Chapter 16
How Platooning Research Enhances the European Innovation System

Ilja Bäumler, Herbert Kotzab, and Walter Aigner

Abstract Maybe we would need a convincing narrative how innovation and our innovation system contribute to societal wealth—a new kind of Adam Smith equivalent. European road transport is part of a wider ecosystem where significantly increasing levels of digitalisation, automation and innovation will re-shape the world as we have known it. Ambitious political agendas to enhance sustainability and to increase transport effectiveness beyond what can be achieved within a fragmented and traditional way of operation have added momentum. Nevertheless, there are significant open issues beyond what road-maps to various futures maintain to know. Management narratives related to innovation and innovation systems have been challenged. This chapter intends to outline some of the elements how this kind of C-ITS-related platooning research has enhanced our shaping and re-framing of new questions and concepts regarding the European innovation system. Even without electronically coupled trucks on European public roads, elements of dynamic capabilities have evolved. On the other hand, it has become obvious how far some stakeholders have fallen behind the knowledge generation in European C-ITS-related projects. By means of rather selective knowledge intake and knowledge-related search paths, some institutions have shown to be some fifteen years behind accessible knowledge.

Keywords European innovation system · Impact · Knowledge spillover · SAE L2 truck platooning · Truck automation · Logistics

16.1 Introduction

European road transport is part of a wider ecosystem where significantly increasing levels of digitalisation, automation and innovation will re-shape the world as we

I. Bäumler · H. Kotzab
Universität Bremen, Bremen, Germany

W. Aigner (✉)
High Tech Marketing, Vienna, Austria
e-mail: wa@hitec.at

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have known it. Ambitious political agendas to enhance sustainability and to increase transport effectiveness beyond what can be achieved within a fragmented and traditional way of operation have added momentum. Nevertheless, there are significant open issues beyond what roadmaps to various futures maintain to know. Management narratives related to innovation and innovation systems have been challenged (see for example [12] or in other contexts [18–20, 37, 38]). Digitalisation of road infrastructure provides one prerequisite for increased effectiveness in a world of connected and assisted mobility (compare also [1, 5, 29, 35]). The European Union has earmarked 20 percent of its post-pandemic recovery funds for digital initiatives. Digitalisation is anticipated to shape the upcoming two decades. In some sense we might feel how far Europe goes in attempting to stimulate innovation. C-ITS—contrary to what some legacy views might suggest—is not one single concept and is seen with rather different expectations and context knowledge in different industries – road operators, traffic management, fleet operation, new mobility and transport service providers, air quality authorities and many more. Some academic knowledge uptake in this field of C-ITS has been rather slow, if compared to project reports in [2–4, 6, 18] and Connecting Austria. Effectively, learning together will continue to be a prime challenge for Europe's innovation system and Europe's economic future. How regions create value will see elements of a new theory and radically opening up of dynamic capabilities in the context of e.g. economic growth. Platooning-related research and innovation will continuously face new questions and white spots in our knowledge. Connecting Austria has demonstrated the potential for bringing in an infrastructure-based view into future forms of road-based freight transport. However, this framing most probably needs to be reinvented in many more ecosystems and knowledge silos. Some examples include (see also our description of contexts in [5, D5.2] and [10]): The inclusion of predictive maintenance in traffic management as well as its ecological role for Europe; changing travel behaviour caused by traffic reduction as a consequence of COVID-19; handling of fluctuating weather conditions or significantly different driver populations due to demographic changes [33].

This chapter intends to outline some of the elements how this kind of C-ITS-related platooning research has enhanced our shaping and reframing of new questions and concepts regarding the European innovation system. Even without electronically coupled trucks on European public roads elements of dynamic capabilities have evolved. On the other hand, it has become obvious how far some stakeholders have fallen behind the knowledge generation in European C-ITS-related projects. By means of rather selective knowledge intake and knowledge-related search paths, some institutions have shown to be some fifteen years behind accessible knowledge. During a recent presentation within the frame of the H2020 ARCADE project Martin Russ from Austria Tech, Vienna has used the term "obfuscation" (creating code that others don't understand") to describe elements of the challenge ahead [11].

Most of this chapter intentionally remains rather implicit and somehow in between the lines. Readers are explicitly invited to use our text as input for taking up and or discussing how we can jointly contribute to making Europe a sustainable ecosystem for innovation, digitalisation and automation.

16.2 Digital Road Infrastructure Leveraging ITS Systems in Europe

16.2.1 Selected Elements of the Current Situation

Some areas in Europe have had an excellent track record in effectively managing the road network as a key element in our context of significantly increased road transport and growing economies. Digitalisation will bring new opportunities for increasing effectivity and efficiency. However, any system at capacity limits will need to mitigate unintended effects from a longer transition period with so called mixed traffic—where most trucks are replaced by newer versions in rather short intervals. Many of these digitally enhanced vehicles with highly professional drivers drive on the same road network with other non-professional road users whose vehicles have rather diverse levels of driver assistance. This allows the mitigation of risks at heavy traffic areas or areas of incidents by making a digitalised road infrastructure in a diverse European traffic landscape possible. However, this requires a high penetration of automated vehicle functions (see [5, 40]). Today, road authorities as well as regional governments can make use of such digital ecosystems making use of such an infrastructure (see our discussions in [5, 33]).

Different dynamics are in place concerning road operators' current situation and key challenges in different regions in Europe. We provided a more extensive picture on the context and current situation as of 2020 in our joint MANTRA WP5 documents. Even though digitalisation can positively affect a country's or even a region's competitiveness, some stakeholders do not focus on this but remain on the level of an efficient and safe road operation. It is however expected that this may change in the near future [5].

16.2.2 Potential Drivers of Socio-technical Transitions Ahead

Digital ecosystems and/or cooperative platforms require digital infrastructures. Mantra [5, D5.2] reports on significant savings of 20 billion € in reduced labour costs, due to less driving hours if real-time traffic avoidance navigation is applied. [24] shows that data economy can make up nearly 90 percent of the EU GDP and important stakeholders are expected to contribute in order to set up a sustainable European data ecosystem (again for more details we refer to our chapter in [5, D5.2]).

Digitalisation is anticipated to contribute to a significantly more heterogeneous vehicle landscape on our roads with various forms of assisted driving and SAE-levels in place even though vehicle manufacturers want to stick on their own services even though there may not be a possibility for cooperation with other stakeholders like networks or different traffic control centres. Vehicle manufacturers plea for upgrading the digital European infrastructure in order to allow automated driving. Consequently, the commitment for investments depend on how first mover behaviour will be rewarded (compare for example [7–9]).

Changing traffic behaviour and actors such as cyclists and/or pedestrians, the increasing importance of ecology as well as demographic changes influence the upcoming of suitable solutions as different types of bottlenecks may occur [5].

All over Europe, freight and passenger traffic is expected to heavily increase and this growth is recognised as a significant driver for an evolving digital infrastructure in the future. Furthermore, changing weather conditions which lead to an increasing number of severe weather events can also be seen as a driver. Besides these, more and more vehicles and service providers apply assisted driving systems based on sensor technology and use more and more AI which will also significantly affect the growth of digital road infrastructures.

At the same time, it is necessary to focus on cyber security issues (see [39]) which will lead to an increased cooperative behaviour between all relevant stakeholders of an ecosystem, even with those that are not primarily a member of a road operator's sphere.

Bishop [13] expects new players outside the existing community of the road transport domain to enter the field. This will also lead to different forms of cooperation. The precise development and design of these new processes and operations depends heavily on who takes the lead in coordinating multiple traffic control systems in a divers European traffic setting [5].

Besides that, it is necessary to consider the different velocity of innovation of different actors like chip manufacturers, mobile network operators, road operators, and other digital service providers when considering the design and operation of digital infrastructures.

External stakeholders are expected to introduce innovative solutions for a digital road infrastructure that can be pooled and thus deployment costs can be reduced. By this, risk can be mitigated and digital networks can be made accessible [5]. This may be a worthfully solution as a full digital infrastructure can not be set up all over Europe due to different traffic densities and road usage.

16.2.3 Particular Demanding Situations for a European Innovation System

The other side of the digitalisation medal refers to the ability of transforming the real world into a digital one as automated decision making is different and require new procedures. While we have studied these phenomena within the CEDR CAD WG in several workshops and documented results in Mantra D5.2 as well as in the final report to the CEDR 2017 call on automation, yet it is uncertain whether existing sensors and automated interactions are capable to deal with the existing complexity or if new types of sensors are required (concept of absorptive capacity; [22]).

It rather looks like a kind of never ending story when it comes the upgrading of a digital infrastructure and a lot of technology representatives see this as a huge challenge, when considering the digitalisation of typical nodes in a value chain such as highways, railways, ports, logistics hubs and/or airports [5].

Another challenge refers to the urban and rural areas of Europe and the acceptance of a full digital infrastructure by their inhabitants. Within the population, we can observe a diminishing acceptance of further improving safety of roads which are considered to be already on a high safety level. The focus could not be only on special interest groups who use high-end vehicles but on all users of a road infrastructure. Such issues have been already heavily discussed e.g. during EUCAD conferences in Brussels 2017 and 2019 [5].

However, national road authorities (NRA) are more and more required to make high quality infrastructures available in order to maintain and to sustain the competitiveness of countries and regions in the future. This shall be realised without waiting until certain technology is available and thus requires first-mover attitudes when it comes to investments. The challenge is even higher, if short innovation cycles are considered [5].

16.2.4 New Roles for Stakeholders

The degree of automated processes and operations depends on how well AI, digitalisation and big data from fixed and mobile sensors are applied. It further depends on the diffusion of such technology within the industry players, which is also inspired by innovative local digital ecosystems. In many cases, existing solutions built upon technology that was acquired some decades ago and was due to safe critical infrastructures as well as less experience of road operators in procuring innovation. Consequently, big tech companies enter more and more the domain of mobility and play an increasing important role in digital mobility ecosystems. One example can be seen in the field of smart cities. NRA’s are called to be more active in such areas by being more proactive in their coordination and supervision tasks [5].

16.2.5 Dynamically Evolving Legal Framework

Human decision making has a huge influence on road operators’ ITS, as well as on traffic control systems due to the increasing degree of automated processes and operations. The traffic centre processes will be increasingly automated, and by 2030 many traffic management systems are anticipated to being capable of 24/7 operation without any human involvement. However, a legal framework is therefore required [5]. Dynamically evolving customer expectations into home delivery, just-in-time delivery and other newly emerging transport services will further stimulate entrepreneurial ventures. Maybe this is a valid opportunity to look into the landscape of some so-called discrepancies. Will the future show some kind of trade-offs? And what can be eventually kind of re-framed as opportunities?

16.3 Discrepancy Between Customer Requirements and Eco-friendly Transport Logistics

The external conditions of the corporate world have changed considerably in recent years. Digitalisation, globalisation, and fast communication options have led to increasingly fierce competition. Delivery concepts such as just-in-time, drop-shipping or same-day delivery are leading to an increase in transport volumes on the road infrastructure. In addition, the end consumers' increasing request for cosiness favours home delivery, resulting in frequent traffic jams and slow-moving traffic both within and outside the cities [17]. This results in increasingly complex flows of goods, information and merchandise along the value and supply chains. For this reason, closer cooperation between the stakeholders involved is necessary.

However, logistics is also under a certain pressure of expectations from society, since on the one hand a trend towards growing ecological awareness can be observed, but on the other hand not all individuals want to limit themselves. In this respect, from the transport service provider's point of view, the focus lies, particularly on the last mile. Here, an above-average proportion of traffic emissions is produced due to the many starts and stops. Cooperative intelligent transportation systems (C-ITS) make it possible to minimize transport distances and optimise the energy efficiency of trucks [21]. The design and further development of transport systems is becoming an increasingly important task in this context to ensure high quality road transport [14].

Such innovations are necessary in Europe, for example, because of the EU's target, set in 2011, of reducing emissions by 80–95% by 2050 compared to 1990 levels. The overall goal is even to become a net-zero greenhouse emission economy [23]. Since limiting freight mobility is not always considered a valid option, the aim is to increase efficiency through improved and new transport and mobility services based upon C-ITS.

In addition to the expectations of the various stakeholders, the need for intelligent traffic management solutions is also due to the increasing complexity of transport systems, especially in urban areas. First and foremost, it is necessary to ensure an adequate infrastructure to avoid negative effects of transport on the environment [34].

One way to satisfy the rising demand for transportation is to expand the road network. However, for most areas in Europe, this is hardly feasible from an infrastructural and financial perspective [16]. However, as a possible solution to newly emerging capacity bottlenecks, C-ITS gained in importance and is anticipated to significantly shape the current transition period into advanced forms of assisted mobility and transport. The use of C-ITS is intended to make transport logistics safer, more efficient, more flexible, and more sustainable than conventional ways of operating. Another goal is to generate new capacities on all modes of transport [30]. The acronym ITS refers to information and telecommunication technologies as well as control and automation technologies, which, through their combined application with the given infrastructure and the political and legal framework conditions, should contribute to increasing efficiency in the transport sector [26, 27]. Giannopoulos et al. [28] see the potential and goals of ITS primarily in enabling safer and more efficient transport and at the same time reducing emissions. A prerequisite for this is the optimisation of existing supply chains and infrastructure regarding energy-efficient use. This can be supported and further developed by innovative ITS-based tools that control and optimise the planning, organisation, and execution of transports, also from an ecological point of view.

16.3.1 Technical, Legal, and Social Aspects of C-ITS

Technical, legal, or societal requirements (see Table 16.1) will continue to interfere with the process of digitalisation along with the possibilities of intelligent traffic management. The process of digitalisation, which according to experts will be a complete part of our everyday and professional lives by 2030, describes the "increasing data-consistent networking of all areas of the economy, cities, infrastructure and private individuals" [21, p.32]. The so-called Internet of Things, as a result of complete digitisation, refers to the linkage of objects in the transport environment such as goods, vehicles and sensors in devices, so that, for example, precise tracking of shipments or messages on goods status and traffic volumes are possible.

Such networking offers many advantages, especially for logistics service providers, since it shortens delivery times and enables the customer to track the goods handling. The complete digitisation of all objects located in public spaces ultimately culminates in the vision of the Smart City, in which all information on the infrastructure, human and technical actors, as well as events taking place, are summarised in a digital image. Ideally, this would show logistics service providers enormous potential for optimising logistics on the last mile and, if necessary, even enable anticipatory transport logistics. Predictive algorithms that rely on Big Data help logistics service providers to cut delivery times and augment process efficiency and service quality [21, 31].

Table 16.1 summarises the technical, legal, and societal challenges and requirements that need to be considered when deploying C-ITS. For a comprehensive C-ITS implementation, however, it will be necessary to continuously adapt road traffic law to technological progress and at the same time promote acceptance and education in society. In addition, data sovereignty over personal and vehicle related data is of high importance. At any time, road users should be able to know and to control what kind of information they transfer through C-ITS application. Similarly, C-ITS applications must not be misused as a means of surveillance. In the light of cybercrime statistics, C-ITS must meet high security standards.

16.3.2 Critical Discussion of C-ITS and the Needs of Society

First, C-ITS must satisfy several stakeholders due to its central importance, both for inner-city traffic and for long-distance trips outside of cities. Private road users and professional drivers are among the most important representatives, as they are

Table 16.1 Challenges and requirements of C-ITS deployment in the fields of technology, law, and society

Technology	Law	Society
Protection against manipulation	Adaption of road traffic law	Investigation of dilemma situations
International standardisation	Extension of data protection law	Development of public acceptance
Implementation of product liability	Formulation of legal liability regulation	Priority of social interests over individual interests
Further development of intelligent road infrastructure	Control by public authorities	Inclusion of the proper use of automated systems in digital education

directly affected. Irrespective of whether it is a question of goods, service or passenger transport, logistics and software solution providers need to conceptualise C-ITS in such a way that these applications support road users in driving their vehicles, while at the same time apply to safety and security standards. Other stakeholders are city administrations, fleet operators, logistics software solutions providers, road administration, traffic infrastructure operators, terminal and or harbour operators, third party logistics, traffic management software providers and truck manufacturers.

Second, electronic toll collection can also play a role in C-ITS. The introduction of toll roads has two main objectives which are the creating of an income source as well as the control of traffic [15]. The collected toll as a source of income is primarily used for road rehabilitation. However, it is also seen as a fair distribution of costs according to the polluter-pays principle. In addition, tolls can offer alternative routes, separate optional from mandatory traffic, or reduce the overall traffic volume. Regardless of the objective, C-ITS can monitor traffic on corridors or in urban areas and use tolls to uncover hidden road capacities in certain sections of the road and thus regulate traffic. Road administrations could use traffic flow information to charge a fee on specific roads to force usage of driving alternatives.

In terms of emergency driving, C-ITS applications can create a priority for fire departments, rescue and emergency vehicles at traffic lights or intersections. The aim of these systems is to ensure that the rescue services reach their destination early and that subsequent accidents are avoided [36]. In these systems, a device is integrated in rescue and emergency vehicles which interacts with infrared beacons installed along the road. If, for example, emergency vehicles pass such beacons in emergency mode, a signal is sent via the device in the vehicle to the traffic control system so that the signal is changed at the next traffic light [32].

A truck drivers' job comprises many activities such as to control the vehicle, secure the transported goods, load and unload and be aware of their risk potential on streets at any time. Professional truck drivers also perform administrative tasks such as documentation, route planning and customs clearance. Furthermore, they need to adhere to legal regulation on rest and driving times. In rare cases, truck drivers even process order picking in warehouses [25]. Beyond that, the range of tasks is expanded to include communication activities, maintenance, and servicing. With C-ITS, the driver can receive support in his numerous tasks. For example, parking spaces can be reserved for the driver at rest areas depending on his rest and driving periods, in such a way, that he does not have to search for a rest area on his own. It is also conceivable that route guidance through the city, by means of suitable measures such as automatic traffic light phase adjustment, could help to get heavy goods traffic to its destination as quickly as possible. Many application scenarios are conceivable here, in which C-ITS can provide additional support for the driver and optimise traffic management by means of suitable display and guidance systems.

The profitability of a company depends on the efficiency of the executed processes. In addition to logistics efficiency, which provides for an increased utilisation of trucks and the optimisation of the logistics chain, vehicle efficiency, driver efficiency and efficient route planning are other dimensions of efficiency measurement. Vehicle efficiency describes an improvement of the vehicle through improved and new technologies, more effective fuel consumption for increased ranges or a more ergonomic design. In terms of driver efficiency, the driver can be supported by increased training or on-board units that measure driving behaviour. The last form of efficiency describes the optimisation of route planning, where fleet operators plan routes based on traffic density and topography and general data of infrastructure. With C-ITS, all efficiency goals can be achieved through the measures presented.

If all efforts are pulled together, a straightforward realisation remains that widespread deployment of C-ITS is achieved once a critical mass of C-ITS users has been reached. The critical mass is defined here as the required number of C-ITS users, in order for other companies to agree to overcome the investment hurdle associated with the purchase of hardware and software and additional staff training, in order to become part of the overall system. To provide this incentive, pilot projects could be started on busy highway sections. While the deployment of C-ITS can be seen as a genuine attempt to solve the discrepancy between customer demands, sustainability issues and ecological responsibility, it is very important to stress out, that customers need to understand their role in this play. This way the responsibility on mitigating negative effects on traffic environment is shared between all stakeholder, and thus can lead to a joint and satisfying solution.

16.4 Jointly Building Absorptive Capacity in Europe's Innovation System

C-ITS and platooning-related research and innovation will continuously face new questions and white spots in our knowledge. Guiding thread for this chapter has been our question: How does this kind of C-ITS-related platooning research enhance the European innovation system—even without electronically-coupled trucks on the road? There have been significant knowledge spillovers into road operator spheres, digitalisation ecosystems for Europe's future, advanced traffic management, logistics, air quality management. Connecting Austria has contributed to raising awareness with several European key stakeholders on how an ecosystem of innovative organisations in a topographically challenging European road transport hotspot can proactively contribute to a kind of redrawing larger parts of the innovation and research roadmap. Four years ago, it seemed like electronically coupled truck platooning is kind of resolved internationally and European road infrastructure or an ecosystem in a country without truck manufacturers would not have any say. Four years ago the claim was: "It will be on the roads soon." The outlook has significantly shifted. Connecting Austria has demonstrated the potential for bringing in an infrastructure-based view into future forms of road-based freight transport. The bottleneck now looks like how we can effectively manage newly emerging bottlenecks by means of effectively using C-ITS. However, this framing most probably needs to be kind of reinvented in many more ecosystems and knowledge silos.

Dynamically evolving customer expectations into home delivery, just-in-time delivery and other newly emerging transport services together with newly emerging technologies and smart take up we will see interesting decades to come. Digital road infrastructure has the potential to significantly leverage the way we will organise road-based freight transport systems in Europe. But it has the potential for more than that. A European innovation system is made of ecosystems and key stakeholders thinking and conceiving their activities also in terms of joint absorptive capacity. However, the future will be open. Unleash entrepreneurial innovation is anticipated to rank high. And the digital capacity building together with innovation brings the opportunity to attract some of the finest talents in this field of road-based freight transport systems and innovation.

This very chapter as well as this book are an implicit illustration of the opportunities and challenges in learning together in a highly dynamic cross-industry field (C-ITS) where many facets are not fully documented in scientific literature. This process of integrating views from one selected team of our distinguished board of scientific advisors in Connecting Austria will be continued by integrating views from our various audiences in the months to come.

References

1. DIGEST (2021) Digitaler Zwilling des Verkehrssystems Straße. https://projekte.ffg.at/projekt/3894859. 10 Feb 2021
2. Elektronische Deichsel–Digitale Innovation–EDDI. https://www.bmvi.de/SharedDocs/DE/Artikel/DG/AVF-projekte/eddi.html. 10 Jan 2021
3. ERTICO: Multi-brand Truck Platooning to become reality in Europe. https://erticonetwork.com/multi-brand-truck-platooning-become-reality-europe-eu-co-funded-ensemble-project/
4. HelmUK, a platooning project under the technical leadership of Highways England: Truck Platooning: the future of road transport. https://www.smmt.co.uk/2020/06/has-truck-platooning-hit-the-end-of-the-road/
5. MANTRA – making full use of automation for national road transport authorities: 2020. https://www.mantra-research.eu/

6. Sweden4platooning 2020 public report. https://www.saferresearch.com/index.php/library/sweden4platooning-public-report
7. ACEA. 25 actions for a successful restart of the eu's automotive sector. https://www.acea.auto/publication/paper-25-actions-for-a-successful-restart-of-the-eus-automotive-sector/
8. ACEA (2019) Automated driving. roadmap for the deployment of automated driving in the european union. https://www.acea.be/publications/article/roadmap-for-the-deployment-of-automated-driving-in-the-european-union
9. ACEA. Roads of the future for automated driving. ACEA Discussion paper 2020. [currently not available online https://www.acea.auto/nav/?content=publications [an archive copy is available from the authors of this chapter]
10. Aigner W, Kulmala R, Ulrich S (2019) Vehicle fleet penetrations and odd coverage of NRA-relevant automation functions up to 2040. mantra: Making full use of automation for national transport and road authorities—NRA core business, deliverable 2.1
11. ARCADE. Workshop on common evaluation methodology for automated driving tests. esp. Martin Russ: Obfuscation: writing code that nobody understands. Recording available at https://www.youtube.com/watch?v=QtHvYvkrsfc
12. Berkun S (2007) The myths of innovation. O'Reilly Media; Sebastopol, CA
13. Bishop R (2020) Automated driving decades of research and development leading to today's commercial systems. In: Fisher DL, Horrey WJ, Lee JD, Regan MA (eds) Handbook of human factors for automated, connected, and intelligent vehicles. CRC Press
14. Boltze M, Schäfer PK, Wolfermann A (2006) Leitfaden Verkehrstelematik. Hinweise zur Planung und Nutzung in Kommunen und Kreisen. Internationales Verkehrswesen, 58 (10), S. 465–468. DVV Media Group
15. Boursas L (2009) Trust-based access control in federated environments. Technische Universität München
16. Bäumler I, Kotzab H (2020) Intelligent transportation system development, main influences and key technologies. In: Nofoma 2017 the 29th Nofoma conference: taking on grand challenges. Lund University, pp 830
17. Bäumler I, Kotzab H (2020) Scenario-based development of intelligent transportation systems for road freight transport in Germany. In: Urban freight transportation systems. Elsevier
18. C-ROADS (2019) C-roads—the platform of harmonised c-its deployment in Europe. https://www.c-roads.eu/platform.html
19. Canton J (2015) Future smart. Managing game-changing trends that will transform your world. Da Capo Press
20. CEDR (2017) Description of research needs (dorn). cedr transnational road research programme call 2017: Automation. cedr transnational road research programme funded by austria. and the United Kingdom
21. Clausen U, Stütz S, Bernsmann A, Heinrichmeyer H (2016) ZF-Zukunftsstudie 2016 Die letzte Meile. ZF Friedrichshafen AG. Friedrichshafen
22. Cohen WM, Levinthal DA (1990) Absorptive capacity: a new perspective on learning and innovation. In: Administrative science quarterly, vol, 35, issue no. 1, pp 128–152 (special issue: technology, organizations, and innovation
23. European Commission (2018) Communication from the commission to the European parliament, the European council, the council, the European economic and social committee, the committee of the regions and the European investment bank-a clean planet for all a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy
24. European Commission (2020) A European strategy for data. communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. com (2020) 66 final. available online at: https://op.europa.eu/en/publication-detail/-/publication/ac9cd214-53c6-11ea-aece-01aa75ed71a1/language-en
25. Flämig H (2015) Autonome Fahrzeuge und autonomes Fahren im Bereich des Gütertransportes. In: Maurer M, Gerdes JC, Lenz B, Winner H (eds) Autonomes Fahren. Springer, Berlin, pp 377–398

26. Gattuso D, Pellicanó DS (2014) Advanced methodological researches concerning its in freight transport. Procedia—social and behavioral science, transportation: can we do more with less resources? In: 16th meeting of the Euro working group on transportation, vol 111, pp 994–1003 (Porto)
27. Giannopoulos GA (2009) European its for freight transport and logistics: results of current eu funded research and prospects for the future. Eur Transp Res Rev 1:147–161
28. Giannopoulos G, Mitsakis E, Salanova Grau JM (2012) Overview of intelligent transport systems (ITS) developments in and across transport modes. JRC Scientific and Policy Reports
29. Hjälmdahl M, Svedlund J, Mattsson F, Bahr M, Baid V (2020) In: EU EIP Activity 4: harmonisation ClusterSub-activity 4.2: facilitating automated driving summary of impacts, benefits and costs of highly automated driving
30. Janker CG, Lasch R (2001) Telematik im Straßengüterverkehr—stand der Umsetzung und Nutzenpotenziale. In: Sebastian H-J, Grünert T (eds) Logistik management. Vieweg+Teubner Verlag, Wiesbaden, pp 245–255
31. Heutger M, Kückelhaus M, Zeiler K, Niezgoda D, Chung G (2014) Self-driving Vehicles in Logistics—A DHL Perspective on Implications and Use-cases for the Logistics Industry. DHL Trend Research, Troisdorf, Germany
32. Kotani J, Yamazaki K, Jinno M (2011) Expanding fast emergency vehicle preemption system in Tokyo. In: 18th ITS World CongressTransCoreITS AmericaERTICO-ITS EuropeITS Asia-Pacific
33. Kulmala R, Ulrich S, Penttinen M, Rämä P, Aigner W, Carsten O, Tuin M, Farah H, Appel K (2020) D5.2 road map for developing road operator core business utilising connectivity and automation project nr. In: 867448 MANTRA: Making full use of Automation for National Transport and Road Authorities—NRA core business
34. Małecki K, Iwan S, Kijewska K (2014) Influence of intelligent transportation systems on reduction of the environmental negative impact of urban freight transport based on Szczecin example. Procedia—social behavioural science, vol 151. Green Cities—Green Logistics for Greener Cities, Szczecin
35. Malone K, Schreuder M, Berkers F, Helfert K, Radics L, Boehm M (2019) Digitalisation and automation. implications for use cases. Identification of Stakeholders and Data Needs and Requirements. DIRIZON Deliverable (3.1. Draft 0.7)
36. Moerke A (2007) Intelligent transport system its. In: Moerke A, Walke A (eds) Japans Zukunftsindustrien. Springer, Berlin, Heidelberg, pp 275–286
37. CCAM Partnership (2020) Strategic research and innovation agenda. proposed European partnership under horizon Europe CCAM connected. Coop Autom Mobilty 9
38. Sainsbury D (2020) Windows of opportunity. How nations crate wealth. Profile Books
39. Strand S, Zofka E, Ponweiser W, Lamb M, Hedhli A, Adesiyun A (2020) Practical learnings from test sites and impact assessments. Technical Report 4
40. Ulrich S, Kulmala R, Aigner W, Wegscheider S (2017) Final programme report CEDR transnational road research programme call 2017 automation MANTRA. DIRIZON. STAPLE. CEDR Contractor Report

Ilja Bäumler is Postdoctoral Researcher at the University of Bremen. His research focuses on Intelligent Transportation Systems (ITS) and Supply Chain Management. In the research area of ITS he is particularly interested in possible future scenarios and their implications on stakeholders. His dissertation "Development paths of intelligent transport systems for road freight transport" was published at the State and University Library Bremen in 2019.

Herbert Kotzab is a Professor at the Chair of Logistics Management at the University of Bremen and International Professor at Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia, Malaysia. He received his Master of Business Administration in Marketing and Management, PhD (1996) and Postdoctoral degree (Habilitation: 2002) from the Vienna University of Economics and Business Administration. Prior to his assignment at Bremen, he held a Professor position at Copenhagen Business School at the Department of Operations Management. His research focuses on Supply Chain Management, Service Operations and Consumer Driven Value Networks. Since 2013, he has been a member of the Editor-in-Chief-Board of Logistics Research.

Walter Aigner has been a kind of boundary-spanning individual [between pioneering users, public administration, research and various industries] since the early 1990ies. As managing director at HiTec he prepared several national and European innovation and technology programmes and serves as an independent expert on evaluation and impact assessment. His focus is on key individuals in the European innovation system and how they nourish our commitment to contributing to a more nuanced answer for Europe's share in a global challenge to effectively cooperate with the US and Asia in a highly competitive environment of innovation, digitalisation and automation.