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Sociotechnical expectations of vehicle automation in the UK trucking sector

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ABSTRACT

Expectations about emerging innovations are an important part of innovation pathways that can help to overcome uncertainties and build hype. Such sociotechnical expectations have been studied extensively by social scientists but the focus is often on collective, widely shared expectations and much less on individuals' specific expectations. Examining the latter can nonetheless aid understanding of the development of, buy-in into and power dynamics around collective sociotechnical expectations. This paper therefore examines individually articulated expectations about vehicle automation in the trucking industry in the UK. It draws on 61 in-depth interviews with freight transport actors, including truck drivers, freight company management, industry representatives, and representative from government departments. It demonstrates alignment of individual expectations on some aspects of vehicle automation, including the difficulty of expression them in terms of chronological (calendar) time and the belief that automation will be quicker and easier on motorways than on other kinds of road. Multiple differences in expectations are identified, in particular regarding the practical feasibility of truck platooning and the role of truck drivers. In all cases, it is clear that individual expectations are shaped strongly by people's current and past professional experience and practices and how these have been affected by wider technological and organisational changes in the freight and logistics sector.

1. Introduction

The road freight sector is in a period of substantial upheaval. Social, economic, political and environmental changes are all challenging the status quo for the sector, and requiring new ways of moving freight. For instance, there is a need to rapidly reduce the carbon emissions of road freight transport, which remains highly dependent on fossil fuels (Churchman and Longhurst, 2022). There is also a need to reduce operational costs, particularly because truck driver salaries make up about a third of operators' costs (Müller and Voigtländer, 2019), and to respond to claims of a driver shortage (Hopkins and Davidson, 2022). One innovation that has been proposed to address these challenges is vehicle automation, with claims that it could increase driving efficiency (thereby reducing emissions) and reduce the need for human drivers (and their salaries; Sindi and Woodman, 2021). Yet there remains a great deal of uncertainty around the freight sector's expectations about this innovation, particularly due to a dominant literature focus on the automation of passenger transport in the academic literature (e.g., (e.g., Nielsen and Haustein, 2018; Penmetsa et al., 2019; Liu, 2020; Rahimi et al., 2020, Martin, 2021). We argue that there is a need to go beyond the techno-economic rationalities that underpin much scholarship on road freight (Churchman and Longhurst, 2022) to understand the messy practicalities of road freight operations and better situate innovation trajectories towards automation. Moreover, since some parts of freight transport may be automated more quickly than other forms of transport, it is important to accelerate knowledge of automation of road freight, with implications for safety, emissions and labour relations.

Conceptually engaging with sociotechnical expectations, this paper is motivated by the important role that the articulation of expectations plays in dealing with uncertainties in the early stages of sociotechnical innovation processes and the generation of momentum and enthusiasm around innovations (Geels et al., 2018). The power of expectations means that they can – and sometimes do – help to build particular futures, and generate effects (e.g., perpetuate or challenge the status quo). Expectations tend to be framed in social science research as collectively held and shared but they emerge from the visions of individuals too. Indeed, there are important connections between individual and shared expectations, with some (collectives of) individuals working to share their imagining of sociotechnical futures. In recognising that collectively held expectations dominate the literature, we seek to reconcile

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methodologies that focus on individual articulations (e.g., interviews) with the shared nature of some forms of sociotechnical expectations.

Our research responds to one question: How do UK road freight actors articulate their expectations of vehicle automation for the road freight sector? It does so through a qualitative investigation of freight transport actors, culminating in 61 qualitative interviews (lasting on average 57 min per interview) with a diversity of actors including truck drivers, haulage firm management, industry organisations and government departments. The diverse sample helps to articulate the plurality of ways that individuals experience and view the sector and its operations, which in turn contributes to ways of thinking about vehicle automation. Semi-structured interviews were selected as an appropriate way to gain holistic framings of participants' expectations of vehicle automation in relation to their everyday working lives. Our focus is on the UK because it represents a country with significant investment – from both public and private sector – in vehicle automation, with a range of public demonstrations largely by way of triple helix consortia (see, for example, Hopkins and Schwanen, 2018), yet it is likely the empirical findings will be relevant to road freight and logistics in other countries and regions across the Global North too.

The research finds points of alignment (e.g., where automation is expected to happen first and/or most easily) and disagreement (e.g., practicalities of specific implementations) among freight industry participants. Importantly, it underscores the importance of attending to individual-level sociotechnical expectations which can offer more tangible reflections on innovation processes in particular places, while also offering a voice to those often neglected from sectoral analyses of innovation – the actual workers (i.e., truckers) themselves. In answering the research question, this paper responds to a number of research needs: (1) practically, it incorporates wide ranging sectoral voices to discussions on vehicle automation, thereby better reflecting the operational constraints and realities in which vehicle automation will be realised; (2) conceptually, it characterises and explicates the need for individual expectations to be recognised as worthy of investigation and traces a methodological route for reconciling the individual with the collective; (3) methodologically, it adopts qualitative interviews for a topic (vehicle automation) dominated by social survey methods and a type of transport (trucking) for which research on innovations is almost exclusively quantitative in nature. This paper thus has relevance for academics, innovators, and the freight sector, as they seek to prepare for the emergence and potential diffusion of vehicle automation.

2. Sociotechnical expectations

Academic scholarship on sociotechnical expectations – here used as shorthand for expectations about the future nature, use and institutionalisation of one or more technologies and the wider changes associated with that use – is both diverse and consonant. It draws on thinking from across the social and behavioural sciences while recognising the situatedness of expectations. It accepts that expectations unite an orientation and openness towards the future with (strong) tethers to past experience. It also recognises that formation and articulation of expectations requires a degree of future-oriented storytelling and thus not only the gathering of information but also the situating of this information in particular socio-cultural, economic, political contexts – i.e., the "real time representations of future technological situations and capabilities" (Borup et al., 2006, page 286).

Expectations are often framed alongside concepts such as (socio) technological promises (van Lente, 2000), visions (Gjøen, 2001); Sovacool et al., 2020), fantasies (Sovacool and Brossmann, 2014), and imaginaries (Jasanoff and Kim, 2009; Mutter, 2021). Yet unlike those concepts, expectations are thought to be the "wishful *enactment* of a desired future" (Borup et al., 2006: 286, emphasis added). Here, Borup and colleagues remind us that expectations are not neutral representations, but play (a) performative role(s) in the innovation process and social life (see also Lazarevic and Valve, 2017). Their anticipatory dynamics can enable or constrain possible futures (Urueña, 2022). In other words, expectations do all kinds of 'work' and make some futures more likely than others. They are often useful coordination devices that facilitate communication and community building between different actors and within organisations, and keep bonds aligned over time (Brown and Michael, 2003; Borup et al., 2006). Expectations can generate a common purpose and consensus about the desirable development trajectory of a given innovation among committed actors, such as designers and entrepreneurs, and help to secure financial and non-financial resources and (politicians') support (Van Lente, 1993). By reducing the uncertainties that complicate innovation processes, the ongoing articulation of sociotechnical expectations can stimulate and accelerate the development of new or reconfigured sociotechnical systems (Geels et al., 2018). Yet this very process can also close down the momentum of alternative sociotechnical systems "by modulating what counts (or should count) as (im)plausible or (un)desirable at present" (Urueña, 2022, page 798).

In social science research on innovations and technological futures, the unit of analysis is often the *collective* expectation (e.g., Kriechbaum et al., 2021), which is held by multiple (groups of) actors, or is widely known, shared and articulated by many (Konrad, 2006; Tidwell and Tidwell, 2018). This focus is important because widely shared expectations can mobilise greater number of actors (Korsnes, 2016) and contribute to the construction of hypes, and hype-disappointment cycles (van Lente et al., 2013; Dedehayir and Steinert, 2016; Kriechbaum et al., 2021; Lehtonen, 2022). In such cycles, 'generalised expectations' – impersonal expressions about the future uptake and impacts of an innovation – are downgraded and changed after a period of hype (Ruef and Markard, 2010).

It nonetheless is important to study the 'specific expectations' held and articulated by individuals (Ruef and Markard, 2010), for multiple reasons. For one, individual and collective sociotechnical expectations are interlinked and entwined (Beckert, 2013; Ambrosio-Albala et al., 2023). Collective sociotechnical expectations can emerge from the visions of individuals (Jasanoff, 2015). Thus, expectations may be constructed by individuals, organisations and actor groups (Konrad, 2006), each of whom will be drawing upon socially shared worldviews, knowledges, sensibilities, emotions, norms, values and also (earlier) collective expectations they have encountered and internalised over their particular life-course and everyday practices in specific places and times (Pred, 1983; Eames et al., 2006; Ryghaug et al., 2022).

Which and to what extent individual expectations are scaled and become shared depends on multiple factors (Budde et al., 2012; Kriechbaum et al., 2018; Sand, 2019). These include the affective forces, manifested in the gut feelings and positive emotions that people are able to marshal and cultivate in others, as well as social standing. Persuading others may be easier if someone has greater social capital or holds a leadership role in an organisation or community. More generally, the ability to insert one's voice into discourses about (technological) innovations are unevenly distributed. As Sand (2019, page 99) notes, it is "a small group of highly educated, male, well-off people from the Northern Hemisphere [that have] attracted most of the attention of … the public discourse on our socio-technical future". Based on this work, it seems reasonable to hypothesise that social standing is inversely correlated with two conditions necessary for the formation of 'specific expectations': the ability to make suggestions about one's possible futures (anticipatory capacity) and the hope that current desires and aspirations will be realised in the future.

A second reason for studying both collective and individual sociotechnical expectations is that alignment and differences between each become visible. This is important because strong alignment can reflect widespread buy-in into collective expectations and/or those expressed by powerful actors and individuals. The latter situation is indicative of the extent to which those actors and individuals are able to shape the thinking, imaginations and aspirations of others. It thus begins to render power dynamics in innovation processes insightful. In contrast, weak

alignment of collective and individual sociotechnical expectations can point to the existence of subtle and soft forms of resistance and subversion (see Scott, 1990) against shared or dominant expectations among specific groups. Such expectation resistance and subversion may be provoked by the perceived threat or risks that an innovation may pose, for instance when vehicle automation is understood as a threat to employment or career opportunities in trucking. Yet they may also emerge from disjuncture between on the one hand collective expectations and the assumptions that underpin them, and the everyday practices and experience of particular individuals, including those working in trucking, freight and logistics.

There is also an explicitly normative case for paying attention to the multiplicity in 'specific expectations.' Doing so contributes to inclusivity and 'epistemic justice' (Fricker, 2007) in scholarship on expectations and sociotechnical futures (Konrad and Böhle, 2019) and therefore to responsible innovation (Valkenberg et al., 2020). The onus is on researchers to put in place theoretical and methodological frameworks and practices that allow the sociotechnical expectations held by individuals with a stake in a given innovation to be articulated and rendered intelligible, an ambition taken forward in this paper.

3. Automating mobility

3.1. Automating vehicles and driving tasks

Gradual automation of the driving task has taken place since the emergence of the first motor vehicle, and has tended to emerge in freight vehicles before their mass adoption in passenger vehicle markets. Initially, automation was a way to reduce the burden of driving and make the task less physically and mentally taxing (Kröger, 2016). Steering, for instance, once required significant bodily capabilities to manoeuvre the vehicle, particularly in heavy-goods-vehicles (HGVs, also called 'trucks' or 'lorries') – a task that was eased over time with incremental changes to design, and eventually the introduction of power steering in the 1950s. While responsibility for performing the task remained firmly within the responsibility of the driver, technological innovations offered *assistance*, altering the physicality of driving.

Driver 'assistance' remains a key term in initial steps towards automation, for instance through features such as cruise control and lane departure warning systems. By way of example, electronic cruise control was developed in the 1960s, but took twenty years to reach mass production in private vehicles (Tatum, 2003). The next iteration of this innovation is now reaching fruition, particularly in freight vehicles, by way of *adaptive* cruise control which automates the driving speed and adapts to the speeds and rhythms of other (motorised) road users. Lane departure warning systems ('lane assist') first emerged in the early 2000s and have long differed in terms of the level of invasiveness in the driving task between original equipment manufacturers (OEMs). Shaout et al. (2011) describe the difference between low level 'invasion' where the driver is still fully in control (e.g., Ford's Lane Departure Warning System) to the 'highly invasive system' produced by Honda ('Lane Keep Assist System') and Toyota ('Lane Monitoring System') where the system has a high level of control over the vehicle. Thus, not only are the automated features diverse, but so too are the applications of these features – and the role of the driver within the system – between the various OEM offerings.

Stages of vehicle automation have been largely understood by way of sequential 'levels of automation' (See Hopkins and Schwanen, 2021), designed by public and private sector bodies including the US National Highway Traffic Safety Administration (NHTSA), Germany's Bundesanstalt für Straßenwesen (BASt), and the US-based Society of Automotive Engineers (SAE). These all run from 'no automation' to 'full automation' via a series of intermediate steps. The focus of technological development has been on achieving (close to) 'full automation', which supposedly unlocks the largest potential for social, economic and environmental benefits of vehicle automation (e.g., increased accessibility, improved safety).

Efforts pre-COVID-19 to track the hype associated with vehicle automation by Gartner, a business research and advisory company, initially focused on an undifferentiated 'autonomous vehicle', yet over time it became clear that the hype (and disappointment) needed to reflect the different types of automation and related practices. This led to a focus on SAE levels 4 (no human intervention in known areas and driving conditions) and 5 (no human intervention at all), which were positioned in the 2019 model with SAE level 5 at the 'peak of inflated expectations', while level 4 sat in the 'trough of disillusionment' (Gartner, 2019). By the 2020 and 2021 Gartner hype cycles, vehicle automation was no longer included as an 'emerging technology'. This might be explained by the relative importance and significance of vehicle automation in relation to other innovations including, for instance, nonfungible tokens and generative AI, both of which appeared on the Gartner cycle in 2021 and 2020 respectively. The comparison between these seemingly disparate innovations is relevant for the primary audience of the Gartner reports, which is framed as those who want help to "understand the real risks and opportunities of innovation, so… [to] avoid adopting something too early, giving up too soon, adopting too late, or hanging on too long" (Gartner, 2022, np).

3.2. Expectations of vehicle automation

There are burgeoning academic and non-academic literatures on automation and road transport which pay attention to aspects such as technical capabilities, legal and regulatory frameworks, ethics, design, infrastructures and public perceptions. Research that examines public, industry and/or policy expectations of vehicle automation is rapidly increasing, but is characterised by a methodological predilection for the use of surveys at a single point in time to gauge the views and beliefs of populations or segments (e.g., Nielsen and Haustein, 2018; Cunningham et al., 2019; Penmetsa et al., 2019; Rahman et al., 2019; Liu, 2020). Population surveys tend to point to segments of sceptics and enthusiasts which often align with innovation adoption models of 'early adopters' to 'laggards', and provide characteristics of these segments in terms of current mobility practices and preference. For instance, Nielsen and Haustein (2018, page 49) report that "people who are enthusiastic about self-driving cars are typically male, young, highly educated, and live in large urban areas, while Sceptics are older, car reliant and more often live in less densely populated areas". Nonetheless, a range of other techniques and measures is also used to probe AV expectations and related issues, including stated preference techniques (Yap et al., 2016; Jiang et al., 2019; Gkartzonikas and Gkritza, 2019) and willingness-to-pay measures (Rahimi et al., 2020; Maeng and Cho, 2022); agent-based modelling (Talebian and Mishra, 2018); and field experiments (Liu and Xu, 2020) and driving simulators (Ulahannan et al., 2020; Chen et al., 2022).

While much of this literature has focused on *public* perceptions and expectations, Whittle et al. (2019) used expert interviews to investigate issues of perceived trust and safety and barriers to uptake around automated vehicles in the context of wider discussions about low-carbon mobility transitions. They found that, compared to non-automated vehicles, "CAVs [connected and autonomous vehicles] represent a more radical and less familiar prospect for most people; and so trust may be harder to establish" (Whittle et al., 2019, page 12). This finding underscores the relative un-known-ness of automated vehicle innovations, and the potential complexities of formulating and articulating expectations. Little research has focused on the expectations, adoption and uptake of automated vehicles in the freight transport sector. A notable exception is a conference paper by Dougherty et al. (2017) which used a small sample ($n = 13$) qualitative study to examine public perceptions of automated trucks in the US. This paper provided initial indications of perceived inevitability of mass adoption and concerns about risk. Other research has examined business model innovation for electric autonomous vehicles in freight and logistics, noting how traditional business

models are unlikely to cope under an autonomous and electric freight future (Monios and Bergqvist, 2020). The work of Pernestål et al. (2021), Engholm et al. (2021) and Sindi and Woodman (2021) present scenarios of a digitised road freight system, large-scale adoption of driverless trucks, and industry perspectives on implementation respectively, reflecting a diversity of possible futures.

Scholarship which examines public and/or expert expectations of vehicle automation has, to date, paid limited attention to spatial dynamics, or to the specific contexts in which the various actors understand the innovation-in-context. Research has focused on the utility of automated features in private motor vehicles (e.g., Gkartzonikas and Gkritza, 2019), often without due consideration of the diverse space of mobility (e.g., hierarchies of road types [motorways, A-roads, B-roads], built environment [urban, suburban, rural]), or with a bias towards urban mobility (Alessandrini et al., 2015). In this paper, we seek to draw attention to the various ways that freight actors make sense of automation, and to show how expectations of automated vehicles are organised.

4. Researching expectations in UK trucking

As a process for investigating sociotechnical expectations, a qualitative research approach provides participants with the space to develop their thoughts and articulate their expectations within the context of their everyday practices and experiences. This paper presents qualitative findings from 61 semi-structured interviews with freight industry actors, including: truck drivers, freight managers, freight industry representatives, private sector (e.g., innovators and entrepreneurs) and public sector (Table 1). The interviews included questions about the freight sector and the participants' specific role and engagement with the sector, contemporary challenges for the sector, historical technological innovations for road freight, understandings of vehicle automation, experiences of automated technologies, opportunities and limitations of vehicle automation including roadblocks to deployment, and the relationship between vehicle automation and other socio-technological changes for the sector.

The first author conducted the interviews either in person or on the telephone depending on the participants' preference and availability, between late 2016 and early 2018. While developments in vehicle automation have continued apace since, we do not believe the interview material has become outdated because there has been little change in the everyday experiences of vehicle automation in trucking. Public trials of autonomous vehicles and the slow creep of automation into passenger vehicles will have increased awareness about vehicle automation since 2018. There have also been experiments with platooning on the UK motorway network, in part justified by rising fuel prices and the truck driver shortage (Sindi and Woodman, 2021). The HelmUK project (2017–2022), which brought together public and private sector actors led by the Transport Research Laboratory (TRL), aimed to evaluate the benefits and risks of truck (HGV) platooning using 'real-world' trials. Based on these 'trials', the project's final report concluded that platooning is as safe as adaptive cruise control, provided the risks associated with merging vehicles at junctions are taken into accounted and managed. It also argues that platooning is likely to save only small amounts of fuel – a key cost factor in trucking – compared to adaptive cruise control, although optimisation of the road network may increase those fuel savings. Nonetheless, despite these so-called 'public' or 'real-world' trials – the locations and timing of which were kept secret for 'safety reasons' – automation has to date remained a fringe issue in trade magazines, online fora and campaigning by industry organisations, with closer attention paid to more immediate responses including reductions in fuel duties and diversifying driver recruitment (see Road Haulage Association, 2022). All things considered, we believe our interpretations of participants' sociotechnical expectations regarding vehicle automation in *trucking* remain pertinent.

Table 1
Interview stakeholder groups, number of interviews and duration.

Stakeholder group	Number of interviews	Total duration (mins)	Average duration
Truck drivers	17	974	57
Freight company	10	500	50
Local government	5	275	55
Consultancy	4	222	56
Freight industry representative	4	276	69
Regional government	4	248	62
National government	3	160	53
Transport industry representative	3	184	61
Innovation/ technology company	3	173	58
Industry support services	3	177	59
Transport lobby group	2	113	57
Research organisation	2	99	50
Community group	1	52	52
TOTAL	61	3453	56.6

A total of 3312 min (over 57.5 h) of audio recordings were professionally transcribed. Following transcription, the 61 MS Word documents (one for each interview) were uploaded to NVivo12 QSR International analysis software. The empirical material were analysed through a process of reflexive thematic analysis (Braun and Clarke, 2021). This version of thematic analysis recognises the need for "nuanced, aware and situated applications of quality criteria" for thematic analysis (Braun and Clarke, 2021, page 329) that reflects the techniques adopted in the research method as well as the values and assumptions of the research paradigm (Kidder and Fine, 1987; Braun et al., 2016). A reflexive thematic analytical approach "emphasises the importance of the researcher's subjectivity as analytic resource, and their reflexive engagement with theory, data and interpretation" (Braun and Clarke, 2021, page 330) and thus defies distinction between description ('results') and interpretation ('discussion').

Our own process involved six fluid stages that loosely maps onto the six-stage process for reflexive thematic analysis proposed by Braun and Clarke (2021) as a heuristic for guidance:

1. Familiarising ourselves with the interview transcripts from the 61 interviews;
2. Iterative but systematic coding of the transcripts using NVivo12 QSR International which generated 21 nodes and 33 sub-nodes;
3. Generating initial themes, or multi-faceted groupings of codes, enriched by (further) interpretation;
4. Discussing, refining and reviewing themes through writing process;
5. Refining, defining and eventually naming the four themes: Times, Spaces, Practices, and Subjectivities; and
6. Developing this manuscript.

Our process involved considerable time of 'dwelling with' the empirical material (Ho et al., 2017) during which we read, reflected, questioned, wrote and debated. As a result, our shared "theoretical assumptions, disciplinary knowledge, research skills and experience" (Braun et al., 2016, page 198) became insolubly linked to the content of the transcripts in the analysis. Our analysis also followed Konrad (2006, page 432), in being "careful not to focus too much on the strategic dissemination and inflation of expectation", but instead to reflect individualised articulations and personal stories which – we found – often wove together expectations of automation with everyday work/life experiences.

In what follows, we present four themes which arose from this process: Times, Spaces, Practices, and Subjectivities. We find these themes to represent the construction of expectations of vehicle automation by participants in the interviews, and draw on verbatim quotes to make or illustrate our arguments.

5. Shared, differentiated and situated expectations

The analysis below suggests alignment of individually articulated sociotechnical expectations on some aspects of vehicle automation in UK trucking, but substantial differentiation across and within actor groups in the freight sector on other aspects. The overlaps and differences are discussed with the help of the themes of Times, Spaces, Practices, and Subjectivities. The text below will also make clear that individuals' expectations about vehicle automation in trucking are tethered in many ways to their past and current practices and professional lifeworld. What research participants expected depended strongly on the mobile places and spaces with which they were familiar, their understandings of the various and intersecting systems of freight mobilities in the UK, and the specific parts freight mobility systems where vehicle automation features and technologies are currently used and/or to be applied.

5.1. Times

Relying on the abstract, linear and metric time – *chronos* (Rämö, 1999) – of the Gregorian calendar, numerous private and public sector commentators and experts have offered timeframes for the development of automated vehicles. Chrono-logical timeframes can empower innovation processes by affording a sense of when an innovation might be actualised and cultivated through experimentation (emergence) and when it will be mainstreamed (diffusion). While some chrono-logical timeframes are based on technological capabilities alone (i.e., when the technology will be 'ready'), others include a broader suite of issues such as fleet turnover, public acceptability and/or regulatory frameworks. All are speculative, but some chrono-logical timeframes have greater power than others, depending on the source and its social capital as well as the implied geographies.

Expectations about vehicle automation articulated by influential organisations such as of the International Transport Forum or McKinsey & Company derive at least some of their power from combining a chrono-logic with a grounding in *choros* (Rämö, 1999) – abstract space in which place-specific mobility cultures, governance arrangements, urban forms, and so forth are (taken to be) immaterial to how vehicle automation will unfold. Largely devoid of geographical specificity, such expectations and corresponding timeframes can rather easily be – and are – circulated and shared within and between countries by agencies and organisations. The circulation of these expectations tends to reinforce beliefs that emergence will occur simultaneously in countries around the world.

Nonetheless, the timeframes articulated in our interviews overlap only very partially with those of influential organisations, suggesting limited buy-in across the UK freight sector into the chrono-logical expectations that prevail in the (inter)national policy world. The expectations of our study participants appeal to *kairos* and exhibit considerable indeterminacy. As Rämö (1999) explains, *Kairos* was the God of the favourable moment in ancient Greek mythology, while *kairos* refers to the right time for humans to act in Aristotle's writings and the right moment for systemic transformation in recent work on complexity in thermodynamics. In the interviews kairo-logical timeframes were constructed in relation to participants' unique life-course and everyday experiences. This was particularly true for participants working directly in trucking, such as truck drivers and transport managers. For example, a freight company manager (G7) stated that vehicle automation will *"change [the sector] a hell of a lot, I think. But I don't think it'll be in my lifetime. I'm 56. I don't think it'll be in my lifetime before we see anything significant changing really. It's just taking so long"*. While some viewed the extent of change to be potentially significant, they considered the right moment(s) to lie beyond the timespans – their 'lifetime' or 'career' – that were meaningful to them, arguably because of their grounding in everyday and biographical experience. These times are event-based rather than clock/calendar-based (Adam, 2004) and therefore lack the quantitative precision of chrono-logical timeframes.

When participants offered chrono-logical timeframes for the emergence of automated vehicles, they did so tentatively and rendered them meaningful through description of distinct changes to driver practices. One regional government participant (N11), for instance, suggested that "*the 10/20 years future is not a kind of person-free vehicle but… [a vehicle] that takes the stress out of the driving… So, a driver might get onto the motorway and have his [sic] nap, his time away from the road in the vehicle*". This points to the intersections of spaces, practices and automated features which configure into an imagining of an automated vehicle future, and an associated timeframe which captures a) the road type (e.g., motorway), b) driver regulations (e.g., on rest periods), c) work practices and emotions (e.g., 'stress'), and d) operational capacities.

More common, however, was uncertainty, with many participants being unable or unwilling to offer specific (chrono-logical) timeframes: "*the degree of automation will go further and further, [but] when and if we're going to get to a fully automated vehicle is not so certain to me*" (N15, Research Organisation). They rather spoke about what might happen in relation to their experiences of automated features, traffic conditions, infrastructures, and rules and regulations accrued over their life-course or in the (very) recent past. The unwillingness to postulate appears to relate to the unknown-ness of automated vehicle for many of our participants, for whom innovation pathways appear opaque, mysterious and/or removed, despite extensive media reporting and 'public' demonstrations of the technology (many of which are hidden from public view).

The levels of vehicle automation introduced in Section 3.1, and associated 'automated features' functioned as discursive tools that facilitated the articulation of expectations regarding automation. Framing automation in terms of 'iterations', 'stages' or 'degrees' allowed some participants to discuss short term expectations in relation to concrete automated features rather than abstract 'full automation'. A freight industry representative (N10) stated, for instance, that: *"the next thing we'd be expecting… would be more automation in forms of braking. And it would be forms of automation that take some functions that you're not expecting the driver not to do, but it's there if the driver fails to do it"*. Participants pointed out the existing automated features of trucks including anti-collision systems and departure warnings, referring to further automations and development of automated features as 'tiny steps':

> All new trucks now have anti-collision systems and what that means if that they very effectively will not crash into something. And the same with departure warnings – they can see the white lines on the road. So, trucks already have that… It's actually not a huge step, it's a tiny step and again it's not the technology, it's the law.
>
> (N13, Consultancy)

This participant reflects upon the uncertainties in and barriers to automated vehicle futures, but notes how this is not related to technological innovation, which the participant refers to as a 'small step'. Instead, they note that the main challenge to vehicle automation is legal frameworks, and the law's capacity to 'keep up with' and 'respond to' automated vehicle innovation. Legal experts have discussed many hurdles, including inertia in international traffic laws and coexistence of disparate national traffic laws within and across different legal systems (Brodsky, 2016; Law Commission, 2018; Vellinga, 2019). Different ways forward have been identified, but ongoing uncertainties around responsibility and liability keep complicating automated vehicle design and programming.

5.2. Spaces

Our research found that participants broadly expected that automated freight vehicles would operate sooner and more smoothly on designated 'limited access' and 'controllable' road spaces, typically private roads (e.g., warehouses) and particularly public motorways. Participants remained loathed to set chrono-logical timeframes for

vehicle automation to occur in limited access, controllable spaces. It was expected that motorway automation would occur 'sooner' than for urban roads, yet with little specificity on when 'sooner' might be. For the freight and logistics sector, the automation of warehousing, including un/loading tasks, order picking and site-based transport was viewed as more conceivable than driving on public roads, as warehouses are already highly controlled, securitised and regulated, for instance by health and safety law and management practices.

Among types of roads, UK motorways emerge from the analysis as primary 'automatable spaces', because their physical, social and institutional infrastructures were seen to offer the greatest potential for automated vehicle use. Descriptions of motorways in interviews centred on relative simplicity – i.e., straightforward driving tasks (e.g., unidirectional traffic), simple physical infrastructures (e.g., no junctions or roundabouts), limited sets of road-users (e.g., only motorised traffic), and highly governed spaces with comprehensive, understood, and – perhaps most importantly – 'obeyed' rules and regulations. As one Transport Industry Representative (N12) explained,

> the one area where we do see them being very possible, of course, is limited access highways, motorways… those sorts of roads are actually very simple. There are only a limited number of choices. You're in one of three lanes, you've got merging and diverged things like that and you're generally following other vehicles and you're generally all travelling at roughly the same speed, somewhere between 50 and 70 [miles per hour], hopefully.

As far as non-motorway spaces were concerned, participants believed that use of automated vehicle technologies required uncomplicated built environments and road infrastructures as well as clearly ordered and managed human behaviour. Segregation between 'automated' and 'non-automated' traffic emerged as one governmental technique to enable automated vehicles on public roads (more) quickly. Implementing segregation may work to further extend the existing hierarchy of UK roads, which excludes non-motorised (and occasionally low-speed motorised) modes from the motorway network, and potentially result in (new) segregated roads for automated vehicles. Participants articulated a perceived need for spatial segregation between automated vehicles and human-driven vehicles, as well as cyclists and pedestrians. They legitimised and explained this need through arguments related to:

1. *Efficiencies* (e.g., speed optimisation): This idea is consistent with dominant transport planning and regulation praxis which has travel time reduction as a central goal, but also reinforces the articulated benefits of vehicle automation (e.g., reduced fuel consumption, improved traffic flows) and thus feeds into the construction of hype and expectation for automated vehicle innovation;
2. *Technical capabilities* and the challenge of automated and non-automated vehicles sharing the same roadspace: This reasoning problematises the capacity of automated vehicles to respond to unpredictable behaviours of road users;
3. *Public acceptability*: Segregation may increase public acceptability by alleviating the widespread safety concerns (Moody et al., 2020) of people who have to share the road with highly automated vehicles.

Controlling who and which vehicles have access to roadspaces enhances the predictability of the latter, and is easiest achieved on motorways and other multi-lane and unidirectional roads. Access can be governed with the help of rules that exclude certain road users, minimum (and maximum) speeds, and education of road users to achieve behaviour change (see also Merriman, 2007). The participants considered the setting of speeds as a particularly effective measure for maintaining roadspace exclusivity. Motorways and dual carriageways, for instance, preclude – or, by way of regulation, discourage – speeds much lower than the various speed limits, which often act as a minimum rather than maximum driving speed for drivers. In this way, motorways again emerge from the interviews as an automatable space, where the limited range of speeds enables a faster transition towards automation, particularly when coupled with the automated features that are already used on motorways such as lane assist, adaptive cruise control and automatic breaking in trucks. The role of motorways was echoed in Sci-Fi imaginings of freight futures, with one participant using the 2017 X-Men superhero movie *Logan* to describe a future with automated freight vehicles 'shooting down motorways':

> I can see a huge amount of autonomy in this industry. What I'm picturing is a scene from a superhero movie which was Logan, which is the Wolverine, and there is a scene in the most recent film where it's set in the future and there's autonomous lorries shooting down the motorways that nearly run him over. But that all aside, it was a really, really good image or a scene of these autonomous lorries shooting down motorways without people.
>
> G4, Freight Company Management

Truck drivers also highlighted the importance of education of 'other people on the road' in the management of conditions in which automated vehicles will operate. In so doing they both mobilise and reinforce a 'rational machine' vs 'irrational human' dichotomy, preferring the former. Use of this dichotomy reflects a broader discourse among truck drivers about the lack of awareness among car drivers about the realities of driving trucks, which leads to unsafe driving practices by car drivers that put truck drivers into dangerous situations, potentially contributing to collisions. For one truck driver (D16), road users need to understand the capabilities of automated technologies, within a wider discourse of reckless (human) car drivers:

> So, with lane assist, I'm sure that it can probably steer you down a road, it's the interaction of other vehicles [that is the problem]. It's like saying 'now I've got to train the public in what these vehicles do, what they can do and what they can't do' before you let them loose on the road because it's not particularly the vehicles and the technology in them that's the issue, it's other people on the roads, I think.

Participants discursively constituted motorways, and the competencies and skill sets required to drive in these spaces, in contrast to complex and challenging urban roads. Urban centres in particular were seen as problematic for automated vehicles and their algorithms because conditions and access cannot be controlled: "*people wandering around, there are cyclists, there are dogs, there's all sorts of things going on*" (N12, Transport Industry Representative). Thus, the unpredictability of urban life and mobilities was considered as incongruous with automated technologies. Truck drivers constructed expectations about automated vehicles on urban roads on the basis of their own experiences of navigating 'hazard-filled' urban environments, which they believed were incompatible with the size and visibility constraints of their trucks. Other participants also viewed urban roads as too complex for vehicle automation. Here are the words of a regional government official who, like many other participants, expected that humans will remain 'in control' in 'more complex' driving situations such as in cities, even if much public discourse touts automated vehicles as safer and more sophisticated than human drivers:

> It's still the driver who will have to drive through the urban roads because they're too complicated. While I see the autonomous vehicle thing working in a motorway situation, in a practical reality, the urban situation, especially with a large dangerous lorry, strikes me as quite difficult…
>
> N11, Regional Government

The relational construction of motorways and urban roads in the interviews as respectively more and less automatable hinges on the use of multiple dualisms relating to road layout (e.g., simple/complex), speeds and rhythms (e.g., fast/slow, rhythmic/arrhythmic) and driving task (e.g., simple/hard). The resulting interpretation of motorway

spaces to some extent resembles earlier social science depictions of motorways as somewhat "blank, generic, placeless spaces of detachment and solitariness" (Merriman, 2009, page 589) where vehicles are driven with quasi-automatism (Crary, 1999, page 78) and distracted attention (Merriman, 2009), and where "pre-cognitive, distracted or 'automatic' action emerge" (Merriman, 2012, page 68). Such interpretations may help to reinforce the idea that vehicle automation is more achievable and falls within the realm of the current *modus operandi* on motorways.

Nonetheless, our research also shows those interpretations to be overly homogenising, particularly for truck drivers. While urban environments present challenges for truck driving, so too do motorways, which are not as straightforward, detached, or generic as might be inferred. Drivers, and especially those with extensive experience, tend to have embodied knowledge of particular (parts of) motorways, which are also full of meaning to them. They often know when best to take/avoid particular routes, where the best scenery is located, or what they can expect to encounter and experience at a given rest stop or service station. This embodied knowledge informed and framed the specific expectations they articulated in interviews about partially or fully automated freight vehicles.

5.3. Practices

The interviews suggest that there are particular institutionalised trucking practices that make UK motorways amenable to vehicle automation. These roads carry large volumes of goods because of freight 'trunking', types of driving work that involves driving various types of trucks (i.e., 'curtain-siders', or container vehicles) on a regular route (e.g., Leeds to London). Trunking routes do not include overnight stops, which is a type of freight work that is called 'tramping'. Trunking jobs are usually hub-to-hub, with few, if any, stops in between depots. Occasionally, such jobs prohibit stopping anywhere but the hubs to protect the transported (high-cost) goods from theft. In short, this type of work often involves fewer stops, more motorways and less customer engagement.

Trunking and tramping have historically been identified as the top of the driving job hierarchy (Hollowell, 1968; Gregson, 2017), with Gregson (2017, page 347) noting how "those at the top of the occupational hierarchy [see] themselves as 'kings of the road' on account of their skill as drivers in driving these behemoths of the road". This framing is somewhat challenged by our participants' narratives. They identify this type of freight driving as simple and automatable, perhaps due to the incremental automated features which have already led to some drivers referring to themselves as "*steering wheel attendants*" (D13, Truck Driver) with the various automated features diminishing the 'art' or 'skill' of driving a truck.

Given the importance of driving practices to the relational discursive construction of motorways and urban roads in Section 5.2, it is unsurprising that motorway trunking and urban 'multi-drop' or point-to-point movements as well as their potential for automation were also framed in terms of dualistic opposition:

> The technology is certainly looking quite good for freight trunking on motorways because of the simpler layout and infrastructure of the roads. I think the actual knocking on doors and doorbells; it's a bit unlikely that we're going to get there in the near future.
>
> G1, Freight Company Management

> If they're just going straight up a road, then I can see it working but overall, like doing multi-drop deliveries and stuff like that, I can't see it. I can't see how it would work.
>
> D2, Truck Driver

These participants argue that *urban* freight mobilities would be more challenging to automate because they require more customer engagement and negotiation of complex routes and congested roads.

Partly because of the institutionalisation of trunking, the formation of new driving practices that are specifically required for vehicle automation may be challenging. This insight can be derived from participants' discussion of their expectations around 'platooning' and 'buddying up'. Participants' interest in discussing platooning during interviews reflected both synergies with motorway automatable spaces discussed above and the UK government's vocal interest in, and intentions to trial, freight vehicle platoons on UK motorways around the time of the interviews (2017–2018). These platooning trials have been delayed repeatedly but the aforementioned HelmUK project was completed in 2022 (Section 4). In our research, participants discussed platooning and an initial stage of 'buddying up', where trucks-and-drivers would partner with other trucks-and-drivers from the same company or group of companies, to share the benefits of automated and communicative vehicle features. This approach was seen to overcome questions of organisational rationalities, insurance and liability. These expectations did, however, differ between those on the frontline of the freight sector (truck drivers and freight managers) and those more tangentially connected (industry representatives and government officials), because of differences in experiences emerging from everyday practice. The process of buddying up amused some truck drivers who struggle to coordinate schedules with their colleagues for a lunch or tea break, and based on this, were unable to understand how companies would operationalise 'buddying up'. Yet other participants, such as the regional government actor quoted below, expected 'buddying up' to be a first stage of platooning practice to enable familiarity to be developed and uncertainties to be overcome:

> I quite expect convoying to develop on a kind of ad hoc basis, kind of vehicle to vehicle, and that's kind of the initial stage of the connected autonomous vehicles thing where it's very much about buddying up of lorries and one of the questions about the who benefits question with those lorries, potentially it will start off with buddying up between two lorries from the same company, those sorts of things.
>
> N11, Regional Government

For truck drivers, the infrequency with which they currently see drivers from their own company raised questions about who they would be platooning with, given the highly competitive nature of the sector and questions of insurance and liability. Everyday experiences were not the only ground for contesting platooning. Some participants questioned the economic, environmental and/or efficiency value of platooning. Indeed, a consultant (N14) asked rhetorically '*what the hell is the point?*' and elaborated that

> even when it gets to the next stage, if that vehicle is ultimately going to blast down the motorway with nobody in it… Okay it might cut a few road deaths, which is good obviously. It might enable platooning, but in terms of a quantum leap of benefit, I don't get it. I absolutely do not get it.

Comments such as N14's reflect uncertainties about benefits arising from platooning given the incongruence of the innovation with the UK's motorway system with its frequent on-and-off ramps that interrupt the platoon and limit efficiency gains, such as fuel savings. This system design quality differs between countries, and is much less in, say, Sweden or the USA, where platooning may be more viable than in the UK. A range of additional infrastructural, organisational, operational, financial and logistical concerns emerged. For instance, a transport lobby organisation (N1) questioned: "*Where will the HGV formulate road trains? Who pays for this? What happens if a vehicle breaks down? How would one vehicle disengage in a roadside refuge?*" These questions highlight the high degrees of uncertainty emerging within the trucking industry relating to platooning as a specific practice of automation.

5.4. Subjectivities

For the freight sector, which is characterised by notoriously low profit margins and high competition, the wages of human drivers and

vehicle fuel are two major financial costs. These two costs have become particularly visible since 2021, with driver shortages and escalating fuel prices having a sizeable effect on the sector (Hopkins and Akyelken, 2022; BBC News, 2022). Nonetheless, even before these events, questions of cost reduction were already a priority across the freight sector. In our interviews, some participants – particularly freight industry representatives – recognised vehicle automation as a potential route for cost cutting and enhanced profitability for freight operators, as reflected by Sindi and Woodman (2021). Others, however, including freight companies and drivers, stressed the skilled nature of professional truck drivers' labour which extends beyond driving to difficult-to-automate customer relations and representation.

Participants were very uncertain about what the role of human drivers might be in the medium to long term, and collectively displayed considerable variability and apparent disagreement. Truck drivers in particular drew on personal experiences when constructing and articulating their expectations of automation within the freight sector. One driver, for instance, questioned how driverless trucks would respond to the system failures – they had experienced power loss in their vehicle the week before the interview – and used this to problematise the emergence of fully automated vehicles:

> It could be driverless but there'd have to be somebody in the vehicle because obviously things can go wrong. Like I had one the other day, it just lost all power and I broke down. When the mechanic came out to it, he said he couldn't find anything wrong with it, so what would the driverless vehicle have done?
>
> D14, Truck Driver

Yet another driver pointed to the gradual vehicle automation over their career and suggested that further automated features to a fully-automated truck are only a short step:

> Certainly, from the gradual automation of vehicles that I've been driving, then you can see how it would only be a short step to the human not being there at all.
>
> D6, Truck Driver

As this quotation suggests, drivers' expectations of vehicle automation are never completely personal. Such expectations are enabled, shaped and conditioned by the ways in which drivers have been affected by, or involved in, wider changes in the freight sector regarding vehicle technology, government regulation, routes and more. This is why for some people (e.g., participant N17 above) vehicle automation heralds a systemic change that reverberates throughout the entire supply chain, while for others automation represents another change to which the sector will adapt in a similar manner as it has responded rapidly to changes in consumer preference and new technology on the past.

6. Conclusions

In this paper, we have examined sociotechnical expectations of automated vehicle technologies and features in UK trucking, using interviews with members of the UK freight sector. Multiple conclusions and contributions to the literature follow from our analysis.

First, across the diversified sample of participants, there is alignment of individually articulated, specific expectations (Ruef and Markard, 2010) about vehicle automation in UK trucking on particular aspects. These mostly fall under the identified themes of Space and Time. The expectation that automation will happen first and be easiest on motorways was the most widely shared, rendering motorways into the UK's automatable roadspaces *par excellence*, at least as far as trucking is concerned. Scepticism about the challenges of vehicle automation in urban settings was equally widespread. Indeed, sociotechnical expectations around vehicle automation in trucking are premised on, and reinforce, motorways and urban roads as relational opposites. This finding extends sociotechnical expectations scholarship by signalling the importance of *spatialising* expectations (see also Ryghaug et al., 2022). This has two clear benefits; it offers greater particularity to articulations, and through this, provides linkages between sociotechnical innovations (e.g., automated trucks) and wider infrastructural and political economic arrangements.

Another shared feature across specific expectations about vehicle automation in trucking relates to temporality. The chrono-logical, calendar-based understanding of when vehicle automation will happen, which prevails in the discourse advanced by policymakers and consultancy firms, was eclipsed among participants by relational, kairo-logical understandings of time. Drawing on the latter understandings was partly a tactic for dealing with the profound uncertainties around if, when and how automation in trucking will happen. More importantly, it reflects that vehicle automation only becomes meaningful if and when it becomes embedded in everyday practices and experiences accrued over one's professional life-course. It is through the perceived (in)congruity of future vehicle automation with current and past day-to-day practices that participants were able to weave together a story of how automation might (not) happen in UK trucking. Foregrounding relational, karological temporalities shows how the coordination of a common purpose may be challenging when a broader range of actors are included (van Lente, 1993). At the same time, our study also signals how momentum may be built for alternative future visions for a sector such as freight transport by centring relational and kairo-logical alterative conceptions of time. This hitherto under-explored aspect of scholarship on sociotechnical expectations deserves greater attention in future research.

Second, we have also identified substantial differentiations in specific expectations about vehicle automation in UK trucking. These are concentrated in the identified themes of Practices and Subjectivity. The clearest differences during discussions of the practicalities of buddying up and platooning have emerged between those with first-hand experience of trucking – drivers and freight managers – and those further removed such as industry representatives and policymakers. Yet we have also shown clear differences in expectations about the role of truck drivers among drivers themselves. Scholarship on expectations about sociotechnical innovations has illuminated the kinds of work expectations (can do) but has broadly relied on those articulated by people in positions of power, such as innovators and government officials. By incorporating voices from across the whole trucking industry – including blue-collar workers – we demonstrate the selective ways in which expectations prime actors for innovation adoption. We propose that it is the absence of frontline involvement in the everyday practices of moving freight that allows actors such as innovators and government officials to be captivated by sociotechnical expectations. This proposition is something future research should probe further, also for sectors beyond (freight) transport.

Third, our analysis foregrounds the importance of studying individually articulated, specific expectations about vehicle automation in UK trucking. The significance of doing so extends, we believe, to geographical contexts beyond the UK and especially to other sociotechnical innovations. As suggested in Section 2, there is a normative case for giving a voice to all those with a stake in innovation processes when examining sociotechnical expectations. Yet our analysis indicates there are also more instrumentally-oriented reasons for doing so. The different expectations about buddying up and platooning are instructive here, for they offer insight into the operational complexities that are not always discussed and appreciated by those working more indirectly with the freight sector. Yet, the custom across our sample to frame motorways as automatable roadspaces and opposed them to urban traffic is equally important. Both findings induce speculation about potential unintended effects of attempts to (further) automate UK trucking. It seems to us that the effects of vehicle automation in UK trucking are most predictable for motorway trunking. Insofar as vehicle automation in trucking is desirable, innovators, policymakers and freight sector actors may want to prioritise this practice in the short to medium term.

Finally, it seems that the specific expectations about vehicle automation in trucking among frontline freight workers and individuals in policy, consultancy and interest organisations with practical knowledge of trucking have limited capacity to change the generalised expectations about vehicle automation in (inter)national public and policy debates. We write this while being conscious that an in-depth analysis of the broader discourses promulgated by policymakers and consultancy firms is beyond this paper (see also Olin and Mladenović, 2022). We nonetheless believe the point is worth making. Our study is consistent with scholarship which suggests that the means to make one's expectations gain momentum are distributed unevenly in ways that map to some extent onto differences in social standing (Sand, 2019). Policy elites in ministries and transnational consultancy firms have voices that tend to reach farthest in public debates, even if industry actors, including truckers, subvert the generalised expectations those elites help to circulate. Our research thereby motivates future scholarship on sociotechnical expectations to reflect upon the breadth of articulations related to a particular innovation, and to consider how and where they emerge from.

Yet other factors beyond social standing are also at play. Actors like national governments and consultancy firms tend to abstract specificities of driving trucks and moving freight the most, and it is this kind of abstraction that allows optimism about the pace and scale of vehicle automation to proliferate. This makes abstraction from the specific contexts in which driving and automation occur a key factor in intense hype-disappointment dynamics. Glossing over the messy practicalities of driving trucks and running a freight company makes vehicle automation an attractive proposition for investors, regulators and others that help innovations gain momentum (Geels et al., 2018) but the devil is in the detail: automated vehicles can make a genuine difference to how freight is moved around but not everywhere and at any (chronological) time.

Our research has thus shown the importance of working through the everyday, spatialised experiences of industry actors in order to appreciate the nuance that exists in sociotechnical expectations of automated futures in trucking, and arguably in innovation processes more generally. The research presented in this paper thereby extends existing innovation scholarship by foregrounding not only the contextual contingency of individually held and articulated expectations of innovations, but also the potential if unevenly distributed potency of those expectations. Future research should move beyond prioritising (policy/technology) elites and recognise the value of individually articulated, specific articulations which foreground new particularities as they relate to times, spaces, practices and subjectivities in relation to sociotechnical innovations.

CRediT authorship contribution statement

DH: Conceptualization; Formal analysis; Funding acquisition; Methodology; Project administration; Roles/Writing - original draft; Writing - review & editing.

TS: Conceptualization; Funding acquisition; Methodology; Project administration; Roles/Writing - original draft; Writing - review & editing.

Data availability

The authors do not have permission to share data.

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