How Information Systems are shaped from the decision-making level to technical implementation: Case Trucking

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Abstract

Digitalization is advancing in all walks of life. One of the areas undergoing a sector-wide transformation is trucking, as part of the logistics sector. This will have a profound impact from societal and economic level down to the individual trucker. Information Systems research has for long focused on system design and deployment on organizational level, implying that this level has the actual power to decide about the design directions. However, our study shows that the transformation is more complex and involves technical and societal aspects that shape the decisions before a single organization, or a network of companies get involved. We thus argue that there is a need to take a broader view to the change. We interviewed 14 high-profile actors in Finland and at the European Union level, trying to understand the highest level of this transformation, how the forces are shaped into drivers, what technical manifestations are foreseen, and how the voice of the individual worker can be heard at this level of the process.

Keywords: Digital transformation, Digitalization, Driving forces, Decision making, Trucking.

1. Introduction

The Information Systems (IS) research focus to digitalization has largely been on changes taking place on organizational level, or technology designs, often implicitly assuming that organizational level is sufficient and that "contextual" issues are given. In current situation neither of these assumptions may not be correct. Over the recent years there has also been more focus on user involvement in design decisions and also to study the work itself and how to make design decisions with work practices in mind, although this is still relatively rare within IS [28, 43]. However, a literature review on work practice view to digitalization in the IS research [43] shows the assumption of the system designers having full power to shape the system designs may not be quite true. Several layers are involved in the change, and they shape it up even before it manifests as technology and is put in place. Understanding this process and how to be involved in the early stages of it is important, especially as there is a danger that decisions taken early on can limit or even impede designs that support work practices.

To get insights to this process we looked into transportation and logistics sector,

especially trucking, as it has factors making it impactful, interesting, timely, and relevant context. Road freight is the backbone of commercial logistics on land, and vital for the economy [24], with a significant economic and societal impact. Intelligent technologies have already been integrated at the level of practice, e.g., navigation and advanced driver assistance systems, giving the actors a baseline to reflect on. The sector is under significant pressure - competition drives for lower costs and higher efficiency [36], increased e-commerce and rapid growth of local delivery services are straining the logistics networks [1, 46, 47], increasing the need for transportation, causing e.g., congested traffic [9, 12], yet there is a need to reduce the impact on environment [22, 32]. Finally, digitalization is considered a key for these challenges, thus the transformation will continue bringing new technical solutions that change the drivers' practices – directly or indirectly – that they can adapt, need to adopt, or have no choice but to accept.

In this qualitative study, we will explore RQ1: what kinds of forces the actors on the highest layer (regulators, decision-makers, etc.) see to affect digital transformation in the trucking and logistics field in Finland, RQ2: who shapes these forces into drivers that guide and spur digital technology development, RQ3: how the voice of the workers can be heard at this level, and RQ4: how all this manifests as technology solutions that will impact the work on practice level. For this, we analyzed interviews of 14 public high-profile actors active in the trucking and logistics field in Finland and in the European Union (EU).

2. Related Work

The discussion of the direction of the 4th industrial revolution [7, 8, 40] has been largely based on the premises of technological determinism – technology will penetrate new areas and cause potentially drastic changes. One of the focuses has been the effect of technological change on jobs [15, 42]. The 4th revolution discussion has also been criticized from several different points of view, such as connection between the 4th revolution and neoliberal rhetoric and pursuit of the accumulation of capital [2, 10], the perspective of north-south divide [5], and the perspective against the technological determinism, pointing out the importance of social shaping of the outcomes [11]. The relationship between technology and change has naturally been a major topic in the IS literature from the beginning, although usually limited to the confines of a single organization. The dominant stance of literature has been what could be called tacit technological determinism, seeing technological change naturally as the driver of whatever is happening in organizations, and this is still valid for a large part of current IS research. There has, however, been a lively thread of literature discussing social construction and IS since 1990s in a wide variety of contexts and settings [16, 25, 39, 45].

The significance of the 4th industrial revolution and changes it brings to workplaces has been noted by IS researchers [43], with the future of work as an emerging area of research [3]. Digital work design to improve cost and work efficiency is an often-mentioned driver for the change e.g., in [38] but also many others. Other identified digitalization drivers induced change in the workplace have been new regulations, forcing a change to happen e.g., [13], radical technology-driven disruption e.g., [26], need to respond for market pressure or competition e.g., [19, 37], or just responding to an opportunity that presented itself e.g., [20], [30].

Various actors have been identified as taking part in the change process: within the organization workers are a natural actor group [43] but in addition to that in-organization decision-makers e.g., [19] and in-organization support units such as IT e.g., [37] have been mentioned. External to the companies in question, IT organizations implementing needed solutions e.g., [19, 37], customers e.g., [18], competitors e.g., [27], non-commercial agencies [17], and various governmental agencies, especially policy makers [48] have been mentioned. The focus on IS research has largely been on in-organizational actors, or actors engaged in implementing the systems. Other external actors have been taken more or less as context that is either not really involved, or whose influence cannot be affected.

In the trucking and logistics context, the general perspective of IS research on digitalization has been that advances in ICT and IoT systems would allow technology

users or providers, e.g., truck manufacturers, to collect ever more detailed information of the vehicle usage in the field, providing insights that help to develop solutions for the challenges [6]. Correspondingly the research has been looking for specific potentially helpful development directions, such as algorithms [21], fleet telematics [23], or autonomous trucks [41]. To our knowledge, no attempt to outline a "big picture" of the digitalization problem field in trucking and logistics, such as what we attempt to do in this paper, has previously been made in IS literature. In IS research in more general, a need for taking the industry level perspective in digitalization has been brought out, however [31].

3. Research Design

This study is part of a larger research effort where we study how digitalization affects trucking work practice. For this paper, we analysed interview data from 14 people in high-level key positions in legislative decision making and implementing laws into practice (Table 1). The interviews were conducted between 10/2021 and 10/2022 via Microsoft Teams in Finnish language (all quotes translated to English for this paper), focusing specifically on trucking and logistics in the Finnish context as we got best access to these actors. The interviews were audio recorded and relevant sections of them were transcribed (duration 51-108 min, on average 73 min, altogether 17 h 45 min of audio). To protect our interviewees' anonymity, we present the demographics to the detail presented in Table 1.

Table 1. Interviewees for the study.

Code	Interviewee role	Organizational level
I1	Expert, intelligent traffic services	National agency
I2	Decision Maker with an interest to logistics	National parliament
I3	Senior Decision Maker, Senior Politician	National parliament, European Union
I4	Director	National agency
I5	Senior Data Expert	National agency
I6	Decision Maker with connection to logistics	National parliament
I7	Senior Expert, traffic and logistics	National ministry
I8	Senior Expert, traffic regulation	National ministry/National agency
I9	Senior Expert, regulation	National ministry
I10	Senior Advisor, transportation	National ministry
I11	Senior Manager	European Union
I12	Director-level, traffic systems	National agency
I13	Director-level, traffic solutions	National agency
I14	Senior Expert, transportation	National agency

The interviews were semi-structured [33], giving the interviewees a possibility to discuss the issues they felt were most important regarding the topic. The interview themes were: 1) Interviewees' background and previous experience related to trucking and logistics. 2) Their views on where the transportation and logistics industry lie currently; what the work is in the field and where it is going and who affect the future developments. 3) How they see if and how drivers and logistics companies can affect the work they are doing, and whether they should have such an opportunity. Then we asked about their own 4) work roles and if and how they affect the work of the drivers and logistics companies, and 5) how long it takes for a process to complete all the way to actual legislation and use. Lastly, we asked about 6) topics related to Digitalization/Digital Transformation, i.e., how they see technology affecting work, who influences the development and whether someone is or should be responsible for the development. Finally, we asked who else we should interview. Most of the interviewee names came from the mentioned larger research discussions as snowballing expert recommendations. Often the same agencies and roles were proposed, that in turn verified the organizational and process stakeholders, and how different parties work together or are connected in a decision making chain that eventually affect truck drivers and companies and their customers. The first interviewees were selected based on our understanding of their central role in regulation and

development in the trucking logistics field. The resulting list of interviewees was based on the factors above, and availability of the interviewees. In addition, we used publicly available official material as a source related to the EU and Finnish national strategies and decisions, also to verify our understanding of what the interviewees had said.

In the first phase of the analysis process, the first author listened through the interviews and browsed through the notes to collect all instances where topics of this paper were discussed, transcribed them, and collected them in a text document. In the second phase, all actors were identified from the excerpts, as well as their roles related to shaping of the field of truck logistics and work practice therein regarding use of intelligent technologies. After that, the analysis was data-driven. Two clear categories arose from the data: forces shaping digitalization of the trucking and logistics field, and characteristics specific to the trucking and logistics field regarding digitalization. The findings were discussed between the authors regularly to reach an agreement.

4. Findings

4.1. Identified actors in the digital transformation

In this section we draw on the interviews to identify who are the actors that are shaping the drivers that guide the digital transformation of the trucking and logistics industry. These actors were mentioned by the interviewees who saw the formal regulation process as highly influential in shaping digital transformation of the industry. The first actor group are the ones who direct action and have a formal position in guiding, preparing or making decisions that become the drivers for the change, eventually affecting work practices, as identified in [43]. In the European Union (EU), European Council define the highest political directions that other EU organizations progress. These all are politically driven. Individual countries can drive topics important to them to influence the future directions. European Commission sets the higher-level strategies and priorities that guide the rest of the actions. One of the Commission's 56 Directorate Generals (DG) and Executive Agencies is DG Move that covers trucking related topics. Each DG develops and executes Commission's policies related to its field. Both European Parliament and European Council are also needed for accepting new laws. Members of the Parliament (MEPs) and their political groups use power in all decisions. Rapporteurs are elected politician members of the Parliament's committees, who analyze the proposals coming from the Committee and lead the process to reach a conclusion. Rapporteurs are not politically neutral; shadow rapporteurs may be named for balance.

The interviewees mentioned a number of lobbyists who influence decision-makers in the EU: industry interest groups and countries outside of the EU, and academic scholars were mentioned. *"Everybody lobbies in the EU ... It is an everyday activity who visits behind the door ... including academics, who build the scientific foundations..."* (I3)

In Finland a new Government creates a programme that includes commonly accepted directions for the rest of the term. Using it Cabinet Ministers guide their ministries to align with the agreed targets. For trucking and logistics the primary ministry is the Ministry of Transport and Communications, but Ministries of Finance and Economic Affairs and Employment are also involved. High ranking ministry officials often have domain knowledge and experience. With guidance from the cabinet ministers on what to work on, officials have quite an independent role in matters of technical and domain expertise. They are key persons in drafting legislation proposals. They organize official hearings and use unofficial channels for input from interest groups and individuals. "*...at least I use Twitter and LinkedIn in work matters for information sharing and also for discussions. ... there are* (truck) *drivers on social media and I occasionally discuss with them.*" (I9)

The EU forms technical working groups from national experts who work on selected topics. Their proposals often form the basis for common technical interfaces and national implementation. Agency officials and experts also participate in national technical preparations and law proposals. National agencies organize and run projects that build the systems required by the local laws or the EU. Online infrastructure and traffic information systems being examples of such. How those are implemented and used, directly affects the logistics industry. "*On the agency level ... there is a lot of activities ongoing and very much interaction with international groups and others.*" (I5) Some

drivers have chosen to become politicians and are influencing from within. Advancement of technology and companies creating new technologies are affecting regulatory processes. Novel technologies are progressing faster than legislation can cover them. Technology companies take an active role in lobbying; e.g., Tesla among others has been active as their interest is in electrification of the mobility.

Technology can also be considered an influencer in itself. Technology may have been initially developed for a different purpose, but then spreads out to other areas as their potential – or possible impact – are recognized by decision-makers and lobbyists alike. "*...often regulating happens so that we watch what is being developed, what is possible; it works as input, that there is a need for new regulation that we take forward.*" (I14) Technology raises also social and ethical questions, such as what the relationship between technology and people is – decision-makers may try to take it into account.

In Finland Parliamentary Committees evaluate new legislation proposals. They have direct influence on the matters being considered. Committee members may ask basically any group or individual to be heard when analysing proposals.

There are two other paths in Finland to bring in proposals to the decision-making process. Individual politicians have a right to propose new laws *"...entrepreneurs have called mainly from my electoral district and told their worries and sorrows ... I made a proposal to increase axle masses ... Business had calculated with the University of Oulu that higher masses do not increase road wear ... Feedback from the field has ended up as a law proposal.*" (I2) Politicians can also influence their parties and the parliament for their favor. Some interest groups share their members' contact information to the politicians to easily connect with the ones working in the field. Second, citizens may also directly propose new bills to be evaluated, though not directly passed, in the parliament. A proposition has to receive support from 50 000 citizens to be taken under consideration. The EU also has a process for citizens' initiatives. Those require at least 1 million signees from 7 EU member states.

Labor unions and other interest groups carry a unified voice on behalf of their members. Their opinions are often specifically asked by participating in the parliamentary committee interviews. That is the main channel for gathering information. Truck drivers and trucking companies can voice through their unions, but also by contacting decision makers directly. "*...for each parliament member (*a truckers' union*) aims to name ... a personal "adopted trucker*." (I2) for drivers and politicians to easily contact each other. Identified from the data are factors influencing the decision-making, but that do not manifest as discrete and nameable actor groups – business and other societal factors. Those are in the EU's list of priorities of focus. All legislation needs to cover the main aspects of "the European way of life" as exemplified in the EU's founding values: Human dignity, Freedom, Democracy, Equality, Rule of law, and Human rights.

4.2. Special factors affecting trucking from digitalization point of view

In this section we describe the role of trucking, the forces that are behind the need to transform the sector, and how digitalization and (digital) technology interplay with trucking.

4.2.1. Role of transportation and trucking

Truck transportation is vital for Europe. Several of our respondents stated that truck transportation is crucial and in practical terms the only option for Europe's economy to keep the society functional "*European manufacturing economy is completely reliant on* (transportation)." (I11) The whole society is reliant on functioning logistics in everyday operations. Almost all consumed goods are transported by trucks at some point. "*The miracle in our food production and daily groceries happens in logistics. That we get food, drinks and other from all over the world to the shelves of ordinary people, is possibly the biggest miracle of the market economy. It is always due to functioning logistics.*" (I2) In addition, several major European truck manufacturers ship their products all over the world. **Truck transportation is heavily regulated by the EU.** Legislation related to trucking is mainly regulated by the EU. Member states participate in the law making and enact them either directly through Acts or set national laws as required by Directives. Only transportation weights and measures are within national decision making. "(Not much difference between Finland and EU) *because EU-level has*

mostly guided our legislation since 1995. ... national implementation, the foundation comes through EU's structures, because the traffic sector is so heavily steered together by the European family." (I3) **Trucking is not just about traffic and transportation.** Trucking does not exist in a vacuum, it is connected to many other parts of society and its functions. Looking only at road transportation is not enough as products are imported through sea, air, and rail. All forms of traffic are connected and must interoperate, "...(It) *must be thought of at the traffic system level, not as silos in different transportation modes but as a holistic transportation chain, end to end. For example, ports share more accurate estimates when ships arrive, also to truck drivers.*" (I13) Building and maintaining traffic infrastructure has major financial impacts. Driving and working times are linked to Social and Employment laws. Schooling and training new drivers is related to Education. Connections reach far and wide.

4.2.2. Trucking industry is facing challenges

Megatrends and strategies affect trucking. The EU is actively fighting against climate change and environmental degradation; it is a strategic priority for the EU. Due to its nature and role, trucking is one of the key industries that contributes negatively to air pollution and traffic congestion. "*We currently have huge societal challenges – climate and air quality topics .... is probably the project for our generation. ... transportation, as one of the key sectors, is surely in the core, and possibly one of the sectors where this is of the most foundational quality.*" (I11) **Cost and other pressure.** In Finland transportation companies' profit margins have been described as low. The average size of trucking companies in Finland, and to some extent in European countries, is small. Raising fuel prices affects companies directly "*...costs during the past year have increased very heavily ... profits and development budgets have melted ... businesses are rather fighting for survival than doing meaningful development.*" (I8). New regulation and customers may mandate more environmentally friendly vehicles that require new investments. Retail customers and households are reliant on timely deliveries, which converts into time pressure. **Lack of truck drivers.** Interviewees unanimously state there is a shortage of truck drivers. Not only in Finland, the situation in the rest of Western Europe and many other countries globally is similar or worse. Lack of drivers is a combination of several things. Europe currently does not get drivers e.g., from East-European countries, who have been available. The younger generation is not interested in trucking as they view it not representing their personal values. Trucking has been a viable option to explore other countries while working, but this is no longer the case. "(In transportation logistics) *we have a chronical and worsening lack of employees. Especially in heavy road transportation ... truck drivers' average age is highest.*" (I11) **Trucking needs a facelift.** In order to combat the challenges trucking is facing at societal and individual level, changes are required. One informant said that while logistics is crucial to society, enhancing sustainability is needed "*...to gain societal acceptance ... It is the license or permission for the future growth of the sector.*" (I11) "*To attract potential younger drivers and be acceptable, the industry and its image need a facelift.*" (I8)

4.2.3. (Digital) technology brings change

Massive changes are coming, and bigger ones are predicted. Digital technology is in use in trucks in various forms. Some of the technologies mentioned were standardized intelligent tachographs. It adds Global Navigation System (GNS) and interfaces to fleet management systems. Truck manufacturers have implemented many Advanced Driver Assistance Systems (ADAS) to aid drivers. Many of those are implemented to increase traffic safety, such as driver alertness monitoring system *"...to reduce workload ... and monitoring driver alertness to ensure traffic safety is of special focus in trucking."* (I3) We were told that the latest dynamic speed assistants that use topographic information, reduce fuel consumption on average by 20-30%. Technology enhances fuel economy for most drivers. Trucking companies and their customers are increasingly taking transportation planning systems into use that are integrated into trucks. Such solutions are and will increasingly be tightly connected to other IT systems, for example real-time load and order systems, payroll, and ERP solutions. Platooning was mentioned by several

interviewees – several trucks driving close to each other, not necessarily having a driver in every vehicle. Truckers may thus act in a controller role, not a driver. There have been platooning trials, but none were known to be in active use. The interviewees presented some expectations and hopes of industry-level linkage to (automatically) distribute loads between companies and trucks. It would make it possible to combine less than full loads and optimize equipment size needed for each job. Most interviewees raised autonomous trucks as one possible alternative in the future for some tasks.

The change will not happen as soon as some have predicted. Although a lot of technology is already in use, there are still limitations and pieces missing. One interviewee mentioned that for the past 10+ years autonomous trucking has always been 5 years away, and continues to move. Automation needs supporting infrastructure for vehicles, road infrastructure and IT infrastructure. Common interfaces and data structures mandated by the EU are being built, also in and by our interviewees' organizations. Digital infrastructure is forming at national levels, but it does not exist everywhere nor is fully interoperable between countries yet. One of the main ingredients missing is data in its different forms. Trucks internally use micro-second level data e.g., for traction control that could be used by another system to e.g., follow road conditions, if data from trucks for example once a minute were available elsewhere. There already is a lot of data, but its depth, availability, and quality are limited. *"...The one who starts the data ecosystem, is the maintenance man who several times a year grinds the road surface sensor to match road wear and saves the quality of the algorithm."* (I12) But all the details for such an encompassing model, and possibly a Digital Twin for the traffic infrastructure, do not exist yet: "*That we try to solve things using data is probably a big thing, but likely smaller than people in the Information sector think.*" (I5) EU is also forming regulation that demands data to be collected all over the EU and make it available. Finland too is pushing data and services to be openly available, and governmental actors build full end-user solutions only if such are not available commercially. Data need to be shared and accessible in a fair way to construct a Digital Twin for the traffic system (e.g., [44]). "*...creating a Digital Twin from traffic ... we need data from the vehicle...what traffic and speeds are ...*(it) *can form a picture where it is slippery ... and to predict how traffic will flow ...*" (I12)

The interviewees estimated that technological development will continue, and we will get new capabilities and features as the work progresses. It is unlikely there will be a one-time big bang. "*...for example, autonomous driving ... has been a hype in information and traffic industries over the past years, but slowly we start to see, that actually we haven't progressed that far in this development. And what problems would it actually solve for us?*" (I5). Many were expecting that autonomous trucks will eventually come, but they will start e.g., within closed factory areas.

Digitalization brings hope – expectations from technology. Even with less than fully autonomous driving, digitalization can and has already changed the work for the drivers. There is less of a need to fill papers, navigation directs around traffic disturbances, trucks can automatically brake in urgent situations. As one interviewee (I13) stated, "(in transportation nodes, such as ports) *digitalization removes hassle* (from work)". Progress continues, new technologies are introduced. Regulators are following if there is a need to intervene and enact new legislation "*Regulator's task is ... to enable use of new technologies ... but also to use regulation to prevent undesirable paths ... first customer driven, then regulate ... technology should serve mankind and be for people to use; and make life easier and better ... regulators surely have an important role to oversee it."* (I9)

Technology can aid in answering many of the challenges we have listed in this paper. Autonomous trucks could (partially) answer to the lack of drivers, would not have driving time restrictions, would remove fuel consumption differences between drivers, would not get mad, and would not be unsure when being able to go home. Questions remain, however: Would there still be a person in the cabin or not? What would their work entail? Would autonomy be a partner or a supervisor? Respondents asked many such questions but did not have answers. Their answer was that they will facilitate and regulate if needed, but the industry and the users will show the directions. Our interviewees see new technologies both take control away from drivers, but can also

leave room for options. It depends on each exact implementation, which way the effect turns out. Most interviewees estimated that actions that make truck deliveries more efficient also reduce the drivers' and companies' ability to influence their work.

5. Discussion

The main contribution of this study is to the emerging discussion on intelligent technologies having an impact on work practice. We show that the transformation is more complex and involves technical and societal aspects that shape the decisions before a single organization, or a network of companies get involved. We thus argue there is a need to take a broader view to the change.

To answer RQ1, the forces behind the need to transform the trucking and logistics industry, as identified by our interviewees, were large megatrends, climate change and environmental degradation being one of the most important ones as it touches everything, but also because trucking is one of the focal industries in this respect. Being central for the European economy and keeping the society functional it has a significant footprint to air pollution and traffic congestion. Because of how European cities have been built up, it is also practically the only choice for most of the transportation logistics and cannot be replaced, so it needs to be transformed to a more ecologically sustainable shape. Another megatrend is the serious shortage of truck drivers and the dwindling pool of people interested in taking up this vocation. Trucking was considered to be in need of a facelift to become more socially acceptable and interesting as a walk of life within the younger generation. The third megatrend mentioned was in line with previous research conducted in other contexts: the pressure from increasing competition, tightening customer demands, and changing operating environment bringing increased costs or requiring new investments [19, 37, 38]. Making business in the trucking and logistics sector is unappealing especially for small entrepreneurs whose profit margins are slim. Solutions to make it more efficient, productive and profitable are sorely needed.

As for RQ2, the sector is crucial for Europe and therefore the actors both on the public and private side are taking action to shape these forces into drivers that guide and support the digital transformation of the trucking and logistics field, both at the level of the EU and in Finland. Previous studies have mostly discussed either in-organizational actors [19, 37] or business actors such as IT implementers [19, 37], customers [18], or competitors [27] and have had less focus on public actors. However, the role of governmental agencies and regulation in digital transformation has been noted in previous research too, see [48]. The central public actors who our interviewees saw as shaping digitalization in the Finnish trucking and logistics field can be seen to operate in three different levels: at the highest level are the EU parliament, committees, and offices, that guide and make decisions about the EU level acts, directives, and strategies. At the national level in Finland, political actors, i.e., national parliament and government, handle legislation proposals with parliament committees and ministries, and bring in the domain area expertise. The third level are the national agencies, such as Fintraffic, Traficom, and Finnish Transport Infrastructure Agency, who act as technical legislators and enablers. The key private actors are engaged with this process via two main routes: official hearings and unofficial contacts. Both are accepted, endorsed, and encouraged ways that the policy-makers rely on to collect domain expertise and get an insight to important aspects that can be small but may have a major impact on e.g., the working conditions. Here the interviewees identified actors such as industry interest groups, academia, labor unions and employee interest groups and organizations, as well as truckers and trucking companies.

Regarding RQ3, the last two actor groups are the primary means of how workers can affect the shaping of the drivers. While official hearings, typically from a representation group, are the official route, the interviewees also highlighted that even an individual trucker can have an impact, through contacting the policymakers directly, and that people indeed do that, on a regular basis. Sometimes personal contacts are even set up deliberately, e.g., by the employee interest groups, offering an "adopted trucker" for the members of the parliament. This is a direct way to influence legislation as politicians in Finland have the right to propose new laws. In addition, both Finland and the EU have a citizen's initiative for making legislative proposals for the parliament to consider. Figure

1 summarizes the forces and the actors that participate in shaping the drivers.

The main focus of the interviews was to find out if and how the interviewees see the current and forthcoming digital technologies impacting trucking logistics in technological solutions (RQ4). The unanimous answer was that digitalization has had and will have an impact, i.e., the forces and drivers manifest as technological solutions, which will impact the work practices, and digitalization is the key to tackle the challenges faced by the trucking and logistics field. Digital technology is already in use in trucks in various forms [6, 21, 23, 41] and the impact at the level of practice has already been felt, often positively. Systems such as automatic braking and monitoring driver alertness increase safety, digitalization has reduced paperwork, and navigation helps from being stuck in a traffic jam. Sometimes, however, the changes can be a bit ambivalent for the driver - for instance, advanced driver assistance systems (ADAS) and its dynamic speed assistants help to reduce the fuel consumption markedly, but it also means that the system regulates the speed, instead of the driver, and accepting this may be a question as it can change the driving experience significantly. Technologies being now brought into use include e.g., development of digital twins of traffic infrastructure, utilizing real-time data from cars on the road. Such information can further help drivers to have broad situational awareness. On the horizon the interviewees saw platooning, where a train of trucks are connected and are being controlled rather than driven, thus changing the role of the driver into something of a small fleet operator. Further beyond, there were some expectations and hopes for a system that would optimize freight operation across companies, maximizing individual loads and providing the best available equipment for each job according to its needs. This would minimize costs and emissions, but the truckers and trucking companies might lose their personal relationships with their customers, both becoming a resource pool to be allocated by some higher algorithm instead. Autonomous trucks were also mentioned by most of the interviewees, as an alternative for the future. If reality, these might then remove the job of a, or some truckers, but could also give birth to other jobs as well.

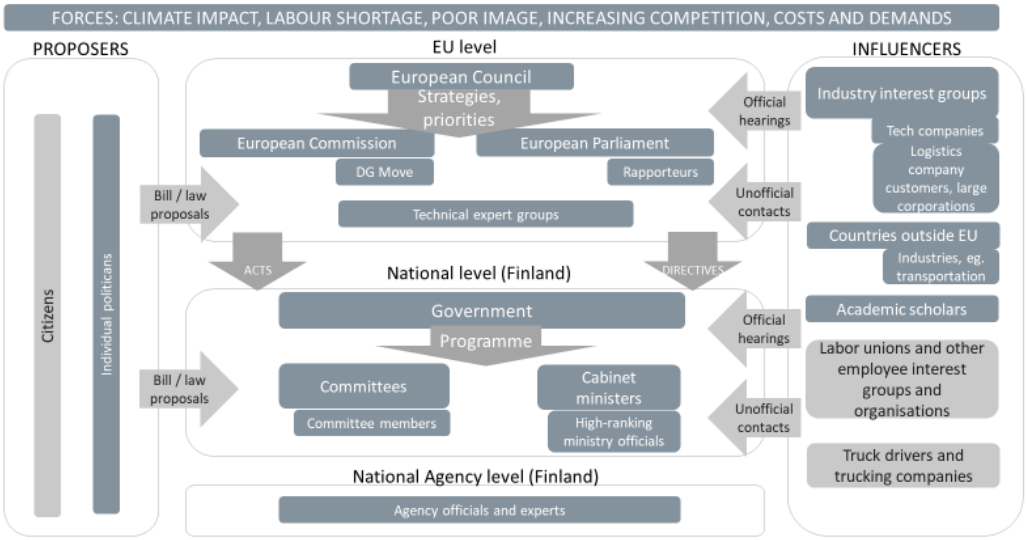

Figure 1. Shaping the drivers: Forces, actors, and how the workers can make themselves heard. The boxes and arrows with lighter shade and black text show how the workers' voice is heard at this level.

The technology will not come in with a big bang. Sometimes it can take years, even decades, for a technology to reach sufficient maturity – autonomous vehicles being an example. As the challenges grow more complex, systems get less and less self-contained and increasingly dependent on integration and support from other systems. A major component, currently often missing, is the availability of good quality data. While the technology to create e.g., a digital twin for the traffic infrastructure might already be there, the data that can fuel it for it to be reliable and useful, is not. Thus, as a result, the digitalization of trucking and logistics will be a long road, not a sprint. To speed up and support the transformation EU and national level actors are taking steps to help out. These include standardization to increase interoperability and broaden the market

opportunity, but also to ensure a level playing field for fair competition and for industries and companies to function and innovate. Regulation is being drawn to require data to be collected and made available across the EU. Finnish interviewees stated that data and services are openly available, and the preference is for the private sector to develop the end-user solutions, instead of governmental actors.

Regarding implications of the study, our findings suggest that it is reasonable to state that the field of trucking and logistics is facing a digital transformation of the entire sector, evident in the breadth of the changes needed, scope of actions ongoing, and how profound the impact will be. In fact, the transformation is already ongoing, and will only grow, as it will not be confined to a single system – the goal is more akin to a system of systems [34], that spans across companies and even across business sectors. In addition, there are clear indications that new, intelligent technologies are being looked for as a means to solve some of the burning issues. We can also already see that the changes have impacted on the level of practice, and will continue to do so, with forecasts of some tasks or jobs disappearing, and new roles and responsibilities being created, echoing the findings by [19]. Since the work of a trucker has traditionally been a blue-collar profession, the change from this to an AI-assisted worker, and towards an augmented operator [3, 38] is very much what e.g., the manufacturing industry in the main is still only envisioning about [29], making this sector a forerunner where change of this kind can be studied, and the lessons used to benefit other businesses centered around traditional labor. We feel that the field is very timely and relevant for the IS research on the 4th industrial revolution, featuring intelligent technologies in the core of digital transformation and how the change takes place at the level of practice.

Our study reveals that the field and the transformation it is going through is complex and involves technical and societal aspects that go beyond a single organization or a network of companies. While IS research has traditionally focused on systems and their adoption and impact on organizations, our research shows that a broader view could be beneficial. In the case of trucking, it is clear that the impact of digital transformation is not – and thus studies shouldn't be – confined only within organizational scope. The entire sector is extremely connected and deeply ingrained in the web of European society, on economic, functional/operational, and societal dimensions. It is clear that new information systems and the changes they bring will have an impact beyond its intended usage and outside the organization taking it into use. Combined with the nature of the intelligent technologies in the center of current industrial revolution, where issues such as trustworthiness, ethics, and acceptability are hot topics, we feel that here – if anywhere – IS research should study how to establish and deploy technical solutions so that they have a good fit to the society and its needs, not only for the users or commissioners.

To conclude, in light of this study the field of trucking and logistics is undergoing significant digitalization, worthy of being called digital transformation, not only at the level of an organization, but of the entire sector. The technologies being adopted already feature intelligent, AI-assisted, and data-driven systems, and will continue on that track, affecting traditional, blue-collar work of a trucker at the level of practice. This makes it an interesting area for IS research as the lessons here can be taken to other, less advanced sectors, hence further research on this field would be both timely and impactful.

As trucking is highly connected and ingrained in the fabric and function of the entire European society, we – in line with [31] – on the one hand recommend that IS research interested on this particular field should go beyond the organization focus and examine the impact of intelligent technologies at the level of the industry and considering structures and needs of society at large as an integral part of system requirements. On the other hand, we see it is crucial to understand how the changes reflect in the work practice level and how the work practice needs should be guiding the change, instead of being a mere object for it. This study is limited by its focus on national actors, who were chiefly decision-makers rather than those who influence the process, technology developers, organizations taking solutions into use, or practitioners themselves. Thus, we call for future research for both of these directions, for the trucking and logistics field, but also taking a similar perspective on other industries and digital transformation more generally.

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