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Driving High and Low: Heavy Vehicle Drivers and Their Supervisors Facing Digitalization[1]

Tuomo Alasoini[2]
Research Professor, Finnish Institute of Occupational Health, Finland

Arja Ala-Laurinaho
Senior Advisor, Finnish Institute of Occupational Health, Finland

Marja Känsälä
Specialized Researcher, Finnish Institute of Occupational Health, Finland

ABSTRACT

Our qualitative study in two Finnish companies examines the view presented as part of the 'employment crisis' debate that digitalization is leading to a significant substitution of the work of drivers of heavy road vehicles. The main effects of digitalization thus far on the drivers' work have been automation of individual vehicle functions, speeding up the communication among them and between them and their supervisors, and more intensive control of work performance. The study does not find support for the claim about labor substitution in the foreseeable future, but, instead, indications of a widening digital divide between drivers and supervisors, leaving drivers as bystanders in learning processes associated with digitalization. Although the results cannot be generalized without reservation to different types of companies or business and labor market environments, the findings of the trends in the drivers' work and labor market position probably have broader relevance.

KEYWORDS

Complementarity / digitalization / driver / substitution / truck / vehicle automation

Introduction

There is a long research tradition in economics and social sciences of how technology is changing jobs and, at worst, leading to massive job losses and mass unemployment in developed industrialized countries. Such an 'employment crisis' debate has taken place under raucous headlines such as 'the end of work' (Rifkin 1995), 'beyond the wage-based society' (Gorz 1999) or—more recently—'the rise of the robots' (Ford 2015) and 'a world without work' (Susskind 2020). However, in reality, the effects of technological change in work and employment have been more diverse than these overarching headlines suggest, manifesting in different ways in different institutional contexts and in different industries and their typical jobs.

The Nordic countries have not typically been at the heart of such a debate. The Nordic labor market institutions have been identified as having qualities that help them

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[2] Corresponding author: Tuomo Alasoini, E-mail: tuomo.alasoini@ttl.fi

face changes in a resilient way. Such 'Nordic traits' (Hasle & Sørensen 2013) have been discussed with reference to the countries' 'constructivist capacity' (Gustavsen 2011), high incidence of 'learning-oriented forms of work organization' (Gustavsen 2007), or 'particular form of social citizenship' (Kettunen 2012) or their nature as 'enabling welfare states' (Kristensen 2011). The importance of these special features as a strength of the Nordic labor market institutions has, at least for the time being, also helped the Nordic countries cope with the digitization of work in a reasonably successful way (Rolandsson 2020).

However, there are also sectors and jobs where such protective mechanisms seem to be less effective in the current technological transformation, such as platform work (Jesnes & Oppegaard 2020), as well as jobs located in sectors where significant infrastructure-level transitions due to digitalization are expected to occur. One of the sectors where digitalization is expected to have profound effects on jobs throughout the world is transportation and logistics.

A report by PwC (2018), estimates that up to 52% of the current jobs in transport and storage are at a high risk of automation by 2037. This is a larger share than in any other industry. In a similar vein, a digitalization report by McKinsey & Company (2017) states that for jobs in transportation, the automation potential through deploying *already available* technology is higher than in any other industry. Frey and Osborne (2017) also state that most workers in transportation and logistics occupations will face the 'first wave of computerization' in which many jobs are automated by means of computer-controlled equipment. According to them, the automation of typical blue-collar occupations in transportation and logistics is a result of the development of computerized cars and the declining costs of sensors that make augmenting vehicles with advanced sensors increasingly cost-effective. It is estimated that in the USA alone, the jobs of nearly two million truck drivers and 800,000 delivery truck drivers are endangered due to the advancement of robotic vehicles (Wasik 2019). Increasing automation can also be expected to lead to a similar development, albeit probably at a slower pace, for drivers of other types of road vehicles.

However, not all researchers share these grim predictions. According to Autor and his colleagues (2019), the highly disruptive predictions for workers caused by autonomous vehicles and machine learning enabled robots reflect the 'industrial heritage of Detroit' and the 'millennial optimism of Silicon Valley' rather than down-to-earth realities. Gittleman and Monaco (2020) point out based on US data that such predictions start out with a too simple view on both the thresholds for vehicle automation and the actual content of drivers' jobs. Given the forecasts that transportation and logistics workers are among the first to face the new wave of computerization, it is worth noting that a global shortage of truck drivers has persisted now for 15 years (Dempsey et al. 2021). It also seems that the number of truck drivers has developed rather sporadically and in different directions in different countries in recent years, likely reflecting the impact of contextual or other intermediating factors. For example, within the Nordic countries, at the same time as the number of heavy truck and bus drivers (Minor Group 833 in the ILO's ISCO-08 occupational classification) fell clearly in Denmark and Sweden in the first part of the 2010s, it rose slightly in Norway and quite significantly in Finland (Berglund et al. 2020).

Contrasting these two opposing views—the 'employment crisis' view based on the belief in massive labor substitution and a more cautious view of incremental change—this paper examines the changing technological context of the work of drivers of heavy road vehicles and their supervisors in two Finnish companies. The paper concerns to what extent digitalization manifests as an aspect of (forthcoming) substitution versus complementarity of the work of drivers and supervisors. The paper looks at the kinds of information systems and digital applications they use, and in terms of skills requirements, learning opportunities, and means of control, it examines the new elements the systems and applications have introduced into their work. Finally, the paper asks to what extent drivers and supervisors have been able to influence the design and the way of use of their new digital applications at work.

The paper starts with an elaboration of the research question and research tasks and the underlying theoretical discussions. This is followed by a description of the research methods and data. Thereafter, the research findings are presented. Finally, the findings and limitations are discussed, and conclusions are drawn.

Theoretical Foundations, Research Question, and Research Tasks

The general research interest of this paper stems from a public debate, which has been dominated in recent years by analyses in which the effects of digitalization on jobs, employment, and work content are often unilaterally derived from advances in digital technology, such as artificial intelligence (AI), robotics, the Internet of Things, or virtual/augmented reality. At the same time, these views of analyses (e.g., Baldwin 2019; Brynjolfsson & McAfee 2014; Ford 2015; Frey & Osborne 2017; Schwab 2016; Susskind 2020) on the economic, social, cultural, and institutional conditions that shape the actual changes in working life have been on a weaker footing. Many of them contain radical claims for the transformation of work or substitution of labor because of digitalization, albeit 'lacking in sufficient analysis and evidence' (Upchurch 2018, p. 215). Alongside such analyses and their dominant role in the public debate, the role of actual industry-level and workplace-level sociological studies in the debate has remained minor. However, as many studies over the years have shown, there is always leeway in how technologies can be applied in different industry and workplace contexts (e.g., Altmann et al. 1992; Briken et al. 2017; Moore & Woodcock 2021; Zuboff 1988). The processes of task restructuring that follow are not technologically determined but are basically socially constructed and shaped processes, reflecting managerial considerations, industry and workplace cultures, and power relations between management and labor. To form a realistic picture of the impact of digitalization on work and employment, targeted empirical studies that help to understand both the specific technological and *non*technological mechanisms characteristic of different industry and workplace contexts are needed.

The paper looks at changes in the work of drivers and their supervisors, drawing on three types of theoretical discussions, on which the research question and research tasks are also based.

The *first* discussion concerns the level at which changes in work and employment due to technological change should be analyzed. There are strong grounds for the analysis to focus on the level of tasks involved in individual jobs rather than on the level of jobs as such (Arntz et al. 2017; Bisello et al. 2019; Holm & Lorenz 2021). This argument can be substantiated by invoking an analysis conducted by McKinsey. McKinsey estimates with the help of comprehensive data on the US labor market that while it is possible to automate as much as 45% of the *work tasks* currently being done by humans in the country, less than 5% of current *jobs* could be totally automated with the existing technology (Manyika et al. 2017).

The distinction between 'job' and 'task' is also the starting point in the well-known ALM hypothesis, named after Autor, Levy, and Murnane (2003), on how the use of computers alters skill demands. According to the hypothesis, the use of computers impacts tasks in two alternative ways—substitution or complementarity—depending on the nature of the task. Both routine manual tasks and routine analytic and interactive tasks for which the rules are sufficiently well understood to be specified in computer code will face substantial substitution. Instead, nonroutine analytic and interactive tasks for which this is not possible will gain strong complementarities that help those working in such tasks to further specialize in their area of comparative advantage. For the rest, that is, those working in nonroutine manual tasks, opportunities for either substitution or complementarity are limited.

The ALM hypothesis has since gained popularity as a basis for many empirical analyses of changes in occupational structure (Asplund et al. 2011; Goos & Manning 2007; Mazzolari & Ragusa 2013). At the same time, its view of what is possible with computers has been recently criticized as obsolete. Susskind (2020) argues that the hypothesis could not anticipate the latest advances in the development of AI in which new technologies are increasingly penetrating the area of tacit knowledge, once considered exclusively a human domain sheltered from machines. Susskind thinks that the distinction between routine *versus* nonroutine tasks is still useful, but new technologies are shifting the boundary between the two. The same message is echoed by Frey and Osborne (2017), who argue that computerization can in the future be extended to any nonroutine tasks that are not subject to engineering bottlenecks. While Autor and his colleagues (2003) mention truck driving as an example of nonroutine manual tasks that do not lend themselves easily to either substitution or complementarity, Frey and Osborne (2017) rank heavy and tractor-trailer truck drivers (SOC code 53-3032) as one the occupations in the USA with a high (79%) probability of automation over the next 20 years. For drivers of many other kinds of road vehicles, their forecast is equally inconsolable.

The fact that changes in work and employment due to technological development should be studied at the level of tasks leads us to the *second* research discussion this paper draws on. As automation mainly advances at the level of tasks rather than at the level of complete jobs, a leeway for redesigning work opens. Digital technology creates new opportunities for both job upgradation in the form of more versatile and skills-enhancing work content and job degradation in the form of increasingly standardized and fragmented content (Agrawal et al. 2018; Daugherty & Wilson 2018). The choice between these two alternatives is not basically determined by the technology in question, but for the most part, it is socially constructed and shaped (Bijker et al. 1987; MacKenzie & Wajcman 1985; Moore & Woodcock 2021; Zuboff 1988). From the perspective of this paper, the key question is how companies, in practice, act and what kinds of assumptions and managerial logics affect their decision-making.

Frey and Osborne (2017) state that engineering bottlenecks to computerization can in some cases be alleviated by the simplification of tasks. In their view, the speed and extent of computerization over the next years will partly depend on innovative approaches to task restructuring. In recent years, special management techniques have been developed for redesigning jobs to better apply automation to work. For example, a four-step approach by Jesuthasan and Boudreau (2018) includes a process model where jobs are first divided into individual tasks. The automation potential of tasks can be assessed based on whether the task is regularly recurring or variable, whether its implementation requires interaction with other people and whether it is primarily physical or mental. In the second phase, an analysis of the value of the performance of the task for strategic value creation by the organization is conducted. The analysis helps to form an idea of what options there are for designing the division of tasks between man and machine (third step). Finally, a new functional entity consisting of humans and machines will be designed based on the chosen option. As the authors demonstrate, the process model shows that the different stages involve significant organizational leeway that is only partially technology dependent.

The *third* discussion underlying the research question revolves around the digital divides. The concept of the digital divide has been used in the research literature to refer to the differences in access to digital applications (first-level divide), the usage of digital applications (second-level divide), or the outcomes of usage for people (third-level divide) (Ragnedda & Muschert 2018). Digital divides in workplace contexts are not randomly distributed among employees. A study among Finnish employees shows that the diversity of the use of digital applications at work is linked to many socio-economic background factors (Tuomivaara & Alasoini 2020). According to the study, blue-collar workers typically use fewer digital applications at work than white-collar workers in both managerial and non-managerial positions. The use among blue-collar workers is also more routine-like, permitting fewer opportunities for learning and skills development.

The results of the above study are in line with the mechanisms presented in previous research debates on the digital divide. The three mechanisms distinguished in the following underlie the paper's research question concerning the drivers' and supervisors' opportunities to influence the design and use of their digital applications at work and how they learn to use them. According to the first mechanism, there exists a positive link between a person's corresponding fields of resources (economic, cultural, social, and personal) in offline and digital contexts. In other words, specific areas of social and digital exclusion/inclusion influence each other (Helsper 2012). The second mechanism concerns the connection between different digital resources, proposing that a person who lacks digital resources in one field also lacks digital resources in another field. The third mechanism concerns the connection between different types of the digital divide. A person who is in danger of falling into one of the divides is in danger of falling into another. In more concrete terms, those who have poor access to digital applications at or outside work probably also lag behind in the development of digital skills, use digital applications in a more routine-like manner, and are not able to benefit from use in the same way as those with better access or higher skills (Van Deursen et al. 2017).

The research question is derived from the three above theoretical discussions. The research question is to what extent indications of predicted job automation and labor substitution can be found in the drivers' work or whether indications of alternative development, where technology is rather complementary and augments the work of drivers, can be found. This overall question is viewed from two directions. The first relates to the discussion on task restructuring, and the latter relates to the discussion on the digital divides and the digital resources of workers. The work of supervisors forms a mirror point for changes in the work of drivers through analysis

The research tasks are as follows. *First*, the paper examines how new information systems and digital applications have affected the skills requirements and learning opportunities of drivers and supervisors, and the means of managerial control of their work and to what extent this has been accompanied by deliberate attempts at task restructuring. *Second*, the paper explores the role of drivers and supervisors in influencing the design and way of use of their digital applications at work.

Methods and Data

The data are based on 14 semistructured interviews that were conducted in two Finnish companies between March and May 2021 as part of a research project funded by Finnish Work Environment Fund, which studied the digital divides among employees. The results of a survey analysis that was conducted in the first phase of the project (Tuomivaara & Alasoini 2020) were supplemented with interviews focused on specific types of sectors and jobs to form a richer understanding of the workplace-level mechanisms leading to the digital divides. It was already decided at the start of the project that a qualitative research approach was best suited to investigating the reasons why certain types of employees had fallen or were in danger of falling into the digital divides. Based on the survey analysis, drivers of heavy vehicles were selected for the interviews as an example of an occupational group, where the use of digital applications was supposed to be typically routine-like, thus constituting a potential risk factor for the long-term employability of workers facing digitalization.

The interviews were spread over two companies, showcasing different types of blue-collar jobs that involve driving heavy road vehicles. Company A has long roots in history as part of the public road and waterway construction administration. Today, the company belongs to a large international group with a staff of over 1000 employees around Finland, and the company is exposed to open competition with other earthworks contractors over road maintenance contracts. Road maintenance covers the maintenance of streets, paved roads, gravel roads, and the traffic environment. Typical blue-collar jobs in road maintenance are formally included within ISCO-08 Minor Group 834 'mobile plant operators'. However, because the main content of the job is driving a vehicle (in most cases a truck), we call them 'drivers' and not 'operators' throughout the paper. Company B operates in waste collection and transport, employing nearly 300 drivers in 14 locations in different parts of Finland. The company was established in the early 2000s and is now part of a major international enterprise group. Here, the jobs of blue-collar workers are included within Minor Group 833 and its subcategory 'heavy truck and lorry drivers'.

The group of interviewees comprised six drivers, six supervisors, and two middle managers. Two of the interviewees also served as shop stewards. Supervisors had comprehensive knowledge, in addition to digital applications used in their own work, of all the digital applications used by drivers. The interviewed supervisors had long work experience, and some of them also had personal experience driving heavy vehicles. The interviews of the two middle managers in both companies differed from the other interviews in that they were conducted in two parts. In the first part, an interview lasting half an hour was conducted before other interviews and was intended to provide an overview of the information systems used and to gain agreement on practical arrangements. The second part, lasting an hour and conducted after all other interviews, focused on commenting and reflecting on the findings made by the researchers.

The middle managers acted as liaisons for the researchers in the companies. For our interviews, these middle managers selected the supervisors who had worked in the companies for a relatively long time and who had a good knowledge of the companies' technological infrastructure. The supervisors, in turn, selected the drivers to be interviewed. The researchers wished to interview both relatively young and experienced drivers employed in the most typical positions in the companies. Using age as a selection criterion was based on the results of the survey analysis (Tuomivaara & Alasoini 2020), according to which age was associated with the level of digital skills among blue-collar workers.

One member of the research team conducted all interviews in Company A, and another in Company B. Both researchers also participated in the first interviews in both companies. All three members of the research team participated in the interviews with the middle managers. Following the same basic protocol, the interviews in Company A lasted from 60 to 92 minutes, and in Company B lasted from 34 to 96 minutes. All interviews were conducted either during normal working hours or immediately after the end of the work shift, via video meeting (or phone, for three drivers) due to the limitations caused by the coronavirus epidemic. The interviews were recorded and transcribed with the permission of the interviewees and were conducted as a whole in accordance with the ethical procedures approved by the research ethical group of Finnish Institute of Occupational Health.

The interview guide was developed based on the three above-mentioned strands of research literature. The goal of the interviews was to deepen the understanding of the extent and nature of the use of digital applications by drivers and supervisors, how digitalization has affected their work, and how they had participated in the processes of change. The main themes of the interviews were materialized accordingly, focusing on changes in job contents, skills requirements, learning opportunities, and well-being at work and prospects for their work. As a methodological analysis tool, we used qualitative content analysis (White & Marsh 2006). Content analysis is 'a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns' (Hsieh & Shannon 2005, p. 1278). This proved to be an appropriate method to extract the themes of interest in this analysis from the data.

The first round of analysis was both theory-informed and data-driven. As a theoretical inspiration, we used our interview guide and the framework of three types of digital divides (Ragnedda & Muschert 2018). As a combination of this theoretical inspiration and inductive data analysis, the following themes of analysis were formed: the use of digital devices; digital infrastructure and accessibility; training, support and orientating a new worker; the management and use of digital information; competence in technology-mediated interaction; participation in developing digital devices; the impact of digitalization on the outlook of one's work; and well-being at work and management of digital strain. The results of this part of the analysis were discussed with the contact person of each company to verify the results. In the second phase, understanding of the data was deepened by analyzing the following theory-informed and data-driven themes: the problems and solutions related to the use of digital devices, participation in the development of digital devices, and orientation toward digitalization. This part of analysis was conducted with the help of the ATLAS.ti 9 software.

After analyzing the interviews, the researchers organized a 3-hour development workshop in September 2021 to which all interviewees were invited. The theme of the workshop was digital opportunities for employees. Discussions in the workshop and its various groups were also recorded with the consent of the participants and transcribed. The workshop materials have been used in this article as a supplement to the interview data and the interpretations based on it.

Findings

Technological Change

The deployment of digital applications already touches upon virtually all operations linked with the work of the drivers in Company A. Information systems and digital devices are used to monitor (e.g., fixed road condition cameras and measurement equipment) and predict (e.g., radars and satellites) the weather; to direct and monitor vehicle locations, working hours and the progress of work tasks on a real-time basis; and to exchange information between and among supervisors and drivers on different work-related issues. For vehicles (trucks or other heavy vehicles such as graders), there are also an increasing number of digital applications that transmit data (e.g., cameras and measuring devices connected to the internet and equipped with AI capabilities) and assist and guide the drivers in certain operations, for example, snow ploughing, salt spreading, road grading, or driving on slippery roads. Besides the company's own systems, the company is connected to the Weather Institute's weather forecasting systems as well as the subscribers' information systems where the road maintenance measures taken are reported in real time.

Supervisors are ahead of drivers in the variety of digital applications and devices used. The most versatile and intensive use among supervisors is demonstrated by the company's road weather maintenance center supervisors, whose jobs can be described as skilled, networked and specialized knowledge work. The center operates on a 24/7 basis, making decisions, implementing control measures, and issuing alerts for the whole country in accordance with varying weather conditions, based on a large amount of digital data from different sources and assisted by advanced machine learning algorithms. With digitalization and the company's increased exposure to open competition, this activity has also faced streamlining; at most, there were a total of nine centers across the country.

The work of supervisors dealing with maintenance tasks and construction contracts is more traditional, including administrative tasks and supervising the work of drivers. Most of the communication between supervisors and drivers on the road or in the field today takes place via a smartphone or a tablet. In many ways, mobile devices and their diversified features have revolutionized the ability for communication for both parties. While the supervisors' communication with drivers has become easier, the supervisors' work has increasingly focused on administrative tasks that have been transferred to them from the company's support services units.

The most important digital application to which drivers in Company A are connected via smartphones is the working time and activity monitoring system. The driver is connected to the system throughout his/her shift, reporting to it the progress of his/her daily tasks. The system can also be used for assigning tasks to drivers, but in practice, with drivers, supervisors prefer more personal forms of communication, such as making phone calls or sending WhatsApp messages. The system is integrated with many activities, including payroll, material storage and customer reporting.

The spectrum of the drivers' tasks in Company B is narrower, which is also reflected in the number and nature of digital applications used. Supervisors operate quite independently at various offices around the country. They plan and optimize driving routes for waste collection, perform logistic contract calculations, deal with customer requests and complaints, monitor and control the progress of the work of drivers, and solve problem situations reported by drivers. Problem situations typically relate to vehicles, driving routes, emptying of waste bins, customer complaints, or the operation of digital devices or information systems. Most of the work of supervisors today in Company B is done using digital technology.

The most significant change in the work of supervisors and drivers in recent years has been the transition of information on the driving routes, address lists, and site-specific tasks from paper to digital form. Drivers now have access to this information via a tablet that is in the truck and connected to the company's driving control system. In different parts of the country, there are different systems that are tailored to the specific needs of the subscribers. However, all systems operate on roughly the same principle. One of the systems also includes hourly tracking, which is used by drivers nationwide. Drivers log in to the system at the beginning of the shift and record the work they have done. They are not tied to the driving order given by the system, but deviations are made difficult in practice by their performance-based pay system. Daily driving routes and to-do lists are updated for drivers in the system the previous night.

As in Company A, supervisors are ahead of drivers in the variety of digital applications used. The use of digital applications and devices among drivers is limited to the driving control system(s), the automation contained in the trucks, and mobile devices for sending and receiving WhatsApp and other messages, including photos of problem areas or situations. Supervisors in Company B today strive to use WhatsApp extensively as a channel for all kinds of information.

Digital Skills Development, Learning, and Control of Work

The tasks of drivers in Company A are quite repetitive and standardized. The driving routes are typically familiar to drivers, and their road maintenance duties mainly include certain repeating routines, at least in normal weather conditions. However, depending on the season, the tasks are weighted differently, ranging from snow ploughing, road sanding, and salt spreading in the cold seasons to spring-time road brushing, bridge washing, earth moving, road grading, or putting gravel on dirt roads in other seasons. The variation in daily routines is also brought about by varying weather conditions. Under Finnish conditions, especially difficult winter and autumn weather with rain and snowfall or cold temperatures brings an additional challenge to work and the need for initiative and flexibility.

Despite the repetitive and standardized nature of the drivers' tasks and the fact that the progress of their work can be constantly monitored via the information system, drivers have much independence in their actual work performances. Despite the increased computerization of vehicles, drivers still have a key decision-making power in their operations. They are also responsible for the general safety of road use on their own routes and for the condition and safe movement of their heavy and expensive vehicles among other traffic.

For the drivers in Company A, the introduction of the working time and activity monitoring system was not so much considered as an intensified control of work. Reporting via the system has partly replaced previous forms of control, reducing the need for drivers to make visits to the office. In the interviews, together with the windscreen cameras of the trucks, the monitoring system was considered by drivers a factor increasing their occupational safety and supporting their position in road accidents or disputes with subscribers or other road users.

Using the working time and activity monitoring system does not require drivers to undergo special training beyond a basic familiarization. The introduction of the system and the fact that the driver is required to make entries in it has brought an element of knowledge work to the job, but otherwise digital applications have not upgraded or diversified their work. Drivers typically seek support from supervisors for problems with the use of information systems or digital devices. The company has its own digital learning environment, where it is possible for all staff to complete ICT courses independently and improve their digital skills. However, drivers have not had the same motivation and underlying need stemming from the requirements of their work as white-collar employees have had for this learning. The drivers' work itself, which mainly takes place on the road, also acts as a practical obstacle to the improvement in digital skills through course-mode training, at least during normal working hours.

Despite the increased automation of functions in vehicles, compared to supervisors, the drivers in Company A have been bystanders in digitalization, with no visible indication of job augmentation or a continuous need for updating digital skills. Moreover, digitalization thus far has not posed a direct threat to their employment. In none of the interviews conducted in Company A were autonomous vehicles in which a person would not act as the actual driver seen as realistic in the foreseeable future. More realistic prospects for the future, according to the interviews, were fleet algorithmic guidance triggered by detections transmitted via radar or road condition cameras or an increasing number of automatic auxiliary functions in vehicles controlled by AI. For example, with the help of computer-controlled salt spreading, the amount of road salt harmful to the environment could be reduced. At the same time, increasing the automation of such tasks can in the long run simplify the drivers' jobs and lead to a reduction in skills requirements.

Much of what was described above also fits the description of the drivers' work in Company B. The work of drivers in Company B is quite repetitive and standardized by content, and driving routes are typically familiar to them. Much of the same routes and similar tasks along them are repeated within certain time cycles, ranging from a day to a few weeks depending on the type of waste to be collected and the residential area. Different types of waste also require the use of somewhat different kinds of vehicles and skills. However, the content of the tasks in Company B does not vary in the same way as it does for drivers in Company A according to the seasons or weather conditions, nor do drivers in Company B face a similar need for flexibility due to the rapid variation of weather conditions or other exceptional situations in road transport.

Garbage truck drivers have a fixed time frame in which they should be able to drive the routes assigned to them. How well they achieve their time target directly affects their pay. Drivers have little influence on the achievement of the time target by driving faster, as they often operate in (semi-)urban environments where speed limits are low and the distance between waste points is short. Vehicles also have speed and fuel consumption monitoring devices. In practice, the efficiency of work comes 'from whether you want to crawl, walk, or run' while emptying the waste bins, as one of the supervisors described it. However, supervisors do not usually intervene in how drivers perform their duties, at what stage they take breaks, or in what order they drive their routes. In some cases, more than one vehicle crew may be collectively responsible for a particular route, permitting crews to agree on their mutual division of labor.

The work of drivers in Company B is subject to dual control, on the one hand, direct technological control via the Driving Control System(s), and, on the other hand, indirect control through wage-bound efficiency standards. As the company periodically competes for each contract, the importance of cost-effectiveness as a competitive factor is emphasized. Supervisors closely monitor the performance of each driven area and address situations where drivers have difficulty reaching target times, by either seeking to directly influence the drivers' work habits, changing drivers, or, if necessary, changing the basics of a contract's calculation. Due to differences in the business environment, the work of drivers in Company B is under more detailed surveillance than in Company A.

Drivers in Company B typically face two types of problems in their work. Problems in the physical execution of work—such as problems related to vehicles, routes, or emptying waste bins—are highlighted among young, more inexperienced drivers. The occurrence of these types of problems is fueled by the high turnover among drivers, which is due to the high physical load of the job and its low status and level of pay. Tight competition between companies for contracts keeps wages low and has led to recruitment problems in some regions. Problems with digital tools are another major type of problem for drivers. Many drivers have low basic training and no experience in the versatile use of digital applications, a problem that is highlighted, in contrast to the above, among older drivers. Supervisors play a key role in solving both types of problems.

The work of drivers in Company B is narrower in content, more closely supervised and includes more physically demanding tasks than in Company A. Despite the differences, digitalization has affected the jobs at both companies in much the same way. In recent years, more development opportunities for the jobs in Company B have been brought about by more precise sorting of waste and the general increase in the importance of environmental responsibility rather than by the introduction of new digital applications. In interviews, job displacement through automation like autonomous vehicles or robots for emptying waste bins was not considered realistic for the foreseeable future, at least in existing residential areas. Large-scale automation of waste collection would require a significant rethinking of the technological infrastructure of transport and house building. According to the interviews, a more realistic vision of how digitalization will affect the drivers' work in the coming years is piecemeal improvement in vehicle automation and existing digital applications.

Employee Influence on Digital Applications

Except a few appointed, technologically oriented supervisors with high digital skills, the opportunities for employees to influence the development of their digital applications are limited in both companies. Both companies are partly tied to the information systems of their subscribers as well as to the hardware and software that is available on the market, which are aspects that further limit the employees' ability to influence.

Company A has been involved in much development and experimentation with digital applications in collaboration with its public subscribers, with the aim of providing new tools for assessing the condition of roads and road infrastructure (e.g., traffic signs, railings, bridges, and wells) and communicating this. The company regularly conducts feedback surveys via email about the functionality of the company's internal applications, and these surveys are also addressed to drivers. Drivers can also provide feedback directly through supervisors. Supervisors also typically give information to drivers about the changes made to the applications.

In Company B, the role of drivers in influencing their digital applications is mainly limited to reporting errors on maps. Announcements regarding errors are made either to supervisors or directly to their subscriber's contact person. In general, supervisors also play a key middleman role in Company B in passing on the drivers' feedback on their digital applications.

Given the limited influence of drivers, it is not surprising that drivers in both companies viewed technological change in quite deterministic terms. They took their information systems and digital tools largely as given, feeling that they did not have much opportunity to influence them. The applications that were still in an experimental phase represented a partial exception to this. Feedback of their functionality and usability is in some cases specifically sought from drivers before the wider deployment of such applications.

However, and despite their technology-determined viewpoint, the drivers' attitudes toward digitalization at their work were largely neutral, if not mostly positive. Although digitalization allowed for more detailed control of work, brought more 'click work', and comprised applications drivers had little opportunity to influence, the drivers felt that digitalization had made their job easier. This manifested in particular as an opportunity for faster communication, but in some cases, was also demonstrated in the reduction of workload, improved occupational safety and better legal security, especially in disputes with subscribers or customers. None of the interviewees felt that digitalization would be a threat to the drivers' employment in the foreseeable future.

Discussion

Amara's law, named after futurist Roy Amara, states that we tend to overestimate the effect of a technology in the short run and that we underestimate the effect in the long run. It is possible to also read our findings in the context of this law. Unlike studies, which examine the substitutability of the drivers' work mainly against the increasing computerization of vehicles and the subsequent automation of vehicle functions (e.g., Frey & Osborne 2017), we take a broader view and assess the possibility of change and substitution against the transformation of the entire traffic and transport infrastructure.

Transport and road traffic can be conceptualized from a broader perspective as one of the key sociotechnical regimes in a society (Geels & Schot 2007; Weber & Rohracher 2012). Such regimes fulfil certain societal needs and are guided by a dominant logic that is embodied in established daily practices, routines, and behaviors; perceptions, mental models, and values; and institutional, physical, and economic structures. Fully fledged transitions of regimes are long, complex, and dynamic processes. Regimes change through the interaction between the pressure arising from new niche innovations that deviate from mainstream practices adopted by regimes, the external tension that changes in the operational environment bring to bear on existing regimes, and the stress within regimes themselves due to internal misalignments among their elements.

Thus, changes in the work of drivers of heavy vehicles are driven not only by the computerization of vehicles and the automation of their functions but also, more broadly, by the transformation of the entire traffic and transport infrastructure. Referring to Amara's law, we are probably still at a stage where the predictions of a radical displacement of drivers (Frey & Osborne 2017; McKinsey & Company 2017; PwC 2018) are overestimated. Of course, digitalization has already affected the work of drivers in many ways. Advanced information systems monitor and control the vehicles' movements and the drivers' actions, drivers communicate with each other and with supervisors via digital devices, and there are an increasing number of automation and computer-controlled functions in vehicles. Despite this, drivers have comprised a type of bystanders in digitalization compared to their supervisors. Within the meaning of the ALM hypothesis (Autor et al. 2003), digitalization has not led to a significant augmentation of the drivers' work by helping them further specialize in their area of comparative advantage. Neither has digitalization thus far led to a significant substitution of the drivers' work. The latter argument does not mean that technology has not already replaced some of the core competencies of drivers. This was particularly the case in Company A; for example, regulating the amount of salt to be spread to a slippery road or the height and shape of grading a road surface is now a fully computer-controlled operation. However, there is still a long way to go from these steps in the automation of vehicle functions to a real possibility of substitution.

A more worrying line of development for drivers than substitutability is the growing digital divide between drivers and supervisors. In many manual tasks, it has been a common practice that supervisors rise from the ranks of skilled blue-collar workers. However, in both companies, the tasks of supervisors have become increasingly focused on administrative work that requires diverse digital skills, while the core content of the drivers' work has not changed much with digitalization. This is also reflected in the differences between drivers and supervisors in the learning requirements due to digitalization. Thus, in both companies, digitalization would appear to have raised the threshold for drivers to advance from blue-collar workers to supervisors.

Digitalization and the increased use of computers have often been seen as leading to a blurring of the boundaries between traditional blue-collar and (lower) white-collar occupations. Examples of this development can be found, among others, in high-tech industrial and logistics environments, where with the advent of computer use, the work of many blue-collar workers has become increasingly knowledge-based (e.g., Daugherty & Wilson 2018; Davis & Mathew 2019; Gekara & Nguyen 2018; Rolandsson, 2020; Zuboff 1988). However, our empirical data for heavy vehicle drivers and their supervisors point in the opposite direction and are more in line with the results of Thun and her colleagues (2019) conducted in Norwegian manufacturing companies. A comparison between operators and production managers in technologically advanced manufacturing companies showed that production managers reported greater availability of digital tools and more extensive use of digital systems than operators, leading the authors to conclude that 'digitalization and ICT systems based on Industry 4.0 visions are designed by and intended more for management than for operators' (ibid., 51).

Our result can be interpreted through two different frameworks. The first of these relates to the extent to which digitalization has affected the core tasks of the jobs. Unlike highly automated industrial work and despite the increased automation of trucks and the new information systems and digital devices used by drivers, the drivers' work is still essentially manual, the core of which is the act of driving a vehicle (supplemented with certain driving-related or other task-specific auxiliary functions, such as road-sweeping or snow-cleaning tasks in Company A or waste collection tasks in Company B). Another frame of reference is the debate on the digital divide and the mechanisms that lead to such divide or that help to explain the existence of such divide (see above). Our results are in line with findings that offline and digital contexts are intertwined and that the digital world often reproduces or even amplifies inequalities already existing in the offline world (Helsper 2012). The drivers' situation can also be interpreted in light of another mechanism deriving from the debate on the digital divide, that is, the sequential digital exclusion hypothesis (Van Deursen et al. 2017). Applied to the drivers, the hypothesis states that the drivers' low digital skills and low incentive to develop such skills foster routine-like use of digital applications and, further, limit their opportunities to benefit from digitalization.

The difference between drivers and supervisors in the use of digital applications is probably not a special case, but one example of a more general trend of a widening digital divide in many sectors between typical blue-collar and white-collar occupations. According to our statistically representative survey, the division of blue-collar and white-collar workers is the most important factor in determining whether an employee uses digital applications in his/her work. Blue-collar employees who use digital applications at all—such as the drivers we studied—also use fewer applications than white-collar employees on average, and their use accounts for a smaller share of working time (Tuomivaara & Alasoini 2020).

Instead of the deterministic 'employment crisis' debate presented at the beginning of the paper, the more relevant topic of discussion would be the inequalities created by the differentiated use of digital applications among employees. Although many employees who use digital applications sparingly or routinely in their work can cope with their current tasks with their current skills, but, at the same time, they threaten to remain on the perimeter of digitalization in accumulating their own digital skills, augmenting their work, or sharing the benefits of digitalization. It is not realistic to think that for many blue-collar employees, the use and learning of digital applications outside working hours could compensate for the low level of use and learning at work. For example, in Finland, population-level data show that amount and diversity of the use of ICTs are negatively correlated with the level of education and earnings (SVT 2020).

This poses major challenges, not yet sufficiently discussed, for the Nordic labor market institutions, including the trade unions. The Nordic policy approaches for those facing restructuring have included the provision of both safety nets to even out risks in working life changes and resources for mobilization as a springboard (Dølvik & Steen 2018;

Kristensen 2011). To bring about a 'springboard effect' also for those who threaten to remain on the periphery of the digitalization of work, three types of means are conceivable.

First, it is possible to compensate for the lack or scarcity of on-the-job learning by supporting employees' non-work accumulation of digital skills. Examples include providing and organizing easily accessible and customizable online courses, study circles, digital support services, training vouchers, or personal training accounts. Here, improving citizens' digital skills in general should be seen as a strategic goal of governments to promote both national competitiveness and democracy and digital equality among citizens. Another way is to encourage employers to also proactively improve the digital skills of employees who do not necessarily need such skills (yet?) in their own jobs to meet the 'digital double exclusion'. The concept 'digital double exclusion' refers to the fact that the part of the personnel that already has the weakest position in the labor market also typically has the weakest access to employer-paid training to improve their digital skills (World Economic Forum 2018, pp. 13–14). This is understandable in the sense that many digital skills are generic and not employer-specific skills that would bind employees more closely to the employer. Indeed, encouraging employers to proactively support the development of digital skills for the disadvantaged requires finding ways to share the costs of development between the employer and society. The third way is to reorganize work so that it consciously incorporates a more diverse use of digital applications for a greater number of employees. There is a strong case for the fact that the greatest benefits of digitalization do not come from the automation or incremental redesign of existing tasks but rethinking the whole architecture of work. For example, the above-mentioned methods for task-level restructuring of jobs (Frey & Osborne 2017; Jesuthasan & Boudreau 2018) could also be used consciously in the workplace to improve the quality of work and strengthen the future digital and other skills of employees on a broad front. All three of the above are means through which the Nordic labor market institutions, based on the consent of and dialogue between employers and trade unions, could well seek to contribute to, given their long tradition of cooperation.

We found the semistructured interviews and qualitative content analysis as suitable methodologies to study our research question. Interviews as a research method, compared to observations for example, are limited to accounts shared by the interviewees, telling us about their own perceptions of using digital devices. The combination of theory-informed and data-driven approach in the analysis also worked well, allowing us also to deal with potentially unexcepted findings in a flexible way.

Our findings are limited by the fact that the number of interviewees was relatively small and that they focused on only two firms, both of which have specific roles for drivers. In the debate on autonomous vehicles and the automation of truck traffic, the focus has been on long-haul trucking. In long-haul trucking, the future potential for automation is likely to be greater than in other kinds of trucking, but as Gittleman and Monaco (2020) point out based on US data, only a minority of truck drivers work in this type of trucking. The biggest obstacles to automation are typically the 'last mile' of trucking and the great number of the drivers' nondriving tasks, many of which do not lend easily to automation. Due to the diversity of the jobs of drivers, the possibilities for automating jobs and the involved tasks probably differ in companies operating heavy trucks or other heavy road vehicles for different purposes. This means that our results cannot be generalized without reservation to the work of drivers in very different types of companies or operating in different types of business and labor market environments. However, it can be assumed that many of our findings on the trends in the drivers' work, the drivers' attitudes toward digitalization and changes in their jobs, and the different statuses of drivers and their supervisors in relation to digitalization also have broader relevance especially in the Nordic labor market context.

Conclusion

Driving a heavy truck is an occupation whose position in the labor market is considered to be particularly affected by smart digital technology. While Autor and his colleagues (2003) classify truck drivers as nonroutine manual laborers whose jobs do not offer much opportunity for either substitution or complementarity, some other authors (Frey & Osborne 2017; Susskind 2020) consider that digitalization is making the boundary between nonroutine and routine work increasingly blurred. However, there are still obvious obstacles to the large-scale automation of the work of drivers of heavy trucks or other similar road vehicles. The obstacles are not so much related to the difficulty of raising the degree of automation of vehicles as to the versatile tasks that drivers have and the need for rethinking the whole traffic and transport infrastructure. Drivers also act in diverse work contexts, where the conditions for even partial replacement of their work with technology can vary widely.

Starting from three strands of research literature, based on qualitative interview data from two Finnish companies, this paper examined indications of potential future substitution or augmentation of the heavy vehicle drivers' work. Although digitalization already affects a large part of drivers' tasks in both companies, no clear signs of either substitutability or complementarity could be found. Although digitalization had not jeopardized the employment prospects of drivers or led to a deterioration in the quality of their work, it has resulted in a kind of a bystander position for drivers, compared to their supervisors. Unlike digitalization in many high-tech industrial environments, digitalization in the two companies studied has not lowered the boundaries between blue-collar and white-collar workers but rather widened the digital divide between drivers and their supervisors.

The paper highlights the importance of workplace-level empirical research on the relationship between digitalization and work. Such research can show that the ways in which digitalization shapes work can be very different in different industries, occupational groups and workplaces and can supplement—or sometimes seriously question—the prevailing views presented in mainstream public debate and (typically quite technologically determined) macrolevel foresight reports on the 'future of work'. To form an overall picture of the impact of digitalization on working life, it is therefore important to better understand the specific nontechnological mechanisms underlying digitalization in *specific* workplace, industry, and country contexts.

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