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A future without drivers? Comparing users', urban planners' and developers' assumptions, hopes, and concerns about autonomous vehicles

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Abstract

Aim: This study identifies and compares perceptions of autonomous vehicle (AV) implementation among three Swedish stakeholder groups: *Future Users*, *Urban Planners*, and *Developers*.

Method: Semi-structured comparative focus groups were conducted separately with each of the three groups of stakeholders and the transcripts were analysed in broad themes using thematic analysis.

Results: *Assumptions, hopes, concerns,* and *direction of development* were the main themes that emerged from the analysis. *Assumptions* included electrification of vehicles, changes in travel demand, and the need for regulations; *Hopes* included the idea that AVs will contribute to a more accessible and safer transport system; *Concerns* included overtrust in AV technology, a possible detrimental impact on the city in the form of congestion and higher demand for investments in infrastructure that could outcompete other modes of transport; and *Direction of development and their own role,* where the need for collaboration between stakeholders and implementation of AVs in connection with society's needs were emphasised.

Conclusions: AVs were seen to lead to both positive and negative consequences depending on implementation and the development of society. The study shows that dialogue between different stakeholders is lacking but it is desired for the inclusive implementation of AVs.

Keywords: Autonomous vehicles, Disruptive innovation, Automation, Policy in automation, Stakeholder analysis, Users

1 Introduction

The development and implementation of autonomous vehicles (AVs) is argued to be a central part in the creation of a future sustainable and inclusive transport system [9]. These fully self-driving vehicles are said to allow new ways of transporting both goods and people and provide services that are customised to individuals' needs and preferences. This includes, but is not limited to, efficient on-demand door-to-door goods deliveries with shorter lead-times [10, 36] as well as accessible multimodal vehicle- and ride-sharing services [10]. However, it is a disruptive technology that has the possibility of bringing positive as well as negative outcomes to stakeholders. For users, it may enhance driving experience by enabling drivers to engage in other tasks instead of controlling the vehicle [26]; for companies, AVs make it possible to create new markets and business opportunities; and for the transport and energy sectors, AVs

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may contribute to reduced emissions and, if combined with shared services, even reduce the number of cars on the roads [2, 13]. However, there are also scenarios in which empty vehicles circulate in urban centres or there is a disproportionate increase in travel demand that challenges the capacity of the city's infrastructure [18].

The positive outcomes will only be achieved if AVs are implemented in a way that society as a whole desires, and by ensuring sustainability and accessibility for all who live in the city [37]. A successful implementation of AVs is complex and relies on the involvement of several types of stakeholders: manufacturers as they make decisions concerning the technology and business models; municipalities and governments as they are responsible for legal issues and decide on city infrastructure; and users as they must adopt the technology.

To date, research has mostly looked at these groups and their issues separately. For example, research on intended users of AVs has investigated issues such as trust [14, 22], understanding of the technology [5], as well as more operational issues such as taking over control from the vehicle [42]. Factors affecting acceptance of AVs in general (e.g. [32, 43]), and the adoption of AVs in specific scenarios, such as shared AVs [30] have also been researched. However, most of these studies have either been unspecific regarding usage and type of AV, or have investigated one specific implementation, giving a limited picture of users' ideas and acceptance of the diversity of AV implementations [28].

Research on issues facing vehicle manufacturers has among other things focused on cybersecurity threats [29] or changes in business models [17]. Since AVs are more complex than manually driven vehicles, new development processes are also needed, which may create challenges in the collaboration between competences [34]. Research on the public sector, such as municipalities and governments, has focused on changes in regulations and liability because of the new technology [4], the effect of AVs on the built environment [24] and social implications of AVs [41].

Even though mismatches regarding preferred implementation scenarios between different actors have been identified [16], comparisons between different stakeholders' views on a future in which AVs have become integrated into the transport system appear to be very scarce. However, to handle the complexity that the implementation of AVs entails, such as issues related to liability, investments in infrastructure and user behaviours, all stakeholders must be considered and their views need to be compared in order to find similarities and mismatches between their perceptions. Thus, there is clearly a need to further investigate and understand these matters in order to provide a basis for decisions on strategies for communication and implementation of AVs.

The aim of the study was therefore to explore how different stakeholders, in other words Future Users, Urban Planners and Developers, anticipate a future without drivers, and their assumptions, hopes and concerns associated with the idea of AVs, including their capabilities and limitations and their effect on urban mobility.

This paper is organised as follows: section 2 presents the study context and the comparative focus group methodology used. In section 3 the key themes and associated issues discovered in the analysis of the focus group are described and illustrated. Section 4 includes a discussion on the findings and finally, in section 5, we summarise the key findings and suggest implications for stakeholder groups.

2 Method

To explore stakeholders' varying perceptions of a future with AVs, we conducted a comparative focus group study with three stakeholder groups: (i) Future Users, (ii) Urban Planners, and (iii) Developers. The first group represents the individuals who are to accept and adopt the use of AVs to satisfy different mobility needs. The latter groups represent important actors in the private and public sectors, both with the power to influence development and implementation of AVs; Urban Planners by making decisions on aspects such as policy and development of infrastructure, and Developers by being involved in the direct development of AVs and making choices that will influence, for instance where AVs can operate and under which conditions.

The study consisted of three mediated focus groups, one with each of the stakeholder groups, and a comparative analysis of the findings, Fig. 1 provides a flow diagram to summarise the steps. Focus groups rather than individual interviews were chosen as, according to Casey and Kueger [8], focus groups provide *"a more natural environment than that of (the) individual interview because participants are influencing and influenced by others - just as they are in real life"* (p.11). Thus, interaction between the participants was desired and, in this case, given a particular value. However, the extent of the influence and interaction was not measured.

2.1 Participants and recruitment

Focus group interviews are typically conducted with a small group of participants, usually between 6 and 12 people, who are recruited based on certain criteria.

Participants were recruited differently depending on stakeholder group. For the **Future User** group (FU), participants living in one of the larger cities in a region in southern Sweden were recruited with the help of a recruitment agency. This particular city was a conscious choice as the region is developing rapidly with investments in urban transport and infrastructure. This was

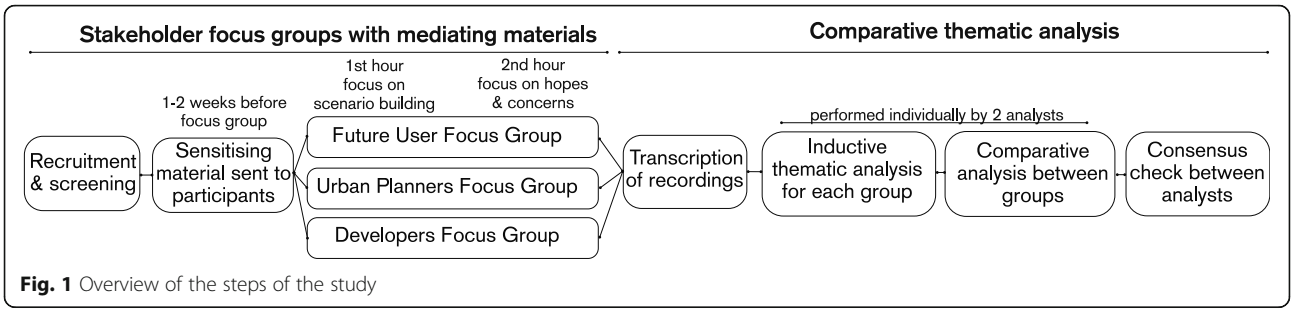

Fig. 1 Overview of the steps of the study

assumed to have raised the residents' and other actors' awareness of innovations for urban transport. At the same time the region has no large vehicle industry or any ongoing trials with autonomous vehicles, which should imply less bias for the specific phenomenon. The recruitment agency was instructed to find participants with an equal distribution as regards age (between 20 and 65), gender, and people with and without children. Applicants who worked in the automotive industry, politics or traffic and city planning were excluded from this group so as to achieve a certain homogeneity within the groups but heterogeneity between them. Ten participants attended the focus group (see Table 1 for details). They had varying interest and knowledge about AVs and varied current mobility patterns. Future Users received compensation for their participation in the form of a gift card (worth 500 SEK, approx. 50€).

Participants for the **Urban Planner** (UP) group were recruited from three cities in the same region as the Future User group. Relevant participants were identified using public contact information on the cities' websites or by contacting the city's information desk. Some snowball recruitment occurred, where participants recommended other participants. Twenty-two Urban Planners were invited, of whom five finally attended the focus group (see Table 1).

Developers (D) who worked in the automotive industry with the development of AVs were recruited by open

Table 1 Participants of the three focus groups, with their occupation and relation to AVs

Future Users	**Occupation**
FU1	Financial officer
FU2	Prison warden
FU3	Elderly care worker
FU4	Military officer
FU5	Historian
FU6	Former medical transport driver
FU7	High school teacher
FU8	Works for the city
FU9	Hospital employee
FU10	Artist
Urban Planners	**Occupation, and professional relation to AVs**
UP1	Traffic planner, currently also strategic development
UP2	Works at business development department, and future innovation platform
UP3	Future strategist, working with future direction for traffic planning
UP4	City planner, working with the new comprehensive land use plan for the city
UP5	Infrastructure strategist, working on a discussion document on future mobility
Developers	**Occupation, and professional relation to AVs**
D1	Works at innovation department of automotive company, sustainable mobility focus
D2	Works with development of automotive chassis systems
D3	Works with automotive interior construction, coaches new development projects
D4	Consultant engineer in automotive sector, exterior camera development
D5	Consultant engineer in automotive sector, object detection, neural networks, and radar sensors

invitation to contacts gained by the researchers through previous projects in the AV domain. Some developers who showed interest in participating were dissuaded from participating by their employers but in the end, five developers attended the focus group (see Table 1). Neither the Urban Planners nor the Developers were compensated for their participation.

2.2 Procedure

In order to enable comparisons between the groups, the procedure was the same for all three focus groups and therefore also for all three stakeholder groups.

According to Denscombe [11] a focus group discussion often revolves around a prompt or some stimulus introduced by the moderator in order to focus the discussion. In advance of the focus group sessions, the participants were given a sensitising stimulus (cf. [39]) in terms of online material to get acquainted with and trigger them to reflect on the topic in their own time and environment. This sensitising material consisted of a video accompanied by written sources of information (technical information, opinion articles and quotes from researchers) regarding automation that were freely available in the media.

Each focus group session lasted for approximately 2 h and was conducted according to a semi-structured guide. Two moderators (1st and 3rd authors) took turns leading the focus groups, and in addition there were at least two note-takers who made notes on interesting discussions, as well as a photographer who recorded video and audio data. During the first half of the session, the discussion focused on building a joint scenario of what AVs could be and which role AVs could play in a not-too-distant future, approximately 10 years ahead. The participants were asked what the AVs were used for, who was using them, who owned them and so on. To aid reflection and mediate the creation of a scenario, different physical materials were used as mediating tools (cf. [21]). Participants were seated around a large printout of a map of a faked average Swedish city (see Fig. 2), and 3D-printed vehicle representations of four sizes (see Fig. 3) were handed to the participants for them to place on the map. The vehicles were either introduced to trigger the discussion to consider more vehicles or provided when participants mentioned vehicle types unprompted. There were also marker pens available for the participants to write or draw on the map. Interaction with the material was encouraged with the intention that this would also encourage further discussion and interaction between the participants and so that they did not merely respond to the moderator's questions.

The second part of the sessions focused more on the participants' assumptions, hopes and concerns regarding the implementation of AVs. Participants were asked what they thought would happen, what they wanted to happen, how society would get there, if there were any necessary changes to the city, and if any new services would arise. They were also asked what questions they wanted us to ask of the other stakeholder groups.

Fig. 2 Set-up with the mediating map and participants using it

2.3 Data collection and analysis

Data was gathered through video and audio recordings, as well as additional photos. The recordings from the three focus groups were transcribed in full, with gestures in relation to the map and vehicles documented as well. The transcripts were subsequently analysed using a thematic analysis which is a common method for analysing different types of qualitative data (see for instance [7]). The purpose of the analysis is to identify themes or patterns across a dataset which provides answers to questions posed. In this case an inductive approach was

Fig. 3 Close-up of the four vehicle representations, where black corresponds to truck, yellow to bus, white to car, and blue to smaller delivery robot

chosen. The data was first classified into the broad themes outlined in the aim; in other words, references to "assumptions", "hopes", and "concerns". During the classification, another major theme emerged: "direction of development", which included uncertainties expressed about the development and the groups' role in that development. Within these main themes, sub-themes were identified and compared between the different stakeholder groups in order to identify common and divergent perceptions. All analyses were individually performed by authors 1 and 2, and the results later compared and discussed to resolve discrepancies and reach consensus.

2.4 Findings

In this section, the comparison of the three stakeholder groups is presented in relation to the main themes: assumptions, hopes, concerns, and direction of development. For each theme, the issues brought up by the groups are described and exemplified with illustrative quotes. Fig. 4 summarises the themes and the issues related to it. For all the themes, some of the issues raised reappeared across all three groups, but there were also clear differences between stakeholder groups, where each group had its unique take on a shared issue, or the issue was discussed by only one or two groups. Using colours for added clarity, Fig. 4 illustrates which issues were raised by which groups. The main issues are encircled with green to show consensus or red to show dissensus among the groups.

2.5 Assumptions

The three groups' assumptions appeared to be shaped by what they had read in the media, by their work experience, and by their beliefs regarding which aspects are linked to the advent of autonomous vehicles. Interestingly, assumptions about autonomous vehicles were quite similar across the three focus groups. For example, the three groups agreed regarding what shape the AVs would take and assumed it could be any kind of vehicle: truck, minibus/shuttle, personal vehicle, drones, or a vehicle for services. *"Well, I imagine pretty normal vehicles that look like vehicles do today. Only they drive on their own"* (UP1). A likely dissemination process was also assumed*: "I think it will start with heavy goods vehicles and then it will seep into smaller and smaller vehicles, until it is in everything, down to […] Smart cars with like two seats"* (FU1). They also assumed that the vehicles would be electric, or at least run on other sustainable fuels such as biodiesel or hydrogen.

In terms of how the vehicles would be used, many different scenarios were discussed from the vehicles being privately owned, to being used in public transport, to building new types of services. The scenarios that participants believed most likely to appear were forms of shared vehicles, on-demand services and transportation of goods: *"I don't think that [privately owned] will be the dominating use, rather more in the city with transport – public transport – or as a complement to that. And then maybe most of all, long-haul trucks and transport of goods. To make it all more efficient"* (D2). The main reason was that such services would benefit from economic savings by not having a driver, which would power development: *"I think that it is ultimately a matter of it being cheaper, less staff, that is an economic factor"* (FU6).

There was consensus about expected behavioural changes due to AVs. These concerned travel demand, housing preferences (people would tend to live further from the city centre) and behaviour while travelling (people would be able to engage in other activities while commuting, such as working) among Urban Planners and Developers. However, there was no consensus regarding the likely direction of change in travel demand among Future Users, as represented by FU7 *"I think that there will quite simply be fewer vehicles, because there will be more ridesharing in different ways"* and FU3 *"... but I also think that it will be more chaotic in the inner parts of the big cities"*.

The three groups agreed that regulations of many different kinds will be necessary for the implementation of AVs. There were many sweeping remarks concerning the importance of the "legal aspect", getting regulations in place, and the current lack of relevant legislation. There were also plenty of suggestions of specific issues to regulate, including who could own and use the vehicles, who could make a business out of them, and how AVs and infrastructure should be standardised across manufacturers, cities and nations. The groups also agreed that there would be limitations regarding where AVs would be allowed or able to circulate since a mixed traffic scenario was regarded as problematic, exemplified by statements such as *"In 10 years, maybe they'll say that you can't have cars in the city centre"* (FU2), and *"To make it work, you will probably have to delimit certain areas for certain vehicles and so on"* (UP2). While Urban Planners tended to speak about containing AVs in certain areas, Developers spoke more about keeping others out: *"Say that you cordon off an area [draws a circle around a neighbourhood] and say 'here it's only autonomous; no motorcycles, no manually operated cars, not even bicycles' then suddenly [it's easier]"* (D5). Both Urban Planners and Developers assumed that infrastructure needed to be improved to meet necessary requirements for safe operation of the system.

However, the three groups had difficulty establishing a timeframe for their assumptions. Developers, due to their professional experience of the technology's limited abilities, tended to have a relatively longer timeframe for

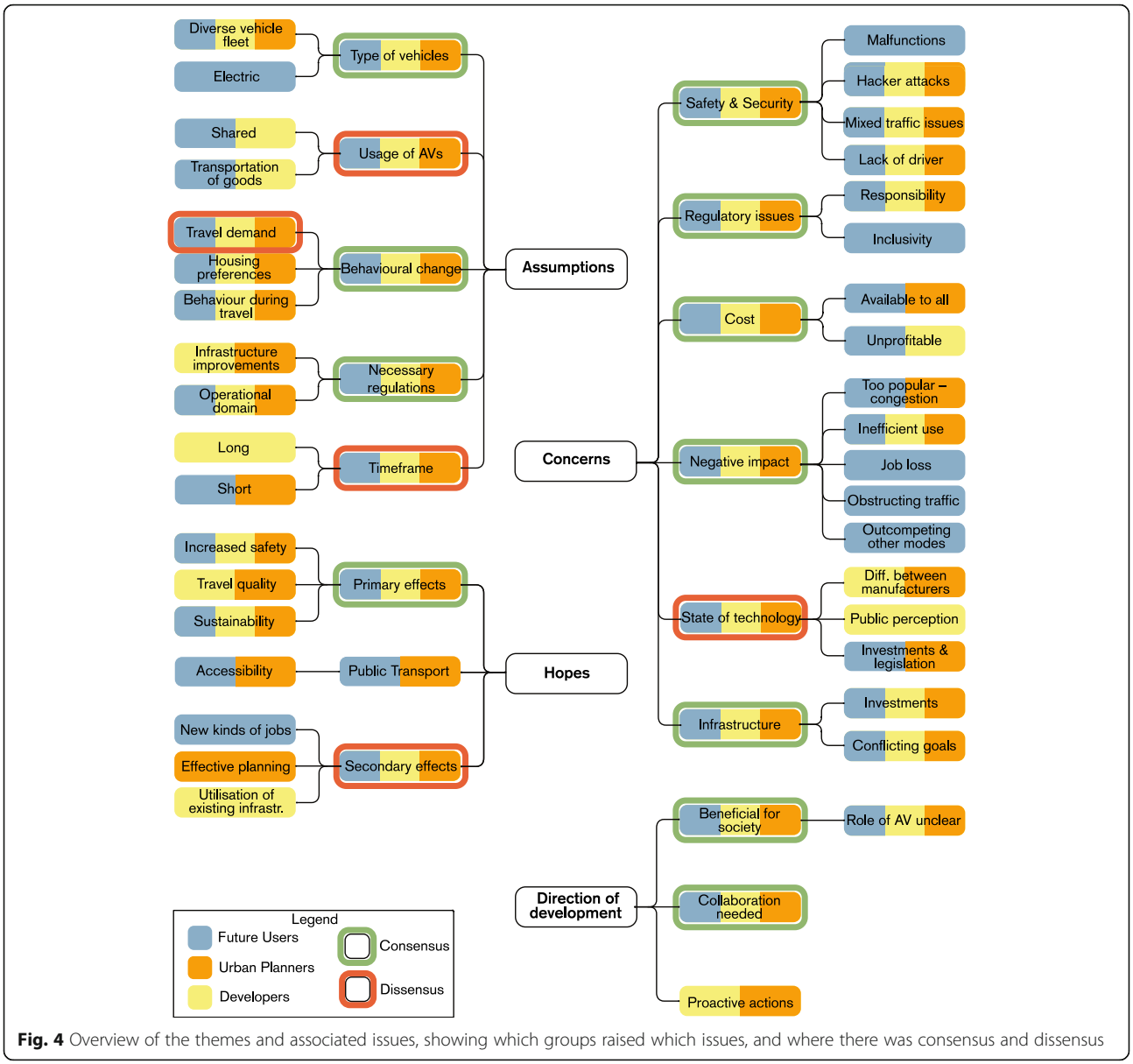

Fig. 4 Overview of the themes and associated issues, showing which groups raised which issues, and where there was consensus and dissensus

their assumptions, with D5 saying *"[call me a] realist/ pessimist, but when you've seen the difficulties close up, then …"* Future Users and Urban Planners had more mixed feelings, stating that a lot could happen in 10 years and that it was easy to underestimate the speed and impact of technological development, but also: *"I also think that this is 10 years, not... it sounds long, but it is not that far into the future, really"* (FU5).

2.6 Hopes

Based on their assumptions of the future use and implementation of AVs, participants brought hopes and expectations regarding AVs to the discussion. These include increased safety, possible solutions, and potential scenarios that they expected to improve.

All three groups agreed that there would be fewer traffic incidents and that AVs will make traffic safer. The Developers and City Planners had hopes for the improvement of quality of travel if you owned your own AV: *"... for those who commute to work on the motorway; they will have a much nicer life"* (D3). The participants discussed the positive potential of AVs in relation to various aspects of people's lives, society and the environment, for example effective infrastructure, more services for users and, once the transport system is more efficient, less use of natural resources and increased sustainability. It would be *"a system with which you can manage the same type of transport we have today, only with smaller [vehicles], so that we don't have to burn as much natural resources as we do today"* (D1).

Many of the hopes concerned possibilities for improved public transport or shared on-demand services. Future Users and Urban Planners spoke a lot about increased access to the city and its functions for a wider group of people, as well as potential for more user-centred public transport, with more frequent services and more stops for a door-to-door experience. The type of vehicle would play an important part: *"I think that these [yellow vehicle] will still be important to them, in the form of self-driving buses, or public transport"* (UP3). A major hope was that due to personnel reductions, public transport and other services using AVs would be cheaper. Urban Planners also brought up the aspect of increasing accessibility outside urban centres: "*I think these [picks up a yellow vehicle] have a super potential in rural areas or smaller rural communities"* (UP5).

There were also other hopes linked to potential offered by development, such as generation of new kinds of jobs (to make up for those lost): *"It means that there will be new jobs, there will be new services and new challenges to face"* (FU1). Urban Planners emphasised that the data produced (if shared by manufacturers and operators) could lead to more effective urban planning as well: *"...and then we can build more efficiently as well, and adapt much more quickly if we get this data"* (UP3) while Developers saw the potential for better utilisation of existing infrastructure and saving on otherwise necessary investments: *"If we want to increase the capacity of trains, a lot of infrastructure is needed, but you could move the trains to the roads if we had a different type of vehicle than today, to use the capacity of the roads in a better way"* (D1).

2.7 Concerns

Plenty of concerns were raised throughout the focus groups. Some related to unease about using a car without a driver. All three groups compared AVs to self-driving metros, which they felt ok about using, but asserted *"... that cars driving around completely without drivers is something else"* (FU8). There was a specific concern about riding in a small public transport vehicle without the presence of an authority figure to guarantee safety (as a bus driver was seen to do), but also a general unease or distrust of AVs. However, Developers also raised a strong concern about overtrust. Connected to the unease aspect was the potential risk of hacker attacks as well as accidents caused by external forces in a mixed traffic scenario. A mix of autonomous and manually driven cars, together with bicyclists, pedestrians and others, was seen as a great challenge for technological development by Developers, and a safety concern by Future Users and Urban Planners. They were concerned that the AVs' need to follow pre-programmed routes and to stop for everything would lead people to take advantage by performing risky manoeuvres with their cars, walking right into traffic or kids playing pranks. This in turn could lead to sudden braking, causing ripple effects and risks for other vehicles. Interestingly, only Future Users worried about the possibility that *"... something in the in-car computer breaks down or it freezes, because that happens relatively often in today's computers after all"* (FU6). In the Urban Planners group, UP3 instead concluded "*It is not one car's fault if something happens. […] because that should not happen. Care has been taken to ensure that it should not happen. If something happens, then some external force has acted.*"

Concern regarding accidents was linked to discussions of responsibility and repercussions in all groups; could Developers be sued? Could Future Users be charged with "non-driving under the influence"? Future Users were especially concerned with where the responsibility would lie, and about being able to control the vehicle in case something happened. They discussed both the necessity of being allowed to take over or stop the vehicle, and whether people who were unable to drive would be allowed to use the vehicles: *"My wife is in a wheelchair and uses a public transportation service, and neither of us has a driver's license, so we would not be able to take over the vehicle if it broke down [...] as long as the system works, it would mean great freedom to be able to use it"* (FU5). That everyone should be able to use the AVs was a very important concern for Future Users, who strongly valued inclusivity and equality in the system's implementation.

Cost was another issue discussed in connection with equality. Future Users and Urban Planners were concerned that only wealthy people would be able to afford the vehicles, emphasising that they should be available to everyone. Both groups concluded that the vehicles would be expensive to buy and would continue to be costly for a long time. The Developers raised the issue of whether there would ever be enough demand to make it profitable to sell AVs to private persons, a question also raised in the Future User group: "*I can't see my old man getting into such a car. He wants to drive.* (FU2) – *Exactly, it's fun to drive a car.* (FU8) – *That's what I thought too, what's the point if you're not allowed to drive yourself?* (FU6)*"*.

However, there were also concerns that if the vehicles were more affordable, they would be (too) popular, which could lead to congestion, especially if the cars drove around empty to park at home after dropping off their owner, or just driving around instead of parking, or looking for customers in a shared scenario. This was seen as wasteful, bad for the environment, and detrimental to the city as it disturbed other city systems: *"The more cars, the more accidents, and the more ambulance*

staff will be hindered from getting to the scene of an accident" (FU3). Future Users also envisioned other forms of AVs, like delivery robots, blocking cycle lanes or causing *"drone chaos"*. They were generally worried that AVs would outcompete better modes of transport, either by obstructing the road or by becoming such an attractive mode of transport that people would use AVs instead of walking, cycling and using public transport.

The Developers expressed concerns that the public was too optimistic about the state of the technology, something they attributed to exaggerated visions presented by companies and media: *"The way I see it, there is massive hype about this in media, […] regarding both how good it will be and how soon it will come"* (D5). Future Users and Urban Planners were instead concerned about getting other things in place, such as legislation, regulations and investments. FU8 explained: *"I think the technology already exists to a large degree; it is more about the legislation, and people's acceptance and trust. That is, society will need to catch up"*. Urban Planners especially worried about the speed of their own slow democratic processes and about being overrun: *"The technology is faster than we understand maybe, but the other things are so slow"* (UP3). They were also concerned that they would lose influence as technology made their current regulatory mechanisms, such as parking restrictions, obsolete.

Necessary investment in infrastructure, and who should pay for it, were concerns that cropped up in all three focus groups. All assumed that investments were necessary for AVs to be able to function in a city, with UP2 explaining: *"Someone will have to pay for this infrastructure, and it is not cheap. Considerably higher quality than is available today is required in the traffic system. So, there will be very, very high costs going forward for a city or municipality to keep these traffic systems running"*. All three groups touched on the issue that the dissemination of AVs (and the investments needed to make it happen) could be seen to conflict with goals to reduce car reliance, emissions and congestion. Future Users were particularly concerned that future investments would only favour AVs and outcompete current work on train and cycling infrastructure: *"There are so many benefits to walking and cycling, so I don't want that to be killed off by some form of "at the end of tech nerdiness"* (FU10).

Future Users were also highly concerned about what implementation would mean for the people working with transport services today. A major worry was job loss for professional drivers but there was also a concern that, during the implementation of AVs, many other roles people play in transport services would be forgotten, like loading and unloading goods, helping riders in and out of vehicles, and being available for users. There was a fear that these people too would lose their jobs, and thus the services would not fulfil the needs of the people; *"Just because the vehicle is driverless does not mean that it doesn't need to be staffed"* (FU1).

2.8 The direction of development and their own role

Throughout the focus groups, the participants returned to the issue of how to implement AV technology in a way that would best benefit society. Future Users, in particular, questioned the driving forces behind the development: *"Is it about money, or about the environment, or safety, or many of the other aspects? What is the main purpose of it?"* (FU7) in connection with fears about job loss and unequal access to services. Developers too were not clear about the role of AVs: *"Well, technology moves forward, maybe it already exists, but in the grand scenario, what is the role of the AV? I haven't seen that for real, or I can't solve that equation today, I feel"* . Urban Planners also asked themselves *"What do we want, what should we work for? Because we see scenarios that are non-desirable, we see scenarios that are more tempting, but we have to discuss which direction we want to go"* (UP5).

There was a strong belief that the necessary collaboration between different partners was lacking today, and that AV development needed to be tied in with societal development. From the Urban Planners there was a call for guidance from the EU, national governments and agencies, as well as collaboration with and across manufacturers and service providers. The Developers also called for strong leadership to steer development in the "right" direction. However, the participants had a hard time seeing their own role in the development. While some Future Users wanted to take an active role, others figured that "they" (referring to an unspecified someone else) would solve it. Developers working on the technical development saw themselves as a very small cog in the machinery without insight or power to influence more strategic decisions within their organisations: *"It feels like one could make a marginal difference, at least I could"* (D4). They even hinted that raising issues and going against the company visions would make you very unpopular, a whistle-blower.

Urban Planners struggled with how to handle AVs, asking themselves how they could integrate future mobility into planning. They wanted to enable as much as possible, and saw some possibilities for creating testbeds and setting demands for instance through procurement procedures. Their experiences from the introduction of e-scooters had made them wary of being faced with a *fait accompli*, concluding that they needed to get a dialogue going in order to come to grips with the situation. Developers reasoned along the same lines: *"We [the car industry] have our delivery to some sort of unclear future,*

like maybe other industries and governments do as well [...] you would need some sort of structured collaboration, where you together create an image of different scenarios and the best way forward" (D3). The work suggested to be done in such a collaboration was clear for both Urban Planners and Developers: to create mobility solutions for the future by *"Understanding both what the possibilities are, and also which needs we have in the cities that we in some way can solve with self-driving vehicles"* (UP5) – *"It would be better if we were more together"* (UP3).

3 Discussion

The aim of the study was to explore how different stakeholders – Future Users, Urban Planners, and Developers – anticipate a future without drivers. The findings show that the three groups had similar ideas about how AVs could be used in different scenarios and had similar hopes regarding what the vehicles could offer if implemented in a way that meets society's needs. They agreed on the complexity of the topic and on the difficulties associated with implementation. However, they did not agree on what preconditions needed to be in place to achieve the desired implementation and had unique concerns about the consequences of the introduction of AVs.

On a general level, AVs were seen to lead to both positive and negative consequences depending on implementation and societal development. This pattern is also echoed in the findings of Kacperski et al. [20], who interviewed a range of expert stakeholders about visions and barriers concerning AVs, revealing an ambivalence and uncertainty about potential consequences regarding aspects such as safety, inclusiveness, cities' layout, available jobs and services, and long-term economic and ecological sustainability. Many of the issues raised in Kacperski et al. [20] were also mentioned in our focus groups, (some quotes even verbatim!), but our study adds the user perspective. The Future Users in our study stand out with their deep-felt concerns about people in relation to the system. They not only wanted to ensure inclusivity and equality in the implementation of AVs, aspects that have previously been determined as important criteria for users' acceptance of AVs [16], they also considered people's relation to automation. This included concerns about how people would feel inside the vehicles, the possibility to help other people in case of incidents inside and outside the vehicle, job loss or changes to jobs in transport services, and AVs outcompeting active and traditional public modes of transport. Underlying these concerns was a fear of what would happen if technology development was allowed to be the main driving force and outcompete other societal values such as sustainability, equality and inclusion. It has previously been concluded that participatory procedures where the city's residents are involved in planning processes are necessary to ensure that such values are captured and safeguarded (e.g. [6, 25]).

With regard to technology as the driver of development, our findings point to a major gap between stakeholders in terms of their understanding of the current state of technology and the timeframe for implementing AVs, with Urban Planners and Future Users on the optimistic side and Developers more pessimistic. Users have previously been found to have too high expectations of the capabilities of AVs in relation to actual capabilities [31], created by the exaggerated descriptions and naming practices used by the media and vehicle manufacturers [1, 12]. Perhaps more worrying, Urban Planners shared this overly optimistic view with users, which may lead to problems for the democratic governance of AVs. In a comparison between AV governance in Finland, the UK and Germany, Mladenović et al. [28] found that policymakers in all three countries tended to attach greater weight to the expectation of benefits from the technology and downplay concerns and conflicts. Policies were then created based on those unquestioned assumptions. Planners have been previously critiqued in research for relying too little on expert knowledge, instead letting compelling ideas (such as visions of the benefits of AVs) and political acceptance (such as the idea AV technology will increase Sweden's competitiveness) take precedence in planning procedures, even if this meant that their explicit sustainable mobility goals would not be reached [38]. According to Hrelja and Antonson [19] transport planners were reluctant to seek insight into actual user needs and values, but instead relied on their own personal experience. This overconfidence in technology, unwillingness to challenge own assumptions and reluctance to seek both expertise and user involvement, run the risk of limiting the imagination of decision-makers in terms of which policies they introduce, which societal values are included in planning and which demands they place on manufacturers, allowing technology development to take precedence over societal needs, just as the Future Users feared. In their literature review, Faisal, Kamruzzaman, Yigitcanlar, and Currie [15] conclude that *"presently, urban planning as a profession is largely unprepared for AVs"* stating that they need to become aware, smart and proactive.

It could be expected that Developers would champion the emerging technology, but instead they expressed concerns about the visions presented by their companies and the media, and the impact that those visions had on users and policymakers. There was also a discernible sense in the Developer focus group that they were unable to challenge those visions from within their companies. It is noteworthy that several of the invited companies were reluctant to let their developers take

part in the focus group. Given that these companies appear to have considerable impact on other stakeholders through the way they communicate their technology and visions, it is necessary to challenge them to become more open about the true state of technology and their underlying motives, and to address the concerns of their employees. Since visions affect decisions, it may also be necessary to question who gets to set our visions for technology implementation, and whether policymakers (and the affected populations) need to present their own competing visions of the future in the same compelling way that companies do.

Developers and Urban Planners were aware of the risks that the current state of affairs presented and sought ways to influence development in a direction that would benefit transition to a more sustainable society. The findings show that there was a common view of what the best scenario would be, that is to say creating inclusive and shared transport services which met society's needs in a sustainable way, and as a next step to find out how AVs could play a part in this. Neither Urban Planners nor Developers could clearly see how they might influence development at the present time but hinted at a solution: **dialogue**. Such a dialogue between stakeholders has been suggested previously, for example by Kacperski et al. [20], and Mladenović et al. [28]. However, as was apparent from the search for leadership and direction among Urban Planners and Developers, this type of dialogue will not start on its own. It is necessary to create an arena where stakeholders can come together and build on their unified visions of a future society, but where they also address the various concerns and break free from the exaggerated and idealised visions presented in the media. As highlighted by Mladenović et al. [28], it is important to explore dissensus and discuss underlying and potentially conflicting societal values.

While literature mainly suggest discrete choice models, agent-based modelling and multi-criteria decision-making methods to capture different stakeholders' needs and objectives in for example policy making and infrastructure investments [23, 35], we strongly advocate meetings between stakeholders. However, such meetings must be facilitated and guided in order to achieve their goals, a claim that finds support in for example the activities proposed by the SUMP concept (https://www.eltis.org/mobility-plans/european-platform) or in the vision-building process, described by Auvinen and Tuominen [3], for creating a common vision of future transport. The methodology used for the study reported in this paper can serve as an example of how the dialogue could (at least) be initialised. In our case the focus groups were run with each of the stakeholder groups. We believe though that different stakeholders, such as Future Users, Urban Planners and Developers, should be placed together in the same concrete setting and scenario including a neutral city and vaguely represented vehicles, in order to provide a good basis for starting a conversation on equal terms. The focus groups carried out in this study could have been organised this way, but the decision was to give the groups the same preconditions but without allowing them to influence each other to see if they differed or not. In a future setting, when the groups are brought together, keeping track of how they influence each other could be useful to examine mutual consideration and equal influence over outcomes, using e.g. similar learning surveys as Papa, Coppola, Angiello, and Carpentieri [33].

Transport systems have been described as complex socio-technical system with interaction between some basic components – users, vehicles and other means of transport, and transport infrastructure as well as organisation, governance and regulation [3]. In addition to the three groups present in this study, a broader range of stakeholders should therefore be invited, including public transport authorities and mobility service providers as well as policymakers at different levels – local, regional and national. Research has also shown that national governments play an important role in supporting regional and local authorities in the way that they develop their mobility plans [27]. Involving a broader set of stakeholders will no doubt pose further demands for facilitation of and structure to the dialogue as existing power structures may create barriers to everyone being allowed an equal voice. At the same time increasing the diversity of stakeholders has shown to increase the diversity of problem definitions as well as solutions in a planning process [40].

4 Conclusion

In conclusion, this study has provided further knowledge about how three groups of stakeholders – *Future Users*, *Urban Planners*, and *Developers* – anticipate a future without drivers. Important similarities and also some differences have been identified regarding their respective assumptions, hopes and concerns associated with the idea of AVs. The study shows further that a dialogue between different stakeholders is lacking but desired (and needed) in order to create preconditions for implementing AVs in a way that can contribute to the transition to an inclusive and accessible mobility system based on shared transport services.

The suggested implication of the study is that each stakeholder group should take steps to initiate this dialogue, as appropriate from their starting point. The outcomes of this paper could be used to guide that initiation. Local policymakers and urban planners, for example, can use the insights presented to question their

own assumptions about the state of technology as well as citizens' concerns and hopes, hopefully sparking internal development towards increased citizen involvement and better handling of industry relations. We echo the suggestion of Faisal et al. [15] to for urban planners to be aware, smart and proactive. Further, national and international policymakers should through the results surrounding the lack of leadership recognise their role to provide overarching coordination and arena(s) for the dialogue. Vehicle manufacturers and the mobility industry can also use the findings to recognise their role, especially in the establishment of the image of AVs and its potentially detrimental side-effects. In light of the findings that developers feel unable to voice their concerns, these companies should also critically review their own internal climate and allow employees to challenge the direction of development from within. For the research community, we hope that the research presented here can inspire to dig deeper into the different stakeholder viewpoint and facets of AV implementation in society, especially in the areas where dissensus was discovered, as well as inspire to incorporate more designerly methods (such as sensitising, focus groups, and mediating objects) in their research methodology.

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Authors' contributions
All authors took part in planning and performing the study, the analysis was conducted chiefly by authors ER and HS, and the paper written by ER, HS, MAK, and MJ with feedback from CB, FE, and LOB. All authors have approved the manuscript for submission.

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Declarations

Competing interests
The authors declare that they have no competing interests.

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