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What happened to the driver? Implications of electrification, digitalization, and automation on truck and taxi drivers

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ABSTRACT

Electrification, digitalization and automation are three trends driving the low-carbon transition of the transport sector. For the transition to be just, it is essential to ensure that those affected by these trends view the changes they bring as acceptable and fair. Transport policy development, however, mostly remains expert-driven. To explore just transitions in the context of transport electrification, digitalization and automation, we use Sweden as a case to analyse how taxi and truck drivers perceive the implications of these trends on six aspects of their quality of working life: skill requirements, work organization, job security, identity, safety and health. We also explore how these perceptions vary across dimensions of age, gender and geography. We found several perceived challenges related to skill requirements and identity, though drivers also see the potential for the trends to improve their work environment, safety and performance. However, these potential benefits are not taken for granted. The perceived implications may also raise potential distributional, procedural and recognition injustices, for instance regarding costs of reskilling, drivers' autonomy and the recognition of drivers' knowledge. We conclude that the technologies can have both positive and negative implications, and it is rather institutional arrangements, social processes, and broader societal and industrial shifts that cause transport workers to question their future in this sector. Incorporating drivers' insights into decision-making can enhance the drivers' quality of working life and wellbeing while preserving their dignity.

1. Introduction

Three emerging trends are expected to drive the low-carbon transition of the transport sector: electrification, digitalization and automation [1,2]. These trends are not only linked to the introduction of new technologies but also to the process of societal embedding, through which society is reshaped to adapt to and adopt the new technologies [3]. As instances of socio-structural change, low-carbon transitions are known to be contested; they have the potential to be perceived as unjust, become politicized, and deepen and exacerbate social divisions [4–6].

Socio-economic trends, including technological developments and climate change, have profound impacts on worker's day-to-day experiences [7]. Although a fair distribution of positive and negative impacts is key for a just transition, it is not sufficient. A just transition needs to be analysed across all three dimensions of justice: distributional justice, that is, the distribution of benefits, costs and risks of the transition across society; procedural justice, which refers to participation in decision-making processes; and recognition justice, that is, equal respect for all, including the acknowledgment of individuality, social context and history [8,9]. A key aspect here too is the inclusion of multiple types of knowledge in shaping transitions [10].

Different social groups also have different voices when shaping the policies and processes that govern these emerging trends. The way these voices are recognized and included determines the justness and equity of low-carbon transitions [5]. The literature on sustainability transitions has so far paid little attention to the role of workers in these transitions [11]. Understanding the implications of electrification, digitalization and automation for transport workers is essential to ensure that those impacted by these changes view them as acceptable and fair, that is, for the transition to be just.

The concept of just transition has been used by labour organizations to highlight the need for complementing environmental and climate action with social safeguards, letting the interests of workers guide sustainable transitions and involving workers in designing the transition [12]. In the low-carbon transition of transport in Sweden, our case study, there is, however, a disconnection between unions' climate policy

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developments at the national level and the engagement of members [13]. Additionally, transport planning and policy development remains mostly expert-driven [14]. For a just transition, in this sense, there is a need to better understand and recognize transport workers' concerns and aspirations.

To explore just transitions in the context of transport electrification, digitalization and automation, this paper draws on the literature on the quality of working life, which studies workers' satisfaction with their jobs [15], including objective and subjective aspects [16]. Grounded in this literature, the research centres on six overarching categories, addressing both objective and subjective elements of working life. These include skill requirements, work organization, job security, identity, safety and health [7,15]. It is important to note that workers are not a homogenous group and that variables such as gender, age and geography can influence their wellbeing at work in different ways [17,18].

In this context, we aim to address the identified knowledge gap by investigating the implications of electrification, digitalization and automation for truck and taxi drivers, and assessing how these vary by gender, age and geography. To recognize the need for including workers' own evaluations of their job [19], we use qualitative methods, including semi-structured interviews with drivers and a workshop with union representatives, to help identify patterns of common perceptions of the transition's implications for transport workers.

We use Sweden as a case study due to its long-standing leadership in climate policy [20] which today is expressed in its ambition of becoming the world's first fossil-free welfare society [21]. There is also a strong interest among trade unions in Sweden to engage proactively on decarbonization [22,23]. In addition, the latest Swedish Climate Action Plan – a white paper that the Swedish Government needs to present one year after an election according to the Swedish climate law (SFS 2017:720) – firmly recognizes justice and acceptance as one of the "three fundamental conditions laying the groundwork the current climate policy" [21, p. 10]. The Swedish Climate Policy Council has highlighted, however, that the plan lacks analysis of climate policy impacts on different groups in society, as well as concrete policy measures to achieve a just transition [25]. While Swedish climate policy in practice has very limited considerations of justice, the action plan clearly links climate ambition with a continued progressive social policy, motivating the selection of Sweden as a case that balances climate action and justice considerations.

In this paper, we aim to explore the following questions.

RQ1. How do transport workers perceive the impact of electrification, digitalization and automation on their working life?

RQ2. How do the perceived impacts of electrification, digitalization and automation on transport workers vary across gender, age and geography?

RQ3. What kind of tensions might arise between current commercial passenger and goods transport systems and the developments in electrification, digitalization and automation?

Through these questions, we aim to connect the literature on the low-carbon transition in the transport sector with that on the quality of working life and just transitions. Indeed, studies on the implications of decarbonization for workers have so far focused on employment levels [26,27] rather than quality of working life, and they have mostly concentrated on the fossil fuel industry e.g. [28,29]. Moreover, the social and cultural impacts of the transition, for instance the way in which people will renegotiate intangible values, such as social and cultural identities, have also received less attention, with the exception of the coal industry [30].

The remainder of this paper is structured as follows. Section 2 offers background and summarizes the relevant literature. Section 3 describes the methods and the analytical approach used in our study. Section 4 presents the results on the perceived significant implications from the decarbonization trends on transport workers, followed by a discussion in Section 5. Finally, Section 6 provides policy recommendations and concluding remarks.

2. Background

Here, we explore the Swedish case in more detail to provide richer context for the just transition in the country's transport sector. We also take stock of the literatures on the quality of working life, the implications of low-carbon transitions on transport workers, and on just transitions for transport workers.

2.1. Sweden's transition to a fossil-free welfare society

We take Sweden as our case due to its ambition of becoming the world's first fossil-free welfare society, a narrative and political climate goal initiated in 2017 by the former Social Democrat-led government together with the Swedish Green Party. This ambition puts focus on how the whole of Swedish society, across parts of society, economic sectors and industry forming the economic base for a modern welfare state, all must contribute in order to reach Swedish climate goals [31]. This discourse remains core to the framing of the standing inquiry "Fossil Free Sweden" (Dir 2016:66/2020:50), tasked with coordinating and supporting Swedish industry in the transition to net zero emissions in line with the Swedish climate goals. The mandate and framing to foster a fossil-free welfare society remains in place under the current right wing coalition government.

Swedish trade unions engage proactively on decarbonization [22,23], aligning with industrial actors on the necessity of transitioning to fossil-free technologies [32]. The climate agenda has thus been adopted by both parties of the Swedish labour market – trade unions and employer organizations – reflecting their long-standing tradition of enabling stable economic progress for both companies and workers through collective bargaining.

However, the transition is not without challenges for workers, particularly in the Swedish transport sector, where decarbonization pathways remain uncertain. This ambiguity can give rise to conflicts, underscoring the need for a justice-focused approach to ensure fair outcomes for all stakeholders [33]. Recent instances include the dispute between the automotive company Tesla and the Swedish Metal Workers' Union in the winter of 2023–2024, where Tesla is declining to enter into a collective agreement with the union [34]. Additionally, there has been some opposition from companies introducing digitalization in the Swedish taxi industry regarding collective agreements pertaining to working conditions [35]. The literature shows that contestation and justice are critical in the energy transition, including in Sweden [36], as competing justice claims, priorities and framings inherently shape transitional processes [37]. Hence, a Swedish case study delving into the justice implications regarding the quality of working life for professional drivers, as outlined in this research, offers important insights. These insights address the contemporary challenges associated with transitioning to a low-carbon transport system amid the accelerating electrification, digitalization and automation trends, all while preserving essential aspects of a welfare society. Moreover, the Swedish case provides a model for understanding similar dynamics in other welfare-oriented economies facing similar challenges in balancing ambitious climate goals with the protection of labour rights and quality of life for workers. By examining Sweden's transition, this research aims to contribute generalizable insights into how other nations might address the justice-related dimensions of energy transitions within their own socio-economic and institutional contexts. Given that the transport sector's transition is partly governed at the EU level, insights from Sweden's approach can offer valuable lessons for other EU countries aligning national efforts with broader EU climate and transport goals and directives.

2.2. Quality of working life and drivers' challenges

This paper draws on the literature about the quality of working life, which studies the relationship between key dimensions of working life and workers' wellbeing [38,39]. As the concept of job quality is multi-dimensional in nature [40,41], there is neither a consensus on what exactly quality of working life entails, nor ready-made indicators and methods to assess it [15]. Broadly, the concept of "quality of working life" refers to "an overall state of satisfaction that includes objective aspects of material wellbeing, satisfactory relationships with the physical and social environment, and objectively perceived health; and subjective aspects of physical, psychological and social wellbeing" [42, p. 618]. Building on this specific definition as well as the broader literature, the present study focuses on six overarching categories, covering objective and subjective aspects of working life: skill requirements, work organization, job security, identity, safety and health [7,15].

One area of research in this field is the implications of structural changes such as globalization, climate change and the emergence of new technologies, contracts and labour relations' frameworks on job quality [7,43,44]. The present study contributes to existing literature by exploring perceived impacts of electrification, digitalization and automation – key structural trends reshaping the transport sector – on the quality of working life in Sweden.

Truck and taxi drivers today face various challenges with regards to their job quality. The main challenges relevant in the Nordic context are summarized in Table 1, grouped into the aforementioned six categories.

These challenges are naturally interconnected. Stress is a major health concern for drivers, which can be attributed to the fast-paced work environment, high workload and considerable time pressure, which may in turn lead to other health issues and traffic safety risks [47]. In addition to stress, insufficient sleep and work monotony may cause drivers to resort to secondary task engagement, further heightening traffic safety risks [47,50].

For truck drivers, the strict Hours-of-Service (HoS) regulations and the unpredictability of other road users' behaviour, are raised as particular stressors which may contribute to increased pressure to work longer days, and sometimes, violate the HoS regulations [48]. In addition to stress related to time pressures, taxi drivers face the economic stress of earning a living wage, as many drivers work on commission-based salaries. This stress can be attributed to the sector's competitive nature and imposed salary structures. For example, in some cases, contracts limit compensation only to working hours when a passenger is present in the vehicle, i.e. idle time is not included. Faced with these stressors, taxi drivers may feel compelled to exceed speed limits or violate working hour regulations – exposing themselves and others to potential safety risks [47].

The low social regard for drivers relates to both salary structures and the complexities of the professions. The deregulation of the Swedish taxi industry led to an over-establishment of taxies in larger cities and increased competition [47]. This weakened collective agreements, resulting in salary structures where taxi drivers are only compensated when they have passengers [47]. Low social regard for truck drivers stems from public unawareness of the job's advanced elements, such as vehicle manoeuvring and traffic navigation, as well as a lack of understanding of the profession's societal importance [49].

Table 1
Current challenges faced by truck and taxi drivers in the Nordics.

Quality of working life category	Type of driver	Challenge	Reference
Work organization	Taxi, truck	Long and frequent shifts and workdays	[45–48]
	Taxi, truck	Tight time schedules	[46–48]
	Truck	Strict Hours-of-Service regulations	[45,46, 48]
	Truck	Unexpected changes in working hour arrangements	[45]
Job security	Taxi	Low salary	[47]
Identity	Taxi, truck	Socially undervalued	[47,49]
Safety	Truck	Poor weather and road conditions	[45,46, 48]
	Truck	Traffic (other road users)	[46,48]
	Truck	Monotony	[48,50]
Health	Taxi, truck	Inadequate sleep	[46,47]
	Truck	Prolonged sitting	[46]
	Truck	Uncomfortable driving posture	[46]
	Truck	Physically demanding work activities	[45,46]
	Truck	Frequent temperature changes	[46]
	Taxi	Maintaining a work-life balance	[47]

2.3. The transition to low-carbon transport

Previous research on vehicle electrification has often focused on techno-economic aspects and risks overlooking social implications. Studies on electric vehicle adoption among professional drivers, for example, assume that drivers of electric vehicles receive the same salaries as drivers of non-electric vehicles, and that they charge their cars only during mandated breaks [51,52]. Electric taxi charging strategies and charging station availability have been studied, but without considering potential travel pattern shifts [53,54]. There are, however, indications that charging, queuing and detouring to reach available charging points do impact driving time, salaries and regulation compliance for professional drivers [55,56].

In relation to digitalization and automation, the literature highlights concerns about transport workers becoming bystanders in the deployment of the technologies [57–59]. For example, digital platforms and algorithmic management often prioritize customer demands, disregarding regulations and professional drivers' wellbeing [60,61]. Liability laws struggle to keep up as driving responsibilities are increasingly shared with machines [62]. At the same time, there are ongoing EU-level discussions to improve platform workers' conditions and rights, and to mitigate challenges for transport workers due to digitalization and automation [63,64].

2.4. Just transitions for transport workers

The academic literature has so far paid little attention to just transitions for transport workers, with research instead focusing on equity concerns in the transition for transport users, e.g. [65,66]. There are some exceptions, however. For instance, Sunio [37] explores the implications of the transport transition on informal motorcycle taxis and public transport drivers in the Philippines. They pinpoint injustices resulting from the transition, such as potential job displacement, concentration of the benefits for existing incumbents, and safety risks. Silva et al. [67] explore how American Midwest automobile workers and communities envision the electric vehicle transition. They identify contrasting views between actors, where managers and communities are optimistic about economic opportunities, while autoworkers are sceptical that their past contributions and knowledge will be recognized in the transition. Another example is Pichler et al. [68], who studied the role of workers and unions in the transformation of the Austrian automotive industry and identified key factors that can support the sector's transformation, including bolstering workers' confidence in their qualifications and expertise, and shaping state policies and framework conditions. Two additional factors in this work relate to the position of unions in the broader society: adopting a social unionism-based approach (i.e. going beyond defending jobs and instead criticizing given modes of production), developing alternatives that benefit society

overall, and fostering alliances with environmental movements.

As fairness considerations have gained prominence in climate-related national and international policy debates, transport unions have highlighted their just transition agenda and pointed to policies and measures that can support transport workers amid the sector's transition. Key priorities include the creation of decent and sustainable green jobs, and support for workers to navigate the transition through reactive labour market policies, effective social protection systems and reskilling and upskilling programs. The latter is particularly important as the sector suffers from skills and labour shortages. They also highlight the importance of transport workers' conditions, labour's involvement in just transition-related decision-making, and the fact that existing just transition mechanisms in Europe are not applicable to the transport sector [69,70].

By gathering first hand perspectives from those directly affected, this study highlights nuanced issues that may not be captured by broader policy discussions.

3. Methods

Our analytical approach combined qualitative content analysis with thematic analysis to interpret textual data. Both methods support the identification and categorization of data excerpts (codes) to describe patterns (themes) and, more broadly, to describe phenomena [71]. This combination, as demonstrated by Brough et al. [72], leverages the flexibility of both qualitative content analysis and thematic analysis in research design [73,74] and utilizes their similar analytical techniques [71]. We further extended our approach by using a hybrid process of deductive and inductive coding for theme development, benefitting from the complementary strengths these modalities have, as demonstrated separately for qualitative content analysis and thematic analysis in prior research [75,76]. Our study began with a deductive content analysis, followed by an inductive thematic analysis to examine Swedish transport workers' perceptions of electrification, digitalization and automation. Inspired by the work of Sovacool et al. [77], we then applied a justice lens through deductive content analysis to critically examine how the identified themes intersect with broader socio-political, economic and environmental concerns, providing a nuanced understanding of justice issues in transport transitions.

Our main method of gathering data was semi-structured interviews. To increase confidence in the validity of the results, we applied methods triangulation, verifying consistency of findings across all the employed data collection methods [78]. A workshop was conducted with trade union representatives as a complementary data source. Insights from the workshop were used to test the consistency with interview findings, and to capture additional dimensions of the explored trends' impacts on transport workers.

3.1. Data collection

3.1.1. Interviews

We conducted semi-structured interviews focusing on understanding truck and taxi drivers' views on the transport-related technological and system changes resulting from three major trends of decarbonization in the transport sector: electrification, digitalization and automation. In total, 20 interviews were conducted between October 2022 and February 2023 with taxi and truck drivers. Each interview was approximately 1 h long. Purposeful sampling was used to recruit a diverse set of participants and capture a broad range of experiences, covering different ages, genders and urban or rural geographies, as well as union membership status (member or not). In this study, we explore gender as the socially constructed behaviours and identities of women and men, leaving the full portrayal of gender out of the scope of study. The majority of the participants were recruited with the help of the Swedish Transport Workers' Union. Participants were provided with written information about the study, data collection and management, and asked for their informed consent. The collected data were anonymized. The consent process adhered to a pre-approved plan by the Swedish Ethical Review Authority. Table 2 summarizes the demographics of the interview participants. In general, our sample comprised an even representation of drivers below and above the average age, and an even representation of male and female drivers. The sample entails a higher representations of truck drivers compared to taxi drivers, and of drivers operating in urban areas compared to rural areas.

A set of guiding questions were designed with the feedback from the Swedish Transport Workers' Union to ensure the practical relevance of the research. They were split into three main sections, exploring: 1) what drivers value about their job, 2) what they view as potential benefits and drawbacks of electrification, 3) what they view as potential benefits and drawbacks of digitalization and automation. The questions, provided as part of the interview guide in Table A1(Appendix A), focused on the impacts of the three decarbonization trends on skill requirements, work organization, job security, identity, safety and health. The interview guide also included preliminary questions about participants' familiarity with electrification, digitalization and automation, along with prompts on possible trend developments, as prior knowledge or experience with these trends was not a recruitment criterion.

3.1.2. Workshop

An online workshop with union representatives was conducted on March 21, 2023. The workshop engaged 14 participants in their capacity as trade union representatives and included 11 men and 3 women from the Swedish Transport Workers' Union, spanning over nine Swedish cities. Again, the consent process adhered to the pre-approved plan by the Swedish Ethical Review Authority. Apart from written information about the study, data collection and management, workshop participants were informed about the risks and benefits of their participation and asked for verbal permission to use the workshop findings for research purposes. The collected information were anonymized.

The workshop began with a presentation of the decarbonization trends, which enhanced the participants' background knowledge but avoided specific insights on challenges or impacts on transport workers, to avoid steering the discussion. Subsequent discussions focused on the participants' concerns around the decarbonization trends; on associated risks and benefits, as well as on just transition measures related to the trends. In a second stage of the workshop, preliminary insights from the interviews were presented to stimulate discussions on potential impacts.

3.2. Data analysis

All interviews were recorded and transcribed verbatim prior to the analysis. Transcriptions were uploaded in MaxQDA 2020, a computer-assisted qualitative data analysis software. Deductive content analysis was conducted using a structured categorization matrix developed based on the six broad categories of the quality of working life. Guided by these categories, themes were then identified by applying an inductive thematic analysis. Line-by-line open coding was first used to inductively derive a set of discrete excerpts from the transcriptions. The codes that emerged were organized and grouped into sub-themes, and then into main themes under the broader theory-induced categories of perceived

Table 2
Overview of interviewed drivers.

		Below average age		Above average age		Non-union member	Total
		Rural	Urban	Rural	Urban		
Men	Truck	1	3	1	2	1	**8**
	Taxi	0	1	0	1	1	**3**
Women	Truck	2	2	1	1	0	**6**
	Taxi	0	1	1	1	0	**3**
Total		**3**	**7**	**3**	**5**	**2**	**20**

impacts. Only the aspects that fit the matrix of analysis were used when coding the qualitative data [74]. Finally, to identify tensions, the resulting themes and sub-themes were analysed through a deductive content analysis based on the three tenets of justice [8,9]: distributional justice, procedural justice and recognition justice.

Interviews were conducted and analysed continuously to ensure that saturation had been reached. All interviews but one were carried out by the same person (the first author), who also subsequently did the coding. As part of the methods triangulation, the workshop complemented our semi-structured interview analysis of transport workers' perceived impacts of the decarbonization trends. The data analysis was conducted by multiple authors.

3.3. Limitations

We acknowledge several limitations. We used purposeful sampling to capture insights from several transport worker categories, across different ages and gender. However, budget and time constraints, as well as difficulties in recruiting respondents from all the groups listed in Table 2, led to an incomplete sample for some categories. For example, taxi drivers operating in rural areas, and non-unionized transport workers, were under-represented in the study. As shown in the following sections, however, our identified main themes of drivers' perceptions of the low-carbon transition trends were common across driver categories. Therefore, we expect that the results are still relevant even for under-represented groups. The smaller sample of female truck drivers might have influenced the analysis on gender-related impacts. Besides, our sampling strategy followed a binary perspective of gender, thus preventing findings related to other gender expressions.

A workshop with trade union representatives was held to complement and test the findings from the individual interviews. Participants of this workshop, however, solely represented the Swedish Transport Workers' Union, meaning the workshop did not include inputs from other relevant trade unions such as the Union for Service and Communications Employees (SEKO).

Our study was also carried out in collaboration with the Swedish Transport Workers' Union. Their involvement was by design in the research project for which they are a partner and was further manifested through co-authorship of this paper. This collaboration facilitated the access to a diverse set of interview participants on sensitive issues and enabled in-depth interviews and purposeful sampling of informants across age, gender and geography that would not have been possible otherwise. The union provided feedback on the interview question design and data collection, which may have contributed to shaping the research findings. To reduce the risk of bias, we grounded the guiding interview questions in existing literature on transport decarbonization trends and their effects on transport workers.

Finally, our study focused on potential impacts perceived by taxi and truck drivers (including delivery truck drivers), lacking further segmentation of different transport worker types, such as public transport drivers, cycling cargo workers, and gig-economy workers. We attempted to target the latter for the recruitment of non-unionized interview participants through alternative channels, such as social media. These efforts were however unsuccessful, further demonstrating the value of the collaboration with the Swedish Transport Workers' Union in this study.

4. Results and analysis

4.1. Perceived implications of electrification, digitalization and automation on drivers' quality of working life

Here, we present the refined results of the analysis and outline the aggregated main themes regarding how drivers perceive the low-carbon transition trends' implications on their working life. These themes of perceived implications are grouped into the six broad categories of working life, as specified in section 2.2. The presentation of main themes is complemented with individual relevant insights from interview participants and trade union representatives, to provide additional nuance. An overview of the main themes of perceived implications and how they are constructed by respective sub-themes and codes is presented in Table B1(Appendix B).

4.1.1. Skill requirements

On the one hand, drivers recognized that existing skill requirements, such as having a driver's licence, will remain relevant even in light of the three trends discussed (electrification, automation and digitalization). In some cases, drivers' tasks might even become easier. One interviewee further noted that the functionality of vehicles already varies significantly, therefore workers already adapt to new operations when switching vehicles.

On the other hand, there is a strong anticipation of a shift away from skills related to active driving and mechanical knowledge, and towards increased proficiency in information technologies (IT), and electric vehicle maintenance and operation, including understanding how factors like terrain, weather and driving style impact a vehicle's range. As one interviewee put it: "In terms of competence, it becomes an additional factor when hiring someone – how to charge and what do you do if the car does not charge or if something does not work properly." The interviewees saw that the regular licence renewal trainings in place pose a natural channel to introducing programs for developing new skills.

In relation to the profession's social prestige, one interviewee anticipated that new skill requirements could make obtaining a driver's licence more difficult, which could in turn heighten the social prestige of the profession and elevate the sense of pride in being a driver. One driver was concerned, for example, that changing skill requirements may attract fewer people to the profession. On the other hand, another interviewee saw an opportunity for upskilling towards a steward role, i.e. someone who ensures that the systems work effectively.

4.1.2. Work organization

In particular, interviewed truck drivers saw advantages in the emerging trends, from the reduction of harmful exhaust gases with battery electric vehicles (BEVs), as this removes the need to turn off the engine when working outside of the vehicle, and improves the climate control of the cabin. The entire group of interviewees further recognized the potential for digital systems to assist with non-driving tasks and enhance overall performance. This includes simplifying administrative tasks, optimizing routes and organizing workdays, but also promoting energy-efficient driving techniques, thus improving the drivers' fuel efficiency performance.

However, there are concerns about potential discrepancies between transport planners' expectations and how the daily work of completing transport trips unfolds in real life. Both trade union representatives and interviewees voiced that digital systems combined with transport planners' tendency to overlook heavy traffic and other sources of delays, could result in unrealistic expectations, and put pressure on the drivers. As expressed by the drivers: "Sometimes the time windows [the time requirements that transport planners set on pick-ups, and deliveries and drop-offs] are impossible, so you're already late when you start."

These concerns are compounded by interviewees' perceived limitations of BEV flexibility, where consuming charging could lead to workday disruptions as it involves a need for stopping and taking the time to charge. Among the interviewees, there was a clear worry around the operational demands of charging, and the pressure to maintain a certain number of trips. These logistical challenges could potentially increase drivers' working hours, and exacerbate their challenges with pressing schedules. As one interviewee put it: "[Charging] would take a few hours that need to be accounted for in the route calculations. […] It will not be possible to make the set timestamps. It will be troublesome to not be able to keep the time schedules. […] There is still a lot one should manage to do in one day."

The introduction of BEVs and their charging needs may further

complicate route planning. If charging is tied to regulated breaks, the interviewees anticipated challenges in finding available charging points, particularly at preferred rest stops serving popular routes and offering good services. A few interviewed truck drivers emphasized the existing difficulties in finding suitable locations for rest and sleep, which electrification could exacerbate. Such logistical challenges were also recognized by a trade union representative who emphasized that drivers have little room to adjust where and when they take breaks.

On the other hand, if charging needs fall outside of the regulated breaks, the broader group of interviewees and trade union representatives raised a need for clear rules on who will bear the costs for the time spent charging. As illustrated by one interviewee, sticking to overnight charging instead could limit workday disruptions and route planning challenges, but drivers were not certain about the batteries' ability to complete a full day's work on a single charge.

Moreover, as electrification might increase logistical complexities, two interviewees foresaw that the transport of electrified goods might take longer. This creates potential conflicts with the current logistics system, where customers' expectations are that goods are delivered the next day, and brings challenges for drivers in meeting customers' expectations. Despite these tensions, one trade union representative envisioned that electrification could be an opportunity: by imposing physical limitations on the amount of work that can be done in a day, companies and customers could be more accepting of logistics taking longer, in turn relieving pressure on drivers.

4.1.3. Job security

Job security uncertainties are linked to perceptions of the employers' ability to manage potentially higher costs associated with the introduction of electric vehicles (both upfront and operational costs), and self-driving vehicles. As one interviewee put it: "There is a fear. If we sit in the coffee room and talk about self-driving cars, that gets the conversation going. In 15 years, we might not be needed." The advent of remote vehicle operation is perceived as a similar threat: "If one person is controlling five trucks from home, then four drivers will lose their jobs." Trade union representatives added that these worries around job loss are strengthened by seeing the progress of automation through pilot projects and other corporate initiatives.

Moreover, there was a perception among interviewees and trade union representatives that it is in the interest of companies and customers to go for the cheapest option. As driver salaries usually represent the largest share of freight services' total operational costs, minimizing the need for drivers is a way to keep the costs down. These worries are contrasted by a prevailing view that the human factor of the driving profession will always be needed.

The interviewees' concerns around job security are further exacerbated by the challenges of meeting transport planners' expectations of the new technologies. For truck drivers, the prospect of reduced load capacity due to heavy batteries and the scheduling adjustments for charging may impede the possible number of deliveries in a day. Taxi drivers expressed job security concerns in relation to charging infrastructure access, i.e. regarding how it affects their ability to undertake specific routes, or the way schedule changes can be communicated to managers. Particularly for commission-based taxi drivers, lost driving time directly translates to lost income. As one interviewee explained, "The taxi is like a casino: the less expenses and the more income the better it is."

4.1.4. Identity

Interviewed truck drivers expressed the worry that the trends under discussion may change truck driver craftsmanship – traditionally associated with mechanical engines, heavy machinery and navigating through complex driving conditions – and diminish the nature of the profession. Trade union representatives emphasized that truck driving craftsmanship is strongly associated with a sense of pride, which might decline with the onset of digitalization and automation. This may diminish drivers' interest in the profession: "I love all kinds of machines and driving them is great fun. That is the main reason why I chose to become a truck driver." Another interviewee expressed a sense of belittlement due to automation: "[You] might be criticized for having less knowledge than computers." Similarly, a trade union representative noted that with digitalization and automation, the credit given to drivers for solving problems and completing trips could decline.

Questions are further raised on how essential non-driving tasks might be overlooked by companies in the transition. The broader groups of interviewees stressed the importance of understanding customer-specific needs as a vital aspect of the profession, and doubts were expressed on the feasibility of automating away social interactions with customers. The taxi drivers we interviewed considered personal relationships with customers as an integral part of their profession. This can be particularly relevant when meeting the needs of specific customer demographics, particularly the older or the sick customers, if, for example, the driver must stop to charge or if the heating system fails in cold weather. For the interviewed truck drivers, cargo handling skills and responsibilities, such as verifying and securing loads, loading and unloading, are earned from experience, and were considered far away from being solvable by automation. Trade union representatives further asked how the cargo handling responsibilities would be handled with driverless vehicles.

Concerns also exist around occupational identity in relation to a more digitalized work organization. The drivers' sense of autonomy and flexibility could be limited, and while digital systems can aid in planning and organizing workdays, there is an apprehension that they may not only impose stricter time schedules but also reduce the drivers' sense of freedom to choose routes and rest locations.

4.1.5. Safety

Drivers recognized that digital systems can aid vehicle manoeuvring and enhance traffic safety. The interviewed truck drivers, for example, saw Advanced Driver Assistance Systems (ADAS) as valuable tools for navigating challenging road conditions and maintaining a heightened awareness of the surroundings. There were, at the same time, strong doubts around ADAS sensors' ability to handle real-life traffic and road conditions, e.g. in challenging weather conditions: "Trucks today [with human drivers] already have problems staying on the road, so this is a big challenge for self-driving [vehicles]."

Furthermore, digitalization was partly envisioned as a transition from more analogue dashboard interfaces to touch-based display screens, potentially leading to distractions, diverting driver's attention from the traffic. Multiple signals from increasing numbers of digital systems could become stressors that elevate the risk of traffic accidents. Further safety risks were flagged in terms of an over-reliance on ADAS, leaving drivers under-stimulated with limited traffic awareness. As one interviewee put it: "[Driving] becomes a bit more mundane. You want to start doing something else when you are driving: you call a friend or listen to music. You get easily distracted with assistance systems."

Moreover, drivers expressed safety concerns about electrification, chiefly regarding crashes involving electric vehicles. The broader group of interviewees cited the dangers and challenges of extinguishing battery fires and the potential risk of exposure to harmful gases. Trade union representatives raised further safety concerns in terms of drivers' lack of knowledge, for instance not knowing if it is safe to approach a vehicle after an accident, and increased risks of being hacked when vehicles are digitalized. Additionally, concerns were raised about the risk of accidents from the quiet operation of electric engines, especially regarding individuals working in freight terminals, older customers and other individuals with hearing limitations.

4.1.6. Health

Interviewees recognized that electrification can result in a quieter work environment (due to the quieter engine) and no exhaust gases – both are perceived as beneficial for workers' health. "It is a lot of little

things that in the end become a whole lot," as described by one interviewee. Additionally, digital systems can reduce drivers' cognitive load, allowing them to focus on important tasks. This was recognized by the interviewees as a way to reduce stress, leading to overall health improvements and safety.

Moreover, digitalization and automation were recognized as potential aids in ensuring adherence to Hours-of-Service (HoS) regulations, alleviating stress in meeting delivery times without violating regulations, and contributing to positive health benefits: "It is linked to commission work when you work so many hours. There are rules for resting periods, and rules for how much you can drive in a day. But today, when it is not digitalized, it opens up for a lot of cheating." BEV charging requirements present an opportunity for imposing more breaks during the drivers' workdays, and improving drivers' health, a trade union representative recommended. Another interviewee further saw the potential for remote operation in alleviating physical demands of prolonged sedentary work and foot pain from the pedals.

However, challenges in meeting transport planners' expectations regarding digital systems, workday disruptions due to the lower flexibility of BEVs, and changing skill requirements were identified as stress-inducing factors and therefore could have negative health impacts on transport workers. According to one interviewee: "Today, I know that if I have a full fuel tank, I can drive the whole route, but if I have to think about the temperature to know [whether I can make the full route] […] it becomes a source of stress."

4.2. Perceptions of challenges for specific driver groups

Our findings suggest that there was a perception of potentially higher job security risks for drivers in smaller transport companies, given the investment risks associated with technically advanced vehicles. Similarly, trade union representatives anticipated that drivers performing transport services that require more human interaction, and take place in more challenging traffic situations, such as cities, are likely to be replaced by automated vehicles at a later stage compared to other drivers. In the sections below, we explore differences depending on age, geography and gender in more detail.

4.2.1. Age

There was a strong perception that older, more experienced drivers may face disadvantages in adapting to technological system changes, both culturally and practically. Older drivers were perceived as less open-minded and more likely to find technological advancements unnecessary and daunting. They were expected to struggle more to learn and adapt to electric, digitalized or automated vehicles, and to need more support. Moreover, it was noted that older drivers may face risks in terms of job market competitiveness: "If you're 30 and become unemployed, you won't find it as difficult to find a new job as a 60 year-old who loses their job."

On the other hand, although younger drivers might be more capable of adapting to new technologies, they were expected to be more affected by the transition in the sense that they are further away from retirement. One trade union representative also noted that younger drivers may be less hesitant to assert themselves and demand better working conditions, as they lack experience and deeper knowledge of what decent working conditions entail.

4.2.2. Geography

Reliability and accessibility of infrastructure can be challenging for drivers operating in remote areas and on long-distance routes. Passing through areas with limited mobile network coverage and internet connection may affect vehicles that require constant connectivity. Concerns were also voiced regarding the charging infrastructure availability in remote areas. Operating in northern Sweden, where temperatures can go down to minus 30 °C, was recognized to pose particular safety implications: a complete battery discharge can potentially disable heating and prevent doors from opening, requiring long response times for assistance and rescue services.

4.2.3. Gender

Gender-specific challenges are less apparent, possibly due to the limited number of female interviewees and workshop participants. However, one of the female truck drivers we interviewed emphasized the need for proper sanitary services at charging stations and rest stops, especially for women. Meanwhile, trade union representatives noted that entrenched gender roles, like family commitments, can explain why men dominate the pool of drivers who have been in the profession for longer. But we found very limited evidence of gender-specific challenges related to the studied emerging trends.

4.3. Potential tensions from a justice lens

Analysing transport workers' perceptions of electrification, automation and digitalization on the quality of their working life raises a series of justice considerations. These span the three tenets of justice [8, 9], i.e. distributional justice (distribution of benefits, costs and risks), procedural justice (participation in decision-making processes), and recognition justice (equal respect for all) (see Table 3).

From a distributional justice perspective, the transition to new technologies in the transport sector raises important questions about who will bear the costs of retraining and reskilling workers and who will have access to these opportunities. There is also uncertainty regarding whether the transition will expand or restrict access to employment within the sector, particularly as new skills are required. Other distributional questions include whether drivers will be compensated for time spent charging vehicles and how work regulations might adapt to ensure social protections and decent working conditions during and after the transition. Regional disparities in access to charging infrastructure, internet connectivity, and assistance and rescue services also shape the specific needs of transport workers, potentially creating uneven impacts across different areas. Age-related factors further influence job security and training needs, as older workers may face greater challenges in adapting to new technologies, while younger workers might more readily embrace these changes. Ultimately, training, compensation and regulatory frameworks will need to account for these diverse factors to promote a just transition for transport workers.

From a procedural perspective, technological advancements and changes in business models also impact drivers' autonomy, as new systems might limit their decision-making power, shifting work towards a more regulated or monitored environment and potentially reducing drivers' sense of control and agency in their work, especially if they are not consulted in the development and implementation of these systems.

From a recognition perspective, the data highlight potential tensions regarding new technologies and how the social systems around them acknowledge and value diverse aspects of drivers' roles and identities. Technological systems and decision-making processes can overlook non-driving tasks, such as cargo handling and building relationships with customers, which are integral to the job and contribute to both worker identity and pride. Similarly, drivers' experiential knowledge of driving challenges – such as navigating complex driving conditions, safety risks and time management – may not be fully accounted for in task management systems and scheduling.

As transport is typically a male-dominated sector, a key recognition justice question is whether the new technologies that are deployed, and their associated infrastructure and decision-making processes, accommodate the specific needs of female workers. Addressing these recognition gaps is crucial to ensuring that the transition is not only efficient but also respectful and inclusive of all workers' roles, contributions and identities.

Table 3
Potential tensions that might arise from the lenses of distributional, procedural and recognition justice.

Sub-theme	Tensions and potential injustices
Distributional justice: distribution of benefits, costs and risks of the transition across society	
Strong shift in skill requirements	Who will cover the costs of training and reskilling, and who will have access to these opportunities?
Economic uncertainties, the human factor	Will the transition expand or restrict access to jobs within the sector?
Economic uncertainties, workday disruptions, different understandings of the technologies	What social protections are in place for transport workers during and after the transition?
Workday disruptions, economic uncertainties	Will drivers be compensated for time spent charging vehicles?
Geography	How do variations in access to charging infrastructure, internet connectivity, and assistance and rescue services across different regions impact transport workers' needs?
Age	How do age-related factors, such as early retirement plans and varying abilities to learn and adapt to new technologies, influence job security and training needs for older versus younger workers during the sector's transition?
Procedural justice: participation in decision-making processes	
Different understandings of the technologies, reduced job satisfaction	How do new technologies influence drivers' agency in shaping their own work lives?
Recognition justice: equal respect for all, including diverse knowledges	
The human factor, underestimating and overlooking tasks, different understandings of the technologies	How do technological systems and decision-making processes acknowledge and accommodate non-driving tasks, such as cargo handling and building customer relationships? How do technological systems and decision-making processes acknowledge and accommodate drivers' knowledge about the unique challenges or complexities they face on the road?
Reduced job satisfaction, underestimating and overlooking tasks	How do technological advancements, along with shifts in business models and regulations, influence drivers' autonomy, job satisfaction and sense of pride in their work?
Gender	How do new technologies, infrastructure and decision-making processes acknowledge and address the specific needs of female workers in the transport sector?

5. Discussion

In this paper, we have conducted interviews with truck and taxi drivers and a workshop with trade union representatives to further our knowledge on the potential impacts from electrification, automation and digitalization on the drivers' quality of working life. In this section, we analyse and discuss the results through the lens of quality of working life and potential justice implications.

5.1. Perceived implications for drivers' quality of working life

5.1.1. Skills, job security and identity

In line with the findings of Christidis et al. [79], our study shows that drivers expect the emerging trends to influence future labour demand, necessitating new skills in IT and sustainable driving practices. Our study also indicates that there is a perception of older drivers being more pessimistic towards new technology and having slower adaptation speeds compared to younger, less experienced drivers, a result also found by Wallengren & Ottoson [49]. The perceived reluctance to embrace new technologies among older drivers and their lower adaptability may consequently influence their job security. That is, a mismatch in skills combined with these types of perceptions can lead to a displacement of older drivers into retirement [80], especially considering that they tend to receive less training than their co-workers [81] and that reskilling opportunities accommodating their needs are perceived as uncertain [49]. Accessible training opportunities may support older drivers' sense of dignity.

While digitalization and automation have the potential to replace driver tasks, our results align with the literature, pointing out that skills like cargo handling, social competence and service orientation are perceived as indispensable, and as making human drivers irreplaceable [82,83]. The persistent need for such skills is seen by the drivers as a source of job security, especially among the driver groups whose work involves human interaction. But even so, the fear of job loss is instilled by perceptions of cost-driven decision-making by companies and visible progress in implementation of self-driving vehicles, possibly rendering traditional driving roles obsolete.

Our study further highlights the impacts of the trends on the current skillset that the drivers value and which they take pride in honing. It is known that the introduction of digitalization and automation brings the risk of deskilling workers through task fragmentation [84]. Our work suggests that deskilling together with drivers' apprehensions about certain responsibilities being overlooked may undermine their sense of pride and recognition for their job competence, further undervaluing the profession. Employee retainment needs to preserve the jobs' significance and meaning for the drivers.

5.1.2. Safety, work organization and health

Our findings indicate that drivers recognized potential safety improvements from the trends. Drivers further acknowledged potential benefits of an improved work environment with BEVs, and of enhanced health and performance through assistance in driving, administrative tasks and adherence to HoS regulations with digitalization and automation. ADAS can be particularly beneficial for aging drivers, given the natural decline in their cognitive and visual capabilities [85]. The trends, however, do not guarantee these potential improvements.

Concerns such as that automated driving increases the monotony of long-distance driving, or that additional distractions will be introduced, are echoed in the findings of Hungund [86]. Furthermore, we find that drivers harbour concerns about the ability of digital and autonomous systems to appropriately respond to dynamic road and traffic conditions, in line with DeGuzman & Donmez [87]. Our study also finds evidence that the needs of currently under-represented groups might be overlooked by the trends, such as women's rest-stop location preferences in terms of sanitation or safety [88].

Regarding drivers' perceived heightened safety risks from battery fires and their harmful gases, this is a case where perceived and actual risks deviate. Statistically, fire risks are not higher in electric vehicles [89], but more education and information on the difference between safety precautions with internal combustion engines and electric engines are evidently needed. Our findings also highlight particular safety challenges for drivers operating in rural areas due to infrastructure contingencies of the trends [90,91] and the limited expansion of charging and telecommunications infrastructure in these areas [92,93].

Our findings also illustrate potential tensions between operational changes that the trends may bring and how drivers' work currently is organized. Interviewees and trade union representatives underscored risks of unachievable timeframes with digitalization and optimized route planning, exacerbating drivers' time-pressure challenges [79]. Introducing BEVs and the need for charging to transport services further adds a layer of complexity to route planning and scheduling [94] and induces stress. Tensions such as how to count charging time add to drivers' concerns about transport planners disregarding drivers' experiences with the pressured nature of transport services. The wariness

among drivers may be warranted by economic pressures stemming from market liberalizations, driving cost-cutting measures within transport services and inducing stressful time frames, as well as increased workloads and hours [79,95]. Being further away from retirement, younger drivers may be particularly susceptible to these risks.

In line with the work of Belzer [95], we find that drivers' other concerns revolve around customer expectations of transport services. Consumers often prefer free, next-day delivery [96], which our interviewees find harder to meet with the emergence of the trends without increasing stress or working longer days. These risks are linked to drivers' perceptions of the lower flexibility of BEVs. However, recent studies suggest that consumers are willing to pay more for sustainable working conditions for drivers [97], or wait longer for low-emission last-mile deliveries [98].

The duality of our results shows that the perceived impact of the trends on drivers can go either way: electrification, digitalization and automation can lead to improvements in driver health and safety, but the trends can also diminish their quality of working life. The direction of the developments is shaped by the larger socio-structural changes intertwined with the technologies and by the institutional and governance arrangements surrounding them [99].

New processes for designing transport services will be necessary. Decisions around the design and implementation of these processes should be informed by drivers' deep understanding of logistics and should involve mutual dialogues with transport companies. The framework for these dialogues should be regulated by relevant national and regional authorities, which further necessitates dialogue between the authorities and transport worker unions. The aim should be to safeguard drivers' dignity and working and employment conditions through avenues such as collective bargaining agreements and national and EU legislations.

Without fostering dialogue that exploits the potential benefits of the new technologies for the driver profession, their implementation may create tensions and eventually make the sector unattractive. This could further lead to a suboptimal implementation of electrification, digitalization and automation at a larger scale, where issues could be attributed to technology immaturity instead of recognizing underlying reasons of failure. Based on our analysis, these reasons rather involve overlooking the workers' perspectives in planning and procuring transport services.

5.2. Justice implications

Keeping up with the technological changes driven by transport decarbonization requires the development of a range of new regulations, standards and skills-related measures. For instance, Articles 6 and 7 on driving times, breaks and rest periods in the EU regulation on the harmonization of certain social legislation relating to road transport [100] were developed primarily for internal combustion vehicles and do not fully account for BEV-specific requirements, such as charging time. Transport sector trade associations have highlighted the need to clarify rules to address how BEV charging affects drivers' driving times and breaks, advocating for the possibility of interrupting mandated breaks in order to move fully charged vehicles [101]. There has been, however, some progress in protecting workers' rights in the transition, with the adoption in 2024 of the EU Platform Work Directive, which clarifies the employment status of people working for digital platforms and established rules on the use of algorithm systems in the workplace [102]. However, this directive still needs to be transposed into national law and effectively enforced to provide an initial foundation for protecting workers' rights. This illustrates the importance of current and future policy processes that define the rules surrounding the deployment of decarbonization technologies and thus determine whether the potential distributional injustices emerging in the transition are effectively addressed or left unresolved.

From a procedural perspective, a key concern is the extent to and ways in which workers are involved in shaping such regulations and standards. Research has shown the importance of unions participating in organizational change processes to mitigate the restrictive impacts of these changes on job quality [103]. Although Sweden has a relatively well-functioning welfare system and has historically seen effective collaboration between unions and employers through the so-called "Swedish model" [104], it is unclear whether the current institutional framework is adequate to guarantee a socially and ecologically equitable transition [105]. While the new Climate Action Plan incorporates justice and acceptability as a key lens on the climate transition [24], the tangible policy responses in this plan are few, and the plan rather leans towards slowing the pace of the transition, e.g. watering down the nearer-term goals for the transport sector.

From a recognition perspective, a key issue is that of better incorporating transport workers' knowledge into planning and decision-making, as these processes are increasingly performed by computers. One of them relates to the need to better account for and value drivers' non-driving tasks, such as meeting specific customer demographics' needs for taxi drivers or handling cargo security for truck and delivery drivers, in assessments of the transition's implications on transport workers. These can be essential for transport services to be carried out effectively, as well as for workers' professional identity.

This study points to aspects of the transition that have so far been neglected. While cultural and identity considerations are rarely prioritized in transition planning, the literature on coal transitions has highlighted how these factors can play a role in the societal acceptance of change [106,107]. Finding ways to maintain key relationships with identity, place and people within communities can support transitions [108]. Our study indicates that these issues are relevant in the transport sector too, with decarbonization potentially leading to the loss of transport workers' autonomy, enjoyment and pride. Importantly, research shows that autonomy and pride influence workers' wellbeing and performance [109–111]. Strategies to ensure workers' autonomy and pride amid decarbonization trends may focus on improving workers' involvement in strategic decision-making and workplace sociability, as relationships with colleagues can mitigate the negative impacts of the lack of autonomy [112,113].

Understanding how these responsibilities may evolve in the future and the resulting impact on workers' wellbeing and transport service delivery necessitates increased attention in both research and policy discussions. Additionally, this research underscores a broader concern within the low-carbon transition and society's escalating technological dependence and complexity: the preservation of workers' dignity [84].

While this study identifies some variations in perceived implications of the transition depending on age, geography or gender, the findings remain limited. Still, the difficulty in interviewing women highlights challenges in fully capturing women's perspectives and experiences in this male-dominated field. Truck and taxi driving remain gendered sectors, with women representing only 8 % of transport workers in Sweden in 2020 [114], and about 17 % in the EU and globally [115,116]. There is an opportunity for including more women in the sector as the transition takes place and education and training processes evolve to match the new skills required. However, this is not a given; rather, it requires active measures to address gendered views of the sector, such as more flexible working arrangements, platforms to address gender bias in recruitments, affordable training opportunities and improving working conditions [116]. More research can help provide a better understanding of the challenges that particular groups may face, or the specific needs they may have. This is especially true for non-unionized drivers, who were under-represented in our sample, and for understanding the influence of gender norms on how the transition is experienced by men, women and people of other genders.

6. Conclusions and recommendations

In this paper, we identified the implications of electrification, digitalization and automation on the quality of working life for truck and

taxi drivers, and explored how these vary from a gender, age and geographical perspective. We found several perceived challenges related to skills and identity, but also that drivers recognized the potential for the trends to improve their work environment, health and safety as well as aid their task performance. However, this potential cannot be taken for granted. The technologies can have both positive and negative implications, and it is rather human decisions – within institutional and governance systems, as well as broader societal and industrial shifts – that make transport workers question their future in the sector. Therefore, it is important to study the social processes that shape and adapt to the use of these technologies and the underlying factors that influence positive or negative developments in order to safeguard the sector's future attractiveness.

As the trends are likely to involve changes to skills and competency requirements, reskilling is essential to safeguard the dignity of the existing workforce. Opportunities to develop the necessary skills should be accessible to all groups of drivers. At the same time, the skills and knowledge that the drivers already possess should not be dismissed in the implementation of the technologies. Reskilling should be seen as a way to build on the advantages that drivers' knowledge offer, which would mean a much higher level of involvement for them in decision-making processes influencing the transition. Apart from driving itself, drivers highly value their skills in performing non-driving tasks, such as customer service and cargo handling, as well as the freedom to choose their own routes. These aspects are integral to consider for the drivers' sense of professional identity and job satisfaction.

Drivers' deep knowledge on how the everyday logistics work can bring unique insights to where attention is needed in the implementation of the technologies. Including these insights in decision-making can enhance the drivers' quality of working life and wellbeing while preserving their dignity. Further, it can potentially lead to a more fruitful implementation of the technologies, cultivate a fair share of benefits and support the sector's future competitiveness.

Many of the challenges that drivers face today are in the wake of cost-cutting strategies following deregulations of the road freight and taxi sectors. Our findings indicate that the emerging trends add complexity to an already strained sector, in which small margins risk exacerbating the challenges of a fast-paced work environment and deteriorating working conditions. These risks may further worsen the sector's labour shortage challenges. We thus recommend that drivers' insights should be incorporated in policymaking to improve working conditions in the sector and to safeguard their occupational health and safety by ensuring decent wages and compliance to working hours regulations.

Lastly, although the results indicate that the emergence of the technologies can influence driver groups differently based on age, gender and the geography they operate in, further data collection and analysis from a larger, more representative sample is needed to draw conclusions about how the perceived impacts of electrification, digitalization and automation vary across these dimensions.

Future research should focus on how social and behavioural aspects of the transition can be linked to technical trends and integrated into energy and socio-economic modelling, where such aspects usually are missing or simplified. This includes further exploration of how the transition is experienced by non-unionized workers and people of different genders, and how it relates to broader governance and socio-political structures. This type of work is particularly relevant in European Union states as EU-level regulations are being developed that shape not only technological deployment but also employment rules.

Our findings provide deeper insights into the previously under-researched impacts of vehicle electrification, digitalization and automation on transport workers' everyday lives, contributing to the literature on quality of working life and just transitions. The implications extend beyond the Swedish context and are relevant to workers in other sectors undergoing low-carbon transitions, especially considering that similar sector regulations exist across the EU. Results can guide trade unions, governments and businesses in developing supportive policies and strategies to ensure decent working conditions for transport workers.

CRediT authorship contribution statement

Jindan Gong: Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation. **Maria Xylia:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Claudia Strambo:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Björn Nykvist:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Sirin Celik:** Writing – review & editing, Validation, Methodology.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used Chat GPT 3.5 in order to improve the language and clarity of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Interview guide

Table A1 provides an English translation of the prompts and questions explored in the semi-structured interviews. When the participants' answers to one question answered other questions as well, we crossed off the covered questions and did not explicitly ask them. The same set of guiding questions were used in all interviews.

Table A1
Overview of the interview guide used in the semi-structured interviews, including guiding questions and prompts.

Topic 1: Background Prompt: n/a	Question 1.1: Could you tell me a bit about yourself? Where do you live and work, what type of transport do you work with, how long you have worked in the trucking/delivery/taxi sector? Question 1.2: How many hours do you work per week? Question 1.3: How big is the company you work for? Question 1.4: What type of vehicle do you drive for work?
Topic 2: Current working life Prompt: n/a	Question 2.1: Can you please tell me about a typical day? Question 2.2: How far do you typically travel for work? Question 2.3: What challenges are you facing in your work life currently? Question 2.4: What do you like about your job? Question 2.5: What don't you like about your job? Question 2.6: What would be a good vs. bad day of work for you? Question 2.7: What aspects of your work make you proud?
Topic 3: Implications of decarbonization Prompt: 3a (asked prior to question 3.1): "The Swedish parliament have adopted a goal that Sweden should reach net zero CO2 emission by 2045. For the transport sector, this means zero emission by 2045 and that transport emission should be reduced by 70 % by 2030 compared to 2010. This means that a lot of change is coming with new low-emission technologies being introduced." 3b (asked prior to question 3.2): "Imagine a future where the transport sector is rapidly changing towards electric vehicles. Both personal vehicles and trucks become battery electric to reduce emissions. Still, the transition can look quite different depending on, for example the range of electric vehicles and how charging takes place. We could see a gradual buildout of charging infrastructure, with charging taking place mostly overnight, at home and in depots, and changing usage patterns due to the limited range of electric vehicles. Or a rapid development of charging technology and extensive networks of fast charging stations, with standardized payment systems, enabling more flexible, but also costlier options for charging." For each question, follow up with categories to cover as many as possible: A) In terms of health and safety? B) In terms of job security? C) In terms of skill requirements?	Question 3.1: What trends regarding decarbonization in the trucking/delivery/taxi sector are you aware of? Where do you get this information from? Question 3.2: What benefits or opportunities do you think these trends will have for your work? Question 3.3: What risks or potential negative implications do you think these trends will have for your work? Question 3.4: What benefits or opportunities do you think these trends will have for the sector overall? Question 3.5: What risks or potential negative implications do you think these trends will have for the sector overall? Question 3.6: Do you think your answer would change if you were another gender or age? If you were unionized/not unionized? And how? Question 3.7: What do you think could help you navigate these changes in the sector better?
Topic 4: Implications of digitalization and automation Prompt: 4a (asked prior to Question 4.1): "As elsewhere in society, digitalization and automation is influencing the developments in the transport sector." 4b (asked prior to Question 4.2): "It is quite uncertain how digitalization and automation influence the transport sector. Examples of more limited impacts are improved route planning support for eco-driving. Digitalization with new ways of organizing work, through digital platforms and new types of business models for transport services such as Uber, means more change. And, finally, more autonomous and even fully self-driving vehicles would mean a very large change to road transport." For each question, follow up with categories to cover as many as possible: A) In terms of health and safety? B) In terms of job security? C) In terms of skill requirements?	Question 4.1: What trends regarding digitalization and automation in the trucking/delivery/taxi sector are you aware of? Where do you get this information from? Question 4.2: What benefits or opportunities do you think these trends will have for your work? Question 4.3: What risks or potential negative implications do you think these trends will have for your work? Question 4.4: What benefits or opportunities do you think these trends will have for the sector overall? Question 4.5: What risks or potential negative implications do you think these trends will have for the sector overall? Question 4.6: Do you think your answer would change if you were another gender or age? If you were unionized/not unionized? And how? Question 4.7: What do you think could help you navigate these changes better?
Topic 5: Closing the interview	Question 5.1: Are there any other issues related to transport workers' working life and the green transition that we did not discuss that you think are important to highlight? Question 5.2: Do you have any questions on the research process? Question 5.3: Do you want us to share the results with you (online)? Question 5.4: Do you have any feedback about this interview you would like to give us?

Appendix B. Data analysis summary table

This appendix provides a summary table of the deductive qualitative content analysis based on the identified categories for quality of working life, and the inductive thematic analysis of perceived implications of electrification, digitalization and automation. Table B1 provides indicative ranges of the number of interviewees associated with each code. This type of quantitative synthesis of the interview data may, however, not align with the qualitative findings [117], which are the focus of this paper.

Table B1
Overview of the qualitative data analysis process exploring drivers' perceived implications of electrification, digitalization and automation. "None" refers to 0 % of the interviewees, "Few" refers to 1–10 % of interviewees, "Some" to 11–50 % and "Most" to 51–100 % respectively.

Deductive qualitative content analysis	**Inductive thematic analysis**			**Mentions by drivers**	
Matrix categories: Quality of working life	**Themes**	**Sub-themes**	**Codes**	**Truck drivers**	**Taxi drivers**
Skill requirements, identity, job security	Changing the nature of the driving profession	Minimal changes in skill requirements	Same requirements as today	Some	Some
			Skill requirements vary already today	Some	Some
		Strong shift in skill requirements	New skills to handle new technologies	Some	Most
			Increased electrical and IT knowledge	Some	None

(*continued on next page*)

Table B1 (*continued*)

Deductive qualitative content analysis	Inductive thematic analysis			Mentions by drivers	
Matrix categories: Quality of working life	**Themes**	**Sub-themes**	**Codes**	**Truck drivers**	**Taxi drivers**
			Current skills may become obsolete	Some	Some
			Higher requirements on fuel efficient driving	Few	Some
		Reduced job satisfaction	Losing interest in the tasks	Some	None
			Risk of less autonomy	None	Some
			Risk of limited access to a variety of amenities	Few	None
		Underestimating and overlooking tasks	Importance of personal relationships with customers	Few	Most
			Complexities in driving	Some	Some
			Importance of cargo handling	Some	None
Work organization, job security, health	Challenges in meeting expectations	Workday disruptions	Charging takes time	Some	Most
			Battery capacity limitations	Some	Some
			Limited idle time	Some	Some
			Tight time schedules	Some	Some
			Challenges in finding rest stops	Some	None
		Different understandings of the technologies	Systems not reflecting reality	Some	Some
			Expectations of perfect systems	Some	Some
		Operational uncertainties	Possibility to charge on mandated breaks	Some	None
			Uncertainty in charging requirements	Some	Some
			Uncertainty in access to charging stations	Some	Most
Job security, identity, health, safety	Uncertain role of drivers in the future	Economic uncertainties	Fewer reasons to have drivers	Most	Some
			Charging time reduces paid working time	Some	Most
			Reduced load capacity with battery electric vehicles	Some	None
			Uncertainty in who will shoulder increased costs	Some	Some
		The human factor	Technology not advanced enough	Most	Some
			Some tasks cannot be automated	Most	Some
Work organization, health, safety	Improved operations	Work environment	Less noise	Some	Some
			Less exhaust gases	Some	Some
			Improved climate control of cabins	Few	None
		Reducing workload	Streamlining operations	Some	Some
			Driving assistance	Most	Some
			Support in administrative tasks	Some	Some
			Support work in general	Some	Some
			Alleviated physical tasks	Some	Few
	New safety risks with new technologies	Distractions	Diverting attentions from traffic	Few	Some
			Overwhelming signals	Few	Some
			Under-stimulation	Few	Some
		Increased risks	Escalating risks	Some	None
			Emerging risks	Some	Some
			Battery dangers	Some	Some
			Not knowing how to manage new risks	Some	None
Job security, skill requirements, health, safety, identity, work organization	Group-specific implications	Age	Older – less job security	Few	Some
			Older – less willing to embrace changes	Some	None
			Older – Struggles to learn and adapt	Some	Some
			Older – will not be affected by changes (close to retirement)	Few	Some
			Younger – easier to learn and adapt	Some	None
		Geography	Remote areas – less access to charging infrastructure	Some	Some
			Remote areas – limited access to internet connection	Few	Some
			Remote areas – limited access to assistance and rescue services	None	Some
			Remote areas – higher battery capacity requirements	Some	Some
		Gender	Women – specific requirements for sanitation services	Few	None

Data availability

The data that has been used is confidential.

References

[1] Becker, H., Becker, F., Abe, R., Bekhor, S., Belgiawan, P. F., Compostella, J., Frazzoli, E., Fulton, L. M., Guggisberg Bicudo, D., Murthy Gurumurthy, K., Hensher, D. A., Joubert, J. W., Kockelman, K. M., Kröger, L., Le Vine, S., Malik, J., Marczuk, K., Ashari Nasution, R., Rich, J., Papu Carrone, A., Shen, D., Shiftan, Y.,

Tirachini, A., Wong, Y. Z., Zhang, M., Bösch, P. M., & Axhausen, K. W. (2020). Impact of vehicle automation and electric propulsion on production costs for mobility services worldwide. *Transport. Res. Pol. Pract., 138*, 105–126. https://doi.org/10.1016/j.tra.2020.04.021

[2] Creutzig, F., Franzen, M., Moeckel, R., Heinrichs, D., Nagel, K., Nieland, S., & Weisz, H. (2019). Leveraging digitalization for sustainability in urban transport. *Global Sustainability, 2*, e14. https://doi.org/10.1017/sus.2019.11

[3] Kanger, L., Geels, F. W., Sovacool, B., & Schot, J. (2019). Technological diffusion as a process of societal embedding: lessons from historical automobile transitions for future electric mobility. *Transport. Res. Transport Environ., 71*, 47–66. https://doi.org/10.1016/j.trd.2018.11.012

[4] Geels, F. W., Sovacool, B. K., Schwanen, T., & Sorrell, S. (2017). The socio-technical dynamics of low-carbon transitions. *Joule, 1*, 463–479. https://doi.org/10.1016/j.joule.2017.09.018

[5] Green, F., & Gambhir, A. (2020). Transitional assistance policies for just, equitable and smooth low-carbon transitions: who, what and how? *Clim. Pol., 20*, 902–921. https://doi.org/10.1080/14693062.2019.1657379

[6] Martin, M., & Islar, M. (2021). The 'end of the world' vs. the 'end of the month': understanding social resistance to sustainability transition agendas, a lesson from the Yellow Vests in France. *Sustain. Sci., 16*, 601–614. https://doi.org/10.1007/s11625-020-00877-9

[7] Sorensen, G., Dennerlein, J. T., Peters, S. E., Sabbath, E. L., Kelly, E. L., & Wagner, G. R. (2021). The future of research on work, safety, health and wellbeing: a guiding conceptual framework. *Soc. Sci. Med., 269*. https://doi.org/10.1016/j.socscimed.2020.113593

[8] Fraser, N. (1999). Social justice in the age of identity politics: redistribution, recognition, and participation. In *Culture and Economy after the Cultural Turn* (pp. 25–52). London: SAGE Publications Ltd. https://doi.org/10.4135/9781446218112.

[9] Fraser, N. (2008). *Scales of Justice: Reimagining Political Space in a Globalizing World*. Columbia University Press.

[10] Ludwig, D., Boogaard, B., Macnaghten, P., & Leeuwis, C. (Eds.). (2022). *The Politics of Knowledge in Inclusive Development and Innovation*. London: Routledge.

[11] Moilanen, F., & Alasoini, T. (2023). Workers as actors at the micro-level of sustainability transitions: a systematic literature review. *Environ. Innov. Soc. Transit., 46*, Article 100685. https://doi.org/10.1016/j.eist.2022.100685

[12] International Labour Organization. (2015). Guidelines for a just transition towards environmentally sustainable economies and societies for all. Geneva https://www.ilo.org/wcmsp5/groups/public/@ed_emp/@emp_ent/documents/publication/wcms_432859.pdf. (Accessed 9 June 2023).

[13] Lundström, R. (2018). Greening transport in Sweden: the role of the organic intellectual in changing union climate change policy. *Globalizations, 15*, 536–549. https://doi.org/10.1080/14747731.2018.1454677

[14] Winslott Hiselius, L., Khan, J., Smidfelt Rosqvist, L., Lund, E., Nilsson, L., & Nilsson, M. (2020). En rättvis omställning av transportsystemet : - En analys av de sociala effekterna av styrmedel för minskade klimatutsläpp, Trafik och väg. http://lup.lub.lu.se/record/086b3dbb-a9f3-4051-87dc-fc2c1e846a9b. (Accessed 9 December 2021).

[15] Stefana, E., Marciano, F., Rossi, D., Cocca, P., & Tomasoni, G. (2021). Composite indicators to measure quality of working life in Europe: a systematic review. *Soc. Indicat. Res., 157*, 1047–1078. https://doi.org/10.1007/s11205-021-02688-6

[16] Ficapal-Cusí, P., Díaz-Chao, A., Sainz-Ibáñez, M., & Torrent-Sellens, J. (2018). Gender inequalities in job quality during the recession. *Employee Relat., 40*, 2–22. https://doi.org/10.1108/ER-07-2016-0139

[17] Wilks, D., & Neto, F. (2013). Workplace well-being, gender and age: examining the 'double jeopardy' effect. *Soc. Indicat. Res., 114*. https://doi.org/10.1007/s11205-012-0177-7

[18] Brooks, M. M., Mueller, J. T., & Thiede, B. C. (2021). Rural-urban differences in the labor-force impacts of COVID-19 in the United States. *Socius, 7*. https://doi.org/10.1177/23780231211022094

[19] Burchell, B., Sehnbruch, K., Piasna, A., & Agloni, N. (2014). The quality of employment and decent work: definitions, methodologies, and ongoing debates. *Camb. J. Econ., 38*, 459–477. https://doi.org/10.1093/cje/bet067

[20] Sarasini, S. (2009). Constituting leadership via policy: Sweden as a pioneer of climate change mitigation. *Mitig. Adapt. Strategies Glob. Change, 14*, 635–653. https://doi.org/10.1007/s11027-009-9188-3

[21] Swedish Climate Policy Council. (2022). Klimatpolitiska rådets rapport 2022, Swedish climate policy Council. Stockholm https://kth.diva-portal.org/smash/get/diva2:1645293/FULLTEXT01.pdf. (Accessed 14 May 2024).

[22] Sverige, Landsorganisationen (2018). Fem förslag för en investeringsledd klimatpolitik - En klimatpolitisk rapport från LO. *Landsorganisationen i Sverige*. https://www.lo.se/home/lo/res.nsf/vRes/lo_fakta_1366027478784_fem_klimatpolitiska_forslag_pdf/$File/fem_klimatpolitiska_forslag.pdf. (Accessed 8 February 2023).

[23] Viredius, M., & Odell, M. (2013). *Transport Och Klimathotet*. Stockholm: Transportarbetareförbundet. https://www.yumpu.com/sv/document/view/20276391/transport-och-klimathotet. (Accessed 8 February 2023).

[24] Government Offices of Sweden. (2023). *Regeringens Klimathandlingsplan - Hela Vägen till Nettonoll*. Stockholm: Government Offices of Sweden. https://www.regeringen.se/contentassets/990c26a040184c46acc66f89af34437f/regeringens-klimathandlingsplan–hela-vagen-till-nettonoll-skr-20232459.pdf. (Accessed 27 June 2024).

[25] Swedish Climate Policy Council. (2024). Klimatpolitiska rådets rapport 2024, Swedish climate policy Council. Stockholm https://www.klimatpolitiskaradet.se/wp-content/uploads/2024/05/klimatpolitiskaradetsrapport2024.pdf. (Accessed 12 June 2024).

[26] Alexandri, E., Antón, J.-I., & Lewney, R. (2024). The impact of climate change mitigation policies on European labour markets. *Ecol. Econ., 216*, Article 108022. https://doi.org/10.1016/j.ecolecon.2023.108022

[27] International Labour Organization. (2020). Jobs in green and healthy transport. *Making the Green Shift*. Geneva https://www.ilo.org/wcmsp5/groups/public/—dgreports/—dcomm/—publ/documents/publication/wcms_745151.pdf. (Accessed 1 December 2023).

[28] Pollin, R. (2023). Fossil fuel industry phase-out and just transition: designing policies to protect workers' living standards. *Journal of Human Development & Capabilities, 24*, 539–568. https://doi.org/10.1080/19452829.2023.2241840

[29] Nacke, L., Cherp, A., & Jewell, J. (2022). Phases of fossil fuel decline: diagnostic framework for policy sequencing and feasible transition pathways in resource dependent regions. *Oxford Open Energy, 1*. https://doi.org/10.1093/ooenergy/oiac002

[30] Kirk, J., Jefferys, S., & Wall, C. (2012). Representing identity and work in transition: the case of south yorkshire coal-mining communities in the UK. In J. Kirk, S. Contrepois, & S. Jefferys (Eds.), *Changing Work and Community Identities in European Regions: Perspectives on the Past and Present* (pp. 184–216). London: Palgrave Macmillan UK. https://doi.org/10.1057/9780230353916_7.

[31] Fossil Free Sweden. (2023). The journey to a fossil-free Sweden. *Fossilfritt Sverige*. https://fossilfrittsverige.se/en/the-journey/. (Accessed 27 June 2024).

[32] Nilsson, L. J., Åhman, M., Bauer, F., Ericsson, K., Johansson, B., van Sluisveld, M., Vogl, V., Andersson, F. N. G., Hansen, T., Bataille, C., Lechtenböhmer, S., de la Rue du Can, S., & Schiro, D. (2020). A European industrial development policy for prosperity and zero emissions. https://escholarship.org/uc/item/5jm87046. (Accessed 27 June 2024).

[33] Ramasar, V., Busch, H., Brandstedt, E., & Rudus, K. (2022). When energy justice is contested: a systematic review of a decade of research on Sweden's conflicted energy landscape. *Energy Res. Social Sci., 94*. https://doi.org/10.1016/j.erss.2022.102862

[34] Eddy, M. (2023). Tesla strike is a culture clash: Swedish labor vs. American management. https://www.nytimes.com/2023/12/27/business/tesla-sweden-strike-labor.html.

[35] Jeppsson, J. (2023). Apptaxi-chaufförer går ut i strejk – utestängda från löneförhandlingar. *Sveriges Radio*. https://sverigesradio.se/artikel/apptaxi-chaufforer-gar-ut-i-strejk-utestangda-fran-loneforhandlingar. (Accessed 12 June 2024).

[36] Sovacool, B. K. (2017). Contestation, contingency, and justice in the Nordic low-carbon energy transition. *Energy Pol., 102*, 569–582. https://doi.org/10.1016/j.enpol.2016.12.045

[37] Sunio, V. (2021). Unpacking justice issues and tensions in transport system transition using multi-criteria mapping method. *Transport. Res. Transport Environ., 96*, Article 102887. https://doi.org/10.1016/j.trd.2021.102887

[38] Hauff, S., & Kirchner, S. (2014). Cross-national differences and trends in job quality: a literature review and research agenda. *Universität Hamburg*. Hamburg https://www.hsu-hh.de/apo/wp-content/uploads/sites/801/2019/11/Hauff-Kirchner-2014_Review-Job-Quality.pdf. (Accessed 16 November 2023).

[39] Sirgy, M. J., Efraty, D., Siegel, P., & Lee, D.-J. (2001). A new measure of quality of work life (QWL) based on need satisfaction and spillover theories. *Soc. Indicat. Res., 55*, 241–302. https://doi.org/10.1023/A:1010986923468

[40] Brown, A., Charlwood, A., & Spencer, D. A. (2012). Not all that it might seem: why job satisfaction is worth studying despite it being a poor summary measure of job quality. *Work. Employ. Soc., 26*, 1007–1018. https://doi.org/10.1177/0950017012461837

[41] European Commission. (2001). *Employment and Social Policies: A Framework for Investing in Quality*. Luxembourg: European Commission. https://www.businesseurope.eu/publications/commission-communication-employment-and-social-policies-framework-investing-quality. (Accessed 16 November 2023).

[42] Díaz-Chao, Á., Ficapal-Cusí, P., & Torrent-Sellens, J. (2016). Economic crisis and job quality in Spain: a multi-dimensional and micro-data empirical approach. *Soc. Indicat. Res., 125*, 613–633. https://doi.org/10.1007/s11205-014-0850-0

[43] Schulte, P. A. (2020). A global perspective on addressing occupational safety and health hazards in the future of work. *Med. Lav., 111*, 163–165. https://doi.org/10.23749/mdl.v111i3.9735

[44] Stacey, S., Ellwood, P., Bradbrook, B., Reynolds, J., Ravetz, J., Williams, H., & Lye, D. (2018). *Foresight on New and Emerging Occupational Safety and Health Risks Associated with Digitalisation by 2025: Summary*. European Risk Observatory. https://osha.europa.eu/en/publications/summary-foresight-new-and-emerging-occupational-safety-and-health-risks-associated-digitalisation-2025. (Accessed 16 November 2023).

[45] Onninen, J., Pylkkönen, M., Hakola, T., Puttonen, S., Virkkala, J., Tolvanen, A., & Sallinen, M. (2022). The self-reported stress and stressors in tram and long-haul truck drivers. *Appl. Ergon., 102*, Article 103761. https://doi.org/10.1016/j.apergo.2022.103761

[46] Reiman, A., & Väyrynen, S. (2020). Occupational health and safety in the trucking industry – current trends and future challenges. In J. P. Liyanage, J. Amadi-Echendu, & J. Mathew (Eds.), *Engineering Assets and Public Infrastructures in the Age of Digitalization* (pp. 431–438). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-48021-9_48.

[47] The Swedish Transport Workers' Union. (2019). *Taxirapport 2019, the Swedish Transport Workers*. Union. Stockholm.

[48] Wallstenius, A., & Ström Olsson, K. (2020). Utmaningar på väg för transport- och åkeribranschen. *Länsförsäkringar*. https://www.lansforsakringar.se/stockholm/foretag/forsakring/forebygga-skador/foretag-i-trafiken/utmaningar-pa-vag/. (Accessed 22 January 2024).

[49] Wallengren, H., & Ottoson, M. (2019). Truckers: a profession in change, centrum för arbetarhistoria, malmö. https://lucris.lub.lu.se/ws/portalfiles/portal/71205397/CFA10_9789197966160.pdf. (Accessed 7 February 2023).

[50] Iseland, T., Johansson, E., Skoog, S., & Dåderman, A. M. (2018). An exploratory study of long-haul truck drivers' secondary tasks and reasons for performing them. *Accid. Anal. Prev., 117*, 154–163. https://doi.org/10.1016/j.aap.2018.04.010

[51] Zhou, Y., Wen, R., Wang, H., & Cai, H. (2020). Optimal battery electric vehicles range: a study considering heterogeneous travel patterns, charging behaviors, and access to charging infrastructure. *Energy, 197*, Article 116945. https://doi.org/10.1016/j.energy.2020.116945

[52] Phadke, A., Khandekar, A., Abhyankar, N., Wooley, D., & Rajagopal, D. (2021). *Why Regional and Long-Haul Trucks Are Primed for Electrification Now, Lawrence Berkeley National Lab*. LBNL). https://doi.org/10.2172/1834571

[53] Cai, H., Jia, X., Chiu, A. S. F., Hu, X., & Xu, M. (2014). Siting public electric vehicle charging stations in Beijing using big-data informed travel patterns of the taxi fleet. *Transport. Res. Transport Environ., 33*, 39–46. https://doi.org/10.1016/j.trd.2014.09.003

[54] Hecht, C., Victor, K., Zurmühlen, S., & Sauer, D. U. (2021). Electric vehicle route planning using real-world charging infrastructure in Germany. *eTransportation, 10*, Article 100143. https://doi.org/10.1016/j.etran.2021.100143

[55] Sellmair, R., & Schelo, T. (2019). Analysis of the effect of charging infrastructure design on electric taxi driving profiles: a case study approach on the example of Singapore. *International Journal of Sustainable Transportation, 13*, 479–496. https://doi.org/10.1080/15568318.2018.1485792

[56] Khani, A., & Davazdah Emami, B. (2022). *Benefits and Barriers to Electrification of the Freight System in Minnesota, Centre for Transportation Studies*. University of Minnesota. https://www.dot.state.mn.us/ofrw/mfac/pdf/white-paper-electrification-of-freight.pdf. (Accessed 10 July 2023).

[57] Alasoini, T., Ala-Laurinaho, A., & Känsälä, M. (2022). Driving high and low: heavy vehicle drivers and their supervisors facing digitalization. *Nordic Journal of Working Life Studies, 13*. https://doi.org/10.18291/njwls.132379

[58] Mohan, A., & Vaishnav, P. (2022). Impact of automation on long haul trucking operator-hours in the United States. *Humanities and Social Sciences Communications, 9*, 1–10. https://doi.org/10.1057/s41599-022-01103-w

[59] Dubljević, V., Douglas, S., Milojevich, J., Ajmeri, N., Bauer, W. A., List, G., & Singh, M. P. (2023). Moral and social ramifications of autonomous vehicles: a qualitative study of the perceptions of professional drivers. *Behav. Inf. Technol., 42*, 1271–1278. https://doi.org/10.1080/0144929X.2022.2070078

[60] Bartel, E., MacEachen, E., Reid-Musson, E., Meyer, S. B., Saunders, R., Bigelow, P., Kosny, A., & Varatharajan, S. (2019). Stressful by design: exploring health risks of ride-share work. *J. Transport Health, 14*, Article 100571. https://doi.org/10.1016/j.jth.2019.100571

[61] Gillis, D., Lenaerts, K., & Waeyaert, W. (2022). *Occupational Safety and Health Risks of Parcel Delivery Work Organised through Digital Labour Platforms*. European Agency for Safety and Health at Work. https://osha.europa.eu/en/publications/occupational-safety-and-health-risks-parcel-delivery-work-organised-through-digital-labour-platforms. (Accessed 16 November 2022).

[62] Morton, R., Richards, D., Dunn, N., & Coulton, P. (2019). Questioning the social and ethical implications of autonomous vehicle technologies on professional drivers. *Des. J., 22*, 2061–2071. https://doi.org/10.1080/14606925.2019.1594930

[63] Council of the EU. (2023). Rights for platform workers: Council agrees its position. https://www.consilium.europa.eu/en/press/press-releases/2023/06/12/rights-for-platform-workers-council-agrees-its-position/. (Accessed 13 July 2023).

[64] European Commission. (2023). Automation in transport. https://transport.ec.europa.eu/transport-themes/social-issues-equality-and-attractiveness-transport-sector/social-issues/automation-transport_en. (Accessed 13 July 2023).

[65] Dawkins, E., Strambo, C., Xylia, M., Grah, R., Gong, J., Axelsson, K., & Maltais, A. (2023). Who is most at risk of losing out from low-carbon transition in the food and transport sectors in Sweden? Equity considerations from a consumption perspective. *Energy Res. Social Sci., 95*, Article 102881. https://doi.org/10.1016/j.erss.2022.102881

[66] Sovacool, B. K., Upham, P., Martiskainen, M., Jenkins, K. E. H., Torres Contreras, G. A., & Simcock, N. (2023). Policy prescriptions to address energy and transport poverty in the United Kingdom. *Nat. Energy, 8*, 273–283. https://doi.org/10.1038/s41560-023-01196-w

[67] Silva, J. M., Carley, S., & Konisky, D. M. (2023). "I earned the right to build the next American car": how autoworkers and communities confront electric vehicles. *Energy Res. Social Sci., 99*, Article 103065. https://doi.org/10.1016/j.erss.2023.103065

[68] Pichler, M., Krenmayr, N., Maneka, D., Brand, U., Högelsberger, H., & Wissen, M. (2021). Beyond the jobs-versus-environment dilemma? Contested social-ecological transformations in the automotive industry. *Energy Res. Social Sci., 79*. https://doi.org/10.1016/j.erss.2021.102180

[69] International Labour Organization. (2022). *Just Transition Policy Brief*. International Labour Agency. https://www.ilo.org/wcmsp5/groups/public/—ed_emp/—emp_ent/documents/publication/wcms_858856.pdf. (Accessed 5 December 2023).

[70] Etf, IndustriALL. (2023). *Building a Just Transition towards a Smart and Sustainable Mobility*. European Transport Workers' Federation and IndustriAll European Trade Union. Brussels https://www.etf-europe.org/wp-content/uploads/2023/09/IndustriAll_JUST_TRANSITION_EN_23_1.pdf. (Accessed 4 December 2023).

[71] Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: implications for conducting a qualitative descriptive study. *Nurs. Health Sci., 15*, 398–405. https://doi.org/10.1111/nhs.12048

[72] Brough, P., O'Driscoll, M. P., & Biggs, A. (2009). Parental leave and work-family balance among employed parents following childbirth: an exploratory investigation in Australia and New Zealand. *Kotuitui, 4*, 71–87. https://doi.org/10.1080/1177083X.2009.9522445

[73] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol., 3*, 77–101. https://doi.org/10.1191/1478088706qp063oa

[74] Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *J. Adv. Nurs., 62*, 107–115. https://doi.org/10.1111/j.1365-2648.2007.04569.x

[75] Sandström, B., Willman, A., Svensson, B., & Borglin, G. (2015). Perceptions of national guidelines and their (non) implementation in mental healthcare: a deductive and inductive content analysis. *Implement. Sci., 10*, 43. https://doi.org/10.1186/s13012-015-0234-0

[76] Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development. *Int. J. Qual. Methods, 5*, 80–92. https://doi.org/10.1177/160940690600500107

[77] Sovacool, B. K., Martiskainen, M., Hook, A., & Baker, L. (2019). Decarbonization and its discontents: a critical energy justice perspective on four low-carbon transitions. *Climatic Change, 155*, 581–619. https://doi.org/10.1007/s10584-019-02521-7

[78] Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health Serv. Res., 34*, 1189. https://pmc.ncbi.nlm.nih.gov/articles/PMC1089059/.

[79] Christidis, P., Navajas, E., Brons, M., Schade, B., Mongeli, I., & Soria, A. (2014). *Future Employment in Transport. Analysis of Labour Supply and Demand*. European Commission. https://publications.jrc.ec.europa.eu/repository/handle/JRC93302. (Accessed 4 December 2023).

[80] Aisa, R., Cabeza, J., & Martin, J. (2023). Automation and aging: the impact on older workers in the workforce. *The Journal of the Economics of Ageing, 26*, Article 100476. https://doi.org/10.1016/j.jeoa.2023.100476

[81] Caliendo, M., Cobb-Clark, D. A., Obst, C., & Uhlendorff, A. (2023). Risk preferences and training investments. *J. Econ. Behav. Organ., 205*, 668–686. https://doi.org/10.1016/j.jebo.2022.11.024

[82] Mudzar, N. M. B. M., & Chew, K. W. (2022). Change in labour force skillset for the fourth industrial revolution: a literature review. *International Journal of Technology, 13*, 969. https://doi.org/10.14716/ijtech.v13i5.5875

[83] Pakusch, C., Boden, A., Stein, M., & Stevens, G. (2021). The automation of the taxi industry – taxi drivers' expectations and attitudes towards the future of their work. *Comput. Support. Coop. Work, 30*, 539–587. https://doi.org/10.1007/s10606-021-09408-1

[84] Anner, M., Pons-Vignon, N., & Rani, U. (2019). For a future of work with dignity: a critique of the world bank development report, the changing nature of work. *Global Labour Journal, 10*, 2–19. https://doi.org/10.15173/glj.v10i1.3796

[85] Liang, D. (2023). Advanced driver assistance systems and older drivers – mobility. *Perception, and Safety*. http://hdl.handle.net/10919/116547. (Accessed 17 January 2024).

[86] Hungund, A. P., Pai, G., & Pradhan, A. K. (2021). Systematic review of research on driver distraction in the context of advanced driver assistance systems. *Transport. Res. Rec., 2675*, 756–765. https://doi.org/10.1177/03611981211004129

[87] DeGuzman, C. A., & Donmez, B. (2022). Drivers don't need to learn all ADAS limitations: a comparison of limitation-focused and responsibility-focused training approaches. *Accid. Anal. Prev., 178*, Article 106871. https://doi.org/10.1016/j.aap.2022.106871

[88] Budnitz, H., & Schwanen, T. (2022). *Preferences for Public Electric Vehicle (EV) Charging, Transport Studies Unit*. Oxford, UK: University of Oxford. https://ora.ox.ac.uk/objects/uuid:276136d1-5bc1-4a44-8031-2cbc9654eee1. (Accessed 28 August 2023).

[89] Sun, P., Bisschop, R., Niu, H., & Huang, X. (2020). A review of battery fires in electric vehicles. *Fire Technol., 56*, 1361–1410. https://doi.org/10.1007/s10694-019-00944-3

[90] Biloria, N. (2023). 11 - autonomous mobility in the built environment. In P. Droege (Ed.), *Intelligent Environments* (second ed., pp. 351–394). North-Holland. https://doi.org/10.1016/B978-0-12-820247-0.00007-2.

[91] Engel, H., Hensley, R., Knupfer, S., & Sahdev, S. (2018). The basics of electric-vehicle charging infrastructure. *McKinsey*. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/charging-ahead-electric-vehicle-infrastructure-demand. (Accessed 23 August 2023).

[92] Eklöf, H. (2018). Infrastruktur för snabbladdning längs större vägar- ett regeringsuppdrag. *The Swedish Transport Administration*. https://trafikverket.diva-portal.org/smash/get/diva2:1426064/FULLTEXT01.pdf. (Accessed 22 January 2024).

[93] The Swedish Post and Telecom Authority. (2022). Bredband till allt – Åtgärder för ett helt uppkopplat Sverige, the Swedish Post and Telecom Authority. https://www.pts.se/globalassets/startpage/dokument/icke-legala-dokument/rapporter/2022/internet/rapport—bredband-till-allt—atgarder-for-ett-helt-uppkopplat-sverige—december-2022.pdf. (Accessed 22 January 2024).

[94] Perger, T., & Auer, H. (2020). Energy efficient route planning for electric vehicles with special consideration of the topography and battery lifetime. *Energy Efficiency, 13*, 1705–1726. https://doi.org/10.1007/s12053-020-09900-5

[95] Belzer, M. H. (2020). The economics of long work hours: how economic incentives influence workplace practice. *Ind. Health, 58*, 399. https://doi.org/10.2486/indhealth.58_500

[96] Buldeo Rai, H., Verlinde, S., & Macharis, C. (2018). The “next day, free delivery” myth unravelled: Possibilities for sustainable last mile transport in an omnichannel environment. *Int. J. Retail Distrib. Manag., 47*, 39–54. https://doi.org/10.1108/IJRDM-06-2018-0104

[97] Briland Rosenström, M., Burman, E., Celik, S., & Palmgren, O. (2023). En studie om e-handelns leveranser och leveransalternativ - Hållbar frakt? *Handels, Seko, Transportarebetareförbundet*. https://kampanj.transport.se/media/2a5j5tyt/ha17115-hallbar-frakt-handels-seko-transport-blank-baksida-74.pdf. (Accessed 22 January 2024).

[98] Caspersen, E., & Navrud, S. (2021). The sharing economy and consumer preferences for environmentally sustainable last mile deliveries. *Transport. Res. Transport Environ., 95*, Article 102863. https://doi.org/10.1016/j.trd.2021.102863

[99] Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., & Barau, A. (2017). Exploring the governance and politics of transformations towards sustainability. *Environ. Innov. Soc. Transit., 24*, 1–16. https://doi.org/10.1016/j.eist.2016.09.001

[100] Regulation 561/2006, Regulation (EC) No 561/2006 of the European Parliament and of the Council of 15 March 2006 on the harmonisation of certain social legislation relating to road transport and amending Council Regulations (EEC) No 3821/85 and (EC) No 2135/98 and repealing Council Regulation (EEC) No 3820/85 (Text with EEA relevance). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02006R0561-20240522. (Accessed 13 November 2024).

[101] Swedish Confederation of Transport Enterprises, Transportföretagen föreslår förändrade kör- och vilotidsregler. https://www.transportforetagen.se/nyhetslista/2023/januari/elektrifierade-transporter-behover-justerade-kor–och-vilotidsregler/, (2023)–. (Accessed 13 July 2023).

[102] Directive 2024/2831, Directive (EU) 2024/2831 of the European Parliament and of the Council of 23 October 2024 on improving working conditions in platform work. https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32024L2831. (Accessed 13 November 2024).

[103] Bryson, J. M., Quick, K. S., Slotterback, C. S., & Crosby, B. C. (2013). Designing public participation processes. *Publ. Adm. Rev., 73*, 23–34. https://doi.org/10.1111/j.1540-6210.2012.02678.x

[104] Forslund, A. (1997). The Swedish model: past, present, and future. In H. Giersch (Ed.), *Reforming the Welfare State* (pp. 121–162). Berlin, Heidelberg: Springer. https://doi.org/10.1007/978-3-642-60497-3_8.

[105] Krause, D., Stevis, D., Hujo, K., & Morena, E. (2022). Just transitions for a new eco-social contract: analysing the relations between welfare regimes and transition pathways. *Transfer: European Review of Labour and Research, 28*, 367–382. https://doi.org/10.1177/10242589221127838

[106] Della Bosca, H., & Gillespie, J. (2018). The coal story: generational coal mining communities and strategies of energy transition in Australia. *Energy Pol., 120*, 734–740. https://doi.org/10.1016/j.enpol.2018.04.032

[107] Mayer, A. (2018). A just transition for coal miners? Community identity and support from local policy actors. *Environ. Innov. Soc. Transit., 28*, 1–13. https://doi.org/10.1016/j.eist.2018.03.006

[108] Tschakert, P., Barnett, J., Ellis, N., Lawrence, C., Tuana, N., New, M., Elrick-Barr, C., Pandit, R., & Pannell, D. (2017). Climate change and loss, as if people mattered: values, places, and experiences. *WIREs Climate Change, 8*, e476. https://doi.org/10.1002/wcc.476

[109] Clausen, T., Pedersen, L. R. M., Andersen, M. F., Theorell, T., & Madsen, I. E. H. (2022). Job autonomy and psychological well-being: a linear or a non-linear association? *Eur. J. Work. Organ. Psychol., 31*, 395–405. https://doi.org/10.1080/1359432X.2021.1972973

[110] Litchfield, P., Cooper, C., Hancock, C., & Watt, P. (2016). Work and wellbeing in the 21st century. *Int. J. Environ. Res. Publ. Health, 13*, 1065. https://doi.org/10.3390/ijerph13111065

[111] Wheatley, D. (2017). Autonomy in paid work and employee subjective well-being. *Work Occup., 44*, 296–328. https://doi.org/10.1177/0730888417697232

[112] Jenkins, D., & Neal, A. (2023). Work relationships and autonomy. *The Journal of Value Inquiry*. https://doi.org/10.1007/s10790-023-09939-4

[113] MacLeod, D., & Clarke, N. (2009). *Engaging for Success: Enhancing Performance through Employee Engagement*. London: Department for Business, Innovation and Skills. https://webarchive.nationalarchives.gov.uk/ukgwa/20110207095901. (Accessed 4 December 2023).

[114] Statistics Sweden. (2023). Anställda (yrkesregistret) 16-64 år efter yrke (SSYK 2012), kön och år, anställda (yrkesregistret) 16-64 År efter yrke (SSYK 2012), kön och år. https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START_AM_AM0208_AM0208E/YREG50N/table/tableViewLayout1/?loadedQueryId=125149&timeType=item. (Accessed 22 January 2024).

[115] Eurostat. (2023). Six million people working in EU transport in 2021 - products eurostat news - eurostat. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20230207-1. (Accessed 1 December 2023).

[116] Sustainable Mobility for All. (2023). *Gender Imbalance in the Transport Sector: A Toolkit for Change*. Washington D.C.. https://www.sum4all.org/data/files/gender_imbalance_in_the_transport_sector_a_toolkit_for_change.pdf. (Accessed 1 December 2023)

[117] Chang, Y., Voils, C. I., Sandelowski, M., Hasselblad, V., & Crandell, J. L. (2009). Transforming verbal counts in reports of qualitative descriptive studies into numbers. *West. J. Nurs. Res., 31*, 837–852. https://doi.org/10.1177/0193945909334434