Automated trucks in road freight logistics: the user perspective.

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Abstract

A current topic of high relevance in the transport sector is the automation of driving. Automation affects not only passenger transport, but also freight transport. While industry players are promoting automation to achieve the next level of driver assistance systems as a selling point, policymakers are supporting this innovation in the expectation of reducing congestion, fuel consumption and accidents. Hence, publicly funded projects deal with activities on infrastructure issues, legal aspects, technology development, connectivity aspects, information technology security and data protection. However, the user side of automated driving in freight traffic, the logistics and forwarding companies so far had little involvement in designing the technology and the framework conditions according to their needs. The exclusion of the user perspective can however lead to non-market-oriented solutions. Against this background, the article aims to convey the perspective of potential users of automation technology and to demonstrate the conditions of technology acceptance.

The main result of the analysis is clear: The great benefit potential for users will be unleashed if the driver is replaced by the technology, due to the increasing scarcity of drivers, the increasing cost pressure and low margins and, the increasing need for efficient logistics processes, which drives the demand for automated trucks. In the opinion of the logistics industry, it is very unlikely that the driver will take on other tasks while driving for labour force qualification and economic reasons. The novelty of this finding contradicts the current use cases considered by the manufacturing industry: an automated truck with a driver who can follow other activities on the tour. There are signs, that the development of a user-oriented product therefore means the development of a driverless truck.

Key words: automated transport, autonomous trucks, logistics

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Introduction

Automatic and connected driving (ACD) is currently a topic of high relevance in transport. A vision of the future of transport without automated vehicles hardly seems to be consistent any more - not only for passenger traffic but also for freight transport. This technology is being strongly fostered by vehicle manufacturers and suppliers because, starting with the use of driver assistance systems, automation is the logical continuation of the development of an intelligent vehicle. Politicians support the technology against the background that traffic jams, accidents and fuel consumption can be reduced. Another political goal by the promotion of ACD is to maintain and secure the German automotive industry market leading worldwide. The promotion of ACD by public efforts comprises activity points on infrastructure issues, legal aspects, technology development, connectivity aspects, information technology security and data protection (BMVI 2015). Hence, the introduction to market of automated and connected driving can be expected to the near future.

However, the user side of ACD, the logistics and haulage companies, have so far been little involved in shaping the technology and the framework conditions according to their needs. Manufacturers and politicians must therefore more or less assume that the products, however automated, will be purchased and that the design of suitable framework conditions required from a technological point of view will be sufficient. But experience from the promotion and development of electro mobility, for example, has shown that the involvement of the user side and user-oriented product development are decisive for technology success.

Against this background, the article aims to provide the perspective of potential users of ACD technology and highlight the conditions of technology acceptance. Interviews with logistics companies have been conducted and evaluated for this purpose. The article is structured as follows: After providing insights in the methodology chapter three addresses the need for ACD technology by its users, their hurdles to adopt the technology, use cases of automated trucks and, the framework conditions of an ACD use case. Finally the article provides implication of the findings for technology development and transport policy.

Methodology of interviews

As buyers of trucks, potential users of truck automation technology are logistics and forwarding companies. The aim of the investigation was to determine their perspective on the new technology in terms of drivers and barriers of technology, use cases and framework conditions of use cases. Because this has not yet been published in the literature, a qualitative research design by in depth interviews was chosen. This choice was driven by two aspects: firstly to discover the scope of opinions and secondly to collect the opinion of high level managers instead of anonymous respondents.

The in depth interviews were guided by questions. This means that 23 questions were prepared (see appendix) and moderated in a one-hour session. The often not direct questioning in the course of the conversation has the advantage that even extensive and previously unnoticed aspects on the subject of automated and connected driving around the core question are discovered, since there is more freedom in the course of the conversation. However, it may have the disadvantage that not all questions could be asked during the interview, as the interviewee focused on a particular aspect during the interview, which was then discussed in more detail.

Supported by the LogistikNetz Berlin-Brandenburg e.V. (LNBB), a logistics competence centre, our research team got access to members of the LNBB. By this support we could gain five high level managers of logistics companies in the region Berlin-Brandenburg for in depth interviews. One additional interview with an interest group was made to consider whether company oriented opinions differ to supposed collective opinions. The interview partners are listed in Table 1.

Table 1: Companies included in the interviews

Company	Internet presence for detailed information
Kroll Internationale Spedition GmbH	www.spedition-kroll.com/
Hermes Schnellverkehr Gebrüder Rieck GmbH & Co. KG	www.rieck-logistik.de
Lekkerland Deutschland GmbH & Co. KG	www.lekkerland.de
Integral logistics GmbH & Co. KG	www.integral.de
eCom Logistik GmbH & Co. KG	www.ecomlogistik.de
Fuhrgewerbe-Innung Berlin-Brandenburg e.V.	www.fuhrgewerbe-innung.de

All companies were guaranteed complete anonymity with regard to the contents of the survey. This ensured open communication in the interviews and independence from corporate policy goals or similar in the discussion. For this reason, the statements contained in the next chapter of the article are presented in such a way that it is not possible to assign them to companies (including the frequency of same answers). Against this background, please note that not all statements are equally supported or rejected by all companies surveyed. The evaluations should produce a spectrum of opinion in the logistics sector. Thus, the investigation in this article can serve as a preliminary study for a future quantitative investigation, for example, to clarify if there is enough potential for specific ACD use case in the logistics industry as a whole.

Logistics is a very inhomogeneous market as far as service integration, position in the value chain, customer profiles etc. are concerned. The business profiles of logistics companies vary accordingly. However, in order to make clear what kind of potential users of automatic vehicles are presented below, the following analysis is offered.

The survey took place in medium-sized companies in the Berlin-Brandenburg area. This is due to the members of the LNBB which could be gained for interviews. These companies are active in the area of general cargo forwarding with their own vehicles and warehouses, without their own vehicle fleet and warehouses, as consulting companies in the area of process planning, as logistics service providers in the function of intermediaries and as trade associations. To characterise the provision of services, the companies surveyed can essentially be described as companies in the following logistics submarkets (Schwemmer 2017):

General land transport: Transportation of dry and stacked goods from "ramp to ramp" or "door to door" with standard trucks and rail in the weight range from 3 tons to approx. 25 tons consignment weight. Transports take place in local or long-distance traffic as well as cross-border. Partial loads are organized in efficient multi-stop tours (milk run principle). The most strongly represented business model in this logistics submarket is depot-bound cargo traffic with the respective fleet at the location. At the location itself are typically the customers and the driver residences.

General cargo transports: Transports of individually labelled dry and stacked goods without special handling requirements in the weight range from approx. 31 kg (consignment sizes above the CEP market) up to approx. 2,500 kg, which are bundled and invoiced in regional depots (branches in Germany) and transported by land in non-specialised standard trucks and loading containers in national general cargo networks. The transit times within the network within Germany are typically 24h-48h and organized in depot-to-depot trips as well as the previous collection or delivery in the regional ‘milk run’ principle.

Consumer goods distribution and contract logistics including temperature-controlled transports: In this submarket, specialised transport, warehousing and value-added services are provided for the distribution systems of the consumer goods industry and the retail trade, in particular for food and other consumer goods as well as durable goods for private use. 62% of food is transported in the

submarket. Special requirements are often the complete compliance and control of cold chains as well as a high demand on reliability of delivery.

With 66.1 billion euros, these three submarkets cover about a quarter of the total German logistics market volume (253 billion euros in 2017). In addition, only the core markets of the companies were named - in many cases logistics companies are active in more than one submarket. For example, 55% of the companies active in consumer goods distribution also serve the submarket of industrial contract logistics (Schwemmer 2017).

After providing the methodology and the description of the potential users of ACD covered in this survey, in the next session the outcomes of the interviews are shown.

The results of the interviews

The answers to the interviews were collected in a first step to identify several answers. Particularly frequent answers can therefore be classified as trends or an opinion in the industry. The questions and answers were then visualized in the form of mind maps. The following analysis of the business survey highlights four key issues: 1) the need for automation, 2) possible barriers to technology adoption, 3) use cases of automated vehicles and 4) conditions for technology adoption in logistics and transport services.

The need for automation technology

The first topic of the evaluation is the question whether there is a need for automation of driving among the users. According to the surveyed companies, there are three main drivers for the automation of the driving process in logistics.

The most frequently mentioned driver is the prevailing shortage of truck drivers. Existing driving costs are generally close to retirement age and will therefore disappear from the labour market in the coming years. The number of young drivers is insufficient, as low wages and poor working conditions make the profession unattractive for career starters. In addition, the abolition of compulsory military service has also abolished a large driving school. Driving licences must now be obtained on the private market, which is another obstacle to entering the labour market. The high and rising demand for transport and the lack of drivers increase transport costs.

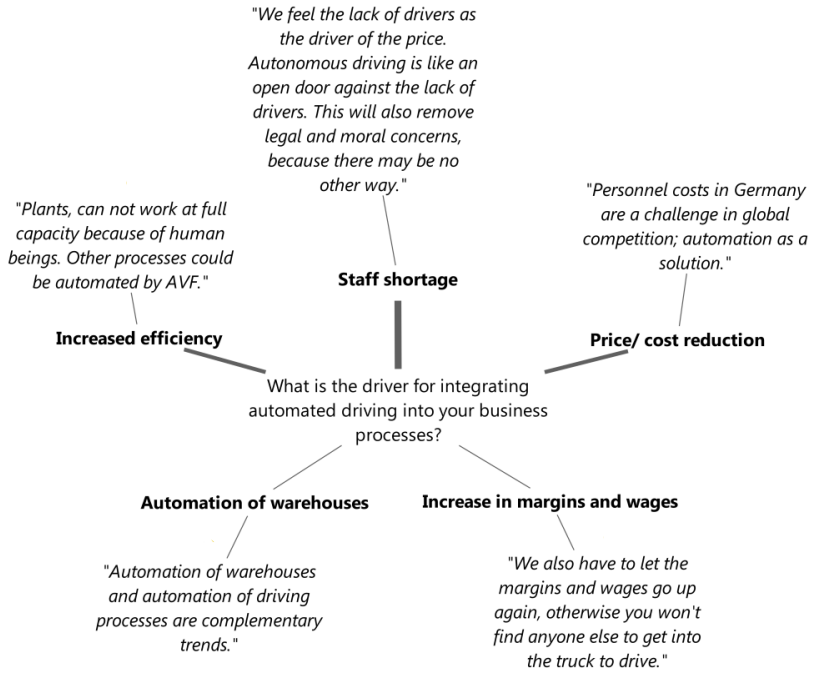
The second key driver is the targeted cost reduction that companies expect from automation. The potential for cost reduction is due to the savings in driver salaries. Increasing profit margins in the industry is a desirable effect of automation. Today the margins for standard logistics processes are very low and the possibilities for product differentiation are limited to additional services and prices. The reduction of process costs through automation and thus of production costs for logistics providers opens up a new window of opportunity for higher margins.

The third aspect is increasing efficiency. By switching from man to machine, companies expect to be able to plan their production more reliably and efficiently. Intralogistics in particular is currently being highly automated, as technology prices have fallen sharply over the past ten years and investment costs are therefore low. Business processes are also currently being digitized. To a certain extent, automation of the driving process is also a consistent penetration of automation technologies into logistical processes in order to achieve high process efficiency. Further improvements in terms of availability and flexibility result from the independence of the drivers. Better planning options reduce storage capacities, fewer vehicles are needed (especially to cover order fluctuations) and throughput times are shortened.

Figure 1 shows the answers to the question "What is the driver for integrating automated trucks into your business processes?". The frequently given answers can be seen in the extension of the connecting lines in Figure 1: The bolder the line is displayed, the more often it was mentioned. For a better understanding of the answers and an insight into the opinion picture, some answers were accompanied by an original statement in the form of a quotation from the interviews.

This is why ACD technology is in great demand in logistics, as market developments exist that promote the need for a technological solution. The advantages of automated road transport in the logistics sector serve to counteract the lack of drivers, reduce costs and thus increase the profit margin and achieve greater process reliability.

Figure 1: Factors driving the need for automated trucks



Potential obstacles for technology adoption

ACD is aimed directly at the job description of the truck driver. Some of the activities of truck drivers, however, go beyond the mere driving task. It can be stated that the drivers are responsible for the safety of the load and the vehicle. Customs clearance and container exchange are also part of the driver's tasks. On the first and last mile, the driver is responsible for the service to the customer, such as unloading the goods, transporting the goods to the warehouse or salesroom or accepting complaints. Although we saw a strong need for the ACD technology, it was necessary to discuss possible obstacles to the integration of the technology. Against this background, the companies were asked what they see as the greatest risks of automation and in which of their business areas automation is excluded.

It can be deduced from the answers that companies consider automation to be out of the question, especially in urban areas or for customers. This is due to the lack of infrastructure, which would also have to be created by the customer (the "dockable ramp" on the sender or recipient side of the freight), as well as the service task of the driver on site at the customer. In the case of automated vehicles, the integration of interfaces must be taken into account. Special transports are considered problematic for automation because they require special monitoring and load securing, for which a driver would be indispensable.

One of the trends to be considered is that depots are increasingly establishing themselves in urban areas. The increasing trade via "eCommerce" platforms is also leading to a change in the industry orientation from industrial customers to private customers. This means that transport companies are increasingly operating within the "last mile". As a result, people's activities are becoming increasingly important, especially for the end customer. Automation is unlikely if a person performs a service activity on the tour or if special requirements are placed on the transport task.

The implementation of platooning (economies of scale) may result in customer restrictions in handling and storage capacity. Customers are prepared to handle a container or truck instead of two or four, as can be the case with a truck platoon.

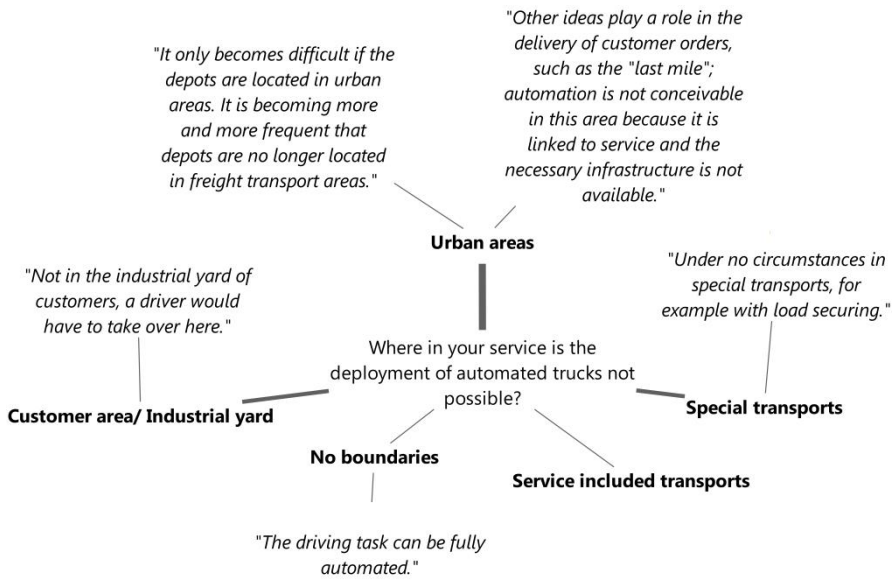
The question of coping with so-called mixed traffic, i.e. when automated and conventional vehicles share the infrastructure, is also of great importance for companies. There is uncertainty as to how accident potential and congestion can be reduced to a minimum, e.g. without a lane for automated vehicles.

In cases where transport services are purchased from logistics service providers, automation is less important than with self-employment. The purchased service must remain the same, if necessary at a lower price. Not every freight forwarder will be able to invest in automated vehicles - but the market will set new prices if automated vehicles are used more frequently. Accordingly, customers will develop a new willingness to pay at the price level of automated vehicles.

Data security is also an important issue for respondents. On the one hand, this includes the expected protection against cybercrime and clear legal regulations on who may read which data and how (e.g. police, Federal Office for Goods Transport, etc.). On the other hand, automated vehicles will also be data suppliers. This is accompanied by the expectation that new companies will enter the logistics market and try to provide logistics services with available transaction data. Existing logistics companies must adapt to this new business model. However, it may result in small service providers in particular not being able to maintain a market segment.

The mind map, to the answers to the question "Where is the deployment of automated trucks not possible?" is shown in Figure 2. In summary, while there are clear benefits of ACD technology, there are also general barriers for customers to take advantage of it. The main risks for technology are seen in the fact that interfaces are not integrated and that autonomous and non-autonomous vehicles will not have separate infrastructures.

Figure 2: The limitation of deployment of ACD trucks



Use Cases of automated vehicles

From the user's perspective on general drivers and barriers of ACD technology, it is important to know how the user is likely to integrate the technology into logistic processes and what features the technology is expected to provide. The companies were asked how they would envisage a logistics world with anyway

automated trucks, what kind of automation would be advantageous and what impact this would have on the industry.

As a probable field of application for ACD, companies consider standardised transports, such as transports between depots and warehouses, to be realistic. The trips often take place at night and most depots are located outside the city limits. Many warehouses are already fully automated, which creates some efficiency pressure to automate the entire transport chain. In addition, the handling process is another conceivable and advantageous process for automation.

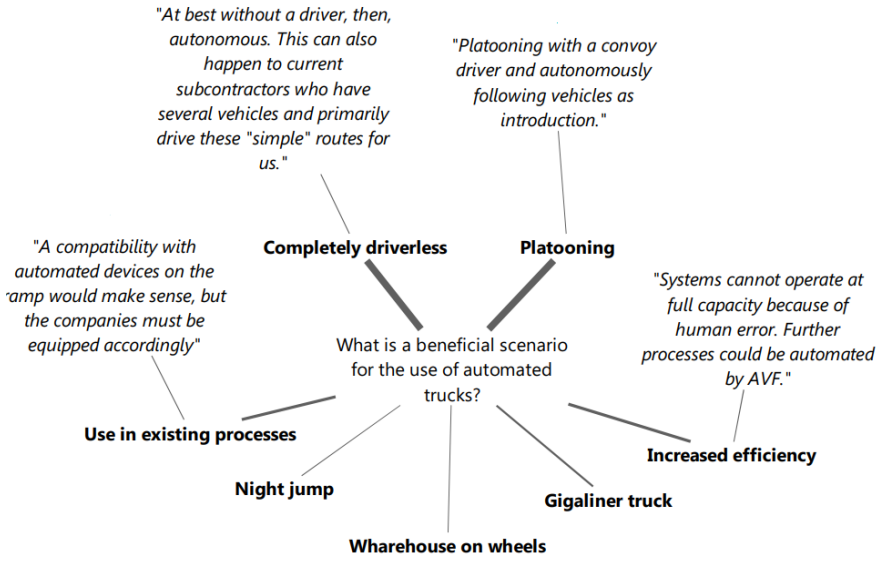
Particularly in the case of physical transport, the distance travelled is limited by the legally prescribed driving and rest periods. The use of ACD promises an increase in efficiency through higher utilization of the vehicles for service provision (not payload). Drivers today make decisions only on the basis of system information and existing contracts. For some of the respondents, the handling of the driving task by automated vehicles does not represent a restriction in this respect.

According to the companies interviewed, platooning in particular is regarded as a conceivable first application of the ACD. With the help of this technology, several vehicles can be coupled together. However, it should be stressed that in this case only the leading vehicle would be manned by a driver and the following vehicles would be electrically coupled trailers. This allows economies of scale such as order peaks or 'an additional pallet' that no longer fits on the truck to be handled. Thus the concept of platooning differs significantly from the previously often associated composition of vehicles on the track for shorter distances and relief of drivers. An extended aspect of this was to make the driver's profession more attractive again by expanding the technical "know-how" - so to speak as a convoy companion. That there would be a driver in every vehicle has been ruled out as it negates the economics of an automated vehicle. The fact that the driver could undertake other activities during the journey is also excluded, as he is not qualified for this, the possibilities for further qualification would only exist in exceptional cases and existing specialist personnel in logistics companies would not have to be mobilised. Platooning has the already mentioned advantage of a higher security by the human instance on site. However, the problem with platooning is that many companies on the receiving side do not usually have the capacity to handle a convoy at the ramp. The availability of personnel at the ramp was also mentioned: "It doesn't help much if the train is parked outside the industrial yard at four o'clock in the morning, but the unloading personnel don't start work until six o'clock in the morning". (one interviewee, literally translated)

Driverless vehicles are most advantageous in the industry as they are the most effective against driver shortages and rising transport costs. The ideas of a completely driverless vehicle and the transport of automatic transport machines as "trailers" (platooning) play a role here. Both systems pursue the core idea of counteracting personnel bottlenecks as far as possible and at the same time achieving cost savings. The completely driverless system offers advantages in terms of route planning and cost optimization. The technical maturity and the necessary infrastructure are decisive. An automated system does not have to be limited by driving times and rest periods. A cross-interface, automated transport chain could thus lead to considerable increases in efficiency.

Figure 3 shows the answers to the question "What is a beneficial scenario for the use of automated trucks?". Most important, therefore, is the realization that driverless trucks are needed by potential users and not automated trucks as mobile offices.

Figure 3: Beneficial use cases of automated trucks



Conditions of the technology adoption in logistic and transport services

For the establishment of autonomous trucks, the large e-commerce companies and global players in the logistics sector can be considered as pioneers. Market power, advanced digitisation of processes and the necessary capital enable them to integrate these vehicles into the processes most easily and to bear the learning costs for the new technology. The sector, which is characterised by medium-sized and small enterprises, lacks the financial resources to invest in innovation or to absorb bad investments. The guarantee of existing processes and the economic manageability of innovations is thus the starting point for every change in medium sized companies. The surveyed companies see a need for action in legal questions concerning the use of ACD. Politicians are therefore expected to adopt clear rules on liability and the adjustment of driving and working times. Other legal aspects are control sovereignty and data sovereignty.

The question of a possible adaptation of the infrastructure also remains to be clarified, in particular for mixed traffic (automated and conventional vehicles). In addition, the general conditions of use need to be clarified: Any temporal or spatial restriction would be an additional hurdle for the economic efficiency of ACD. The companies therefore want consistent support for the technology - the political process for the approval of the Gigaliner truck was cited as a negative example in some interviews.

The companies surveyed assume or expect that the technology will be available on the market in the near future, about 10 years. It was assumed that it would not be the technology, but the other framework conditions that could delay the broad application of ACD in logistics.

Figure 4 provides answers to the question "What legal, regulatory and financial framework conditions would you like to have for beneficial deployment?". It becomes obviously that clear rules and framework conditions have to be designed which do not reduce the economic efficiency of the ACD technology and ensure the reliability of the logistics processes.

Figure 4: Conditions of technology adoption in logistic processes

Implications for technology manufacturers and transport policy

The subjects of the strategy of automated and connected driving at present are infrastructure issues, legal aspects, technology development, connectivity aspects, IT security and data protection (BMVI 2015). Through interviews with managers of logistics and forwarding companies, we have discovered that these topics are important aspects for potential users. But what we also noted was a discrepancy between the vision of automated and connected trucks promoted by the manufacturing industry and currently being demonstrated on test fields, and the user-oriented automated truck expected by potential users. The mainstream vision of an automated and connected truck in the manufacturing industry is an automated truck with a driver, where the driver can use the technology for more comfortable working hours or business activities. A platoon is configured by several automated trucks, each with a driver on board. However, an analysis of the requirements on the user side shows that this scenario brings little benefit. The great potential for benefit for users will be unleashed when the driver is replaced by the technology, due to the increasing scarcity of drivers, increasing cost pressure and the growing need for efficient logistics processes, which are driving the demand for automated trucks.

The consideration of the demand side, the needs of the logistics and forwarding industry for the new technology is an important step to develop the technology user-oriented and to set the framework conditions accordingly. From the survey the following key points for a realistic application scenario of ACD in road freight transport can be summarised:

- There is a high demand and a strong interest in ACD in the logistics industry. ACD has the potential to solve one of the industry's most critical challenges: the increasingly dramatic shortage of drivers.
- The pioneering achievement can be expected from the global players in the industry and the e-commerce retailer. Although small and medium-sized enterprises show a high interest in the technology, the currently realisable profit margins, the entrepreneurial risk calculation and the learning costs generally do not allow these enterprises to play a pioneering role.

- ACD technology is expected to initially be utilized to (cost) optimize existing processes. An expansion of services or a significant reorganisation of logistics processes is therefore not to be expected in the short to medium term.
- The more standardized the logistics processes are, the more likely it is to use ACD. This opens the native application potential for the technology in the logistics submarkets served by hub and spoke network. On the first and last mile, where customer service has a high priority and is becoming increasingly important for the business development of logistics companies, the use of ACD technology is to be ruled out as a driver or customer personnel would still be required. The decisive reason for this is that in this case the costs of the technology and the benefits are at best the same.
- The foreseeable field of application for ACD technology is the tour between depots resp. logistic centres. This concerns also the distance between the motorway and the depot resp. logistic centre.
- It is unrealistic for the driver to take over other business activities while driving. Tasks that were previously performed by specialist staff in the offices of logistics companies could only be transferred to the driver with a considerable amount of retraining. However, the qualification potential of today's drivers, the lack of drivers and the knowledge and experience of existing specialist personnel contradict this notion.
- This means that driverless vehicles must be available for use on federal motorways and beyond in order to offer advantages in logistics. Vehicles in which the driver would quasi have a mobile office would not be user-oriented. Against this background, autonomous trucks are expected by users. This requires not only technical development, but also the political and legal framework conditions to make corresponding products possible.
- The use of autonomous long-distance trucks and the facilitation of platooning would increase the benefits. However, platooning in the sense of the interviews differ from the general definition of platoons. Beneficial would be if vehicles do not drive with drivers at reduced distances, but that a platoon leader can move several electronically coupled trailers (driverless). This would allow absorbing peak order volumes and achieving extended economies of scale.
- The companies surveyed did not show a long-term scenario for ACD deployment. This can be explained on the one hand by the pressure of short-term day-to-day business and the lack of strategy and R&D units in small and medium-sized enterprises. On the other hand, the required technology is not available, i.e. it is not testable and relatively abstract for the players in the operative business. In addition, innovation scenarios such as long trucks and electric mobility have also left traces of discrepancies between political decisions, technical implementation and practical application. It therefore cannot be excluded that new services and applications for ACD will be developed in the long run. However, the actors initially concentrate on the first step of innovation, which can be reflected from a business perspective.
- The advantageous deployment scenario - fully automatic (long) trucks on the motorway without a driver - requires not only clear political support with regard to the framework conditions (adaptation of the Vienna Agreement, data protection, customs issues, etc.), but also an extended catalogue of requirements for vehicle manufacturers so that user-oriented products can be launched on the market in the next decade.

The concluding point of this paper is that the perspective of potential users opened new and different issues to what is in the scientific and public discourse so far. Hence it is very important to involve the users for "technology-success" in future by broadening the public discourse on automated and connected driving. It moreover needs further research to specify and quantify the qualitative research done in this paper to obtain representative status.

Acknowledgement

The project team would like to take this opportunity to thank the interview partners and the companies for their valuable time, the openness in the conversation and the pleasant atmosphere. We have collected a lot of valuable information and for the first time we have been able to create an opinion poll that show the potential user side of automated vehicles. With your support, these findings can provide valuable impetus for user-oriented vehicle development and policy setting. Ultimately, a contribution to the social discourse on the automation of road traffic is also possible.

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Annex

Prepared questions resp. aspects for the interviews (translated from German)

Company-specific starting point

1. What is the specific logistic service of your company?
2. Where in the value chain is your company located (predecessor, successor)
3. What transport logistics structure does your logistics have?
4. In which processes are the driver involved and what activities does he perform?
5. Is the business segment (new services, services, products) currently being changed?

Company-specific expectations

6. Where in this logistics chain/your service is an automation of the driving task conceivable?
7. What would this automation look like in concrete terms (driverless, vehicle attendant, centrally controlled)?
8. What role would be given to the driver (Other / extended tasks)
9. Where in this logistics chain/your service is automation excluded? What's the matter with you?
10. Can new services be developed by automating the driving task?

Enterprise-specific scenario

11. What is a useful scenario for the use of automation technology?
12. What improvements do you expect in this scenario? (tours, costs, quality...)
13. What risks do you expect for this scenario? (compatibility, market position...)
14. What legal, regulatory and financial framework conditions would you like to see for this scenario (and its introduction)?
15. When is the realisation of this scenario realistic?
    a. From your point of view, is the required technology available for the outlined scenario?
    b. Which diffusion pathway do you expect?
16. What is the driver for integrating automation technology into your business processes? (Competition?, optimization?, new service possibilities?)

Industry-specific aspects

17. Who will take the early adopter role?
18. To what extent will the automated truck (as defined above) become the standard in the logistics industry?
19. How would this change the logistics industry? (logistics chains, actors, tasks)
20. Which vehicle technologies, apart from automation, are other future-oriented for your business? (electrification of vehicles, software, hardware, aerodynamics)
21. What would you expect from vehicle manufacturers as the next innovation?
22. What other technological innovations do you expect to change your logistics processes and structures?
23. Which aspects that are important to you have not been discussed?