the strategy process EnergiX. Digitization will affect transport needs, transport solutions, business models and management systems.

There are essentially three possible technologies that underpin technological innovations in the transport sector: artificial intelligence, the Internet of Things, and Big Data. New concepts such as autonomous vehicles, advanced management and optimal utilization of intelligent transport system (ITS systems) are referred to as technological innovations where digitization will directly contribute to major changes in the transport sector. Digitization affects the transport sector in several different ways, both directly by changing the way people or goods can move and indirectly by how these trends affect mobility needs. Technology trends in the transport sector are not just about the development of new technology, but also the use of existing technology. This means that technology development has also contributed to the design of new business models such as car sharing and Mobility as a Service (MaaS). These business models could have a major impact on the

design of the transport system and change the offer structure by providing completely new forms of transport services.

According to ITS Norway, the market penetration of transport technologies, self-propelled vehicles (selvkjørende), MaaS, electric vehicles (EV) and collaborative ITS (samvirkende) will have the following time course:

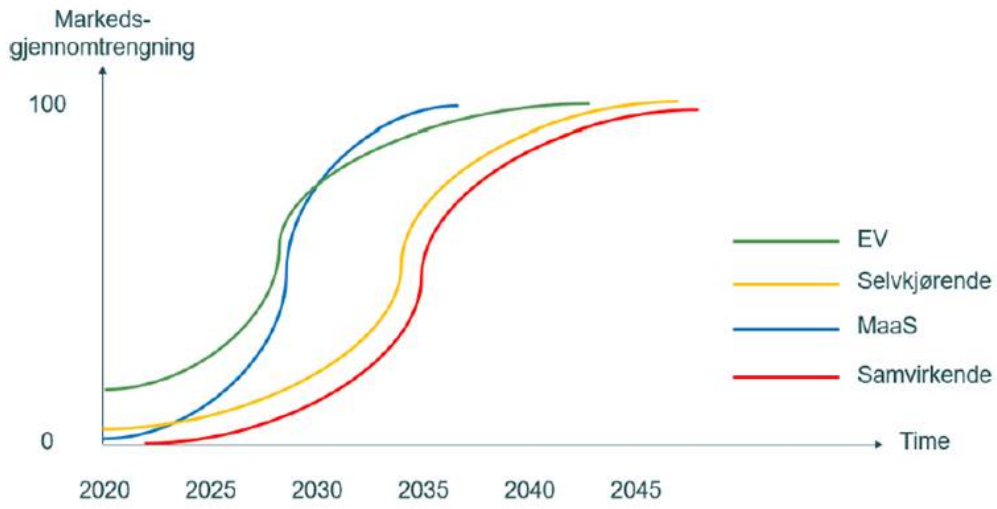

Figure S1: Market take-up for smart transport technologies (Source: Lunde et al., 2017)

Summary of chapter 4: Socio-economic macro-trends

In Chapter 4, the report looks at broader social trends that affect transition in the transport sector. Society is changing, and maybe faster than it has been before. This affects how people relate to mobility and what needs they have. Important social trends that affect the demand for transport are demographic trends, geography and economic development, as well as climate and environment.

Important demographic changes are that people live longer and are healthy longer. Together, this points both towards increased need for individually adapted travel, and increased mobility needs in general. The number of journeys per person is striking constantly over time. Travelling and the transport mode clearly correlate to both living and working places. Those who work and live in cities travel relatively briefly and use largely public transport, walking and cycling. Those living in the suburbs travel longer, and usually use public transport on work trips, but cars on other trips. Those living in rural areas travel relatively short and either go by car or walk. Changes in transport needs have a clear correlation to economic and population growth. Furthermore, there is a clear correlation between people's prosperity and how far they travel, and especially how far they travel by car and plane. Economic growth, and the distribution of wealth affects how much and what types of transport are being demanded. Climate change and local environmental challenges have a direct effect in influencing the possibility of transport and an indirect effect in influencing the types of transport that are desired. Both effects point in the direction of a desire for less transport and less emissions per unit of transport.

Summary of chapter 5: Perspectives from sector representatives

In Chapter 5 we present the interview material that has been analyzed for this project. A key purpose of the interviews has been to provide input from the Norwegian transport sector to the Transport21 strategy group. The perspectives presented in chapter 5 are therefore based partly on individual statements, but also on statements that have been mentioned evenly by sector representatives. The statements stand for themselves, but are also put in a broader context. Based on the three introductory chapters (innovation literature, technology trends and social trends in the Norwegian context) we have systematized the interview material and established four categories. These categories express the main features of the material, and these categories are: parallel timelines, data in the future transport system, technology development and geography. Table S2 provides a brief overview of the categories and individual statements.

Table S2: Perspectives from sector representatives

	Category	**Statements**
1	Parallel timelines (Transition in the transport sector is characterized by different parallel processes that increase complexity)	• A market crisis for used cars may occur when phasing in electric vehicles, the subsidy and regulation system must be adapted. • There are different time horizons for technology development, development of social acceptance and adaptation of political institutions. • Research (especially participation in EU projects) and business R & D follow different timelines.
2	Data (Dilemmas and complexity around the use of data in the future transport system)	• Ownership of customer data is a competitive advantage in order to develop MaaS solutions. Data availability may limit business development in the transport sector. • There is a comprehensive understanding of privacy and cyber security in the transport system. Will foreign tech-companies own transport-related data in Norway? • Research does not have enough access to data.
3	Technology development (complexity in developing own technology and phasing-in of foreign technology and R&D)	• Norway is the leader in autonomous ships - otherwise, technological niches will be important for Norway. • European R & D cooperation for phasing-in of foreign technologies. • We understand the technologies, but not the complexity of the business models. • Standardization coordinates technology development and helps keep the innovation process open.
4	Geography	• MaaS and ITS solutions are so far suited for metropolitan areas. • Concession laws (and other regulations) may be a barrier to the introduction of comprehensive MaaS solutions. • The transition process must be technology neutral and it must be open to initiatives with regional character.