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ORIGINAL RESEARCH

Road user opinions and needs regarding small modular autonomous electric vehicles: Differences between elderly and non-elderly in Norway

Claudia Moscoso | **Isabelle Roche-Cerasi**

Department of Mobility, SINTEF Community, Trondheim, Norway

Correspondence
Claudia Moscoso, Department of Mobility, SINTEF Community, S.P. Andersens vei 5, 7465 Trondheim, Norway.
Email: Claudia.moscoso@sintef.no

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SINTEF Community

Abstract

This study examines road user opinions regarding small modular autonomous electric vehicles, focusing on the differences between the elderly and non-elderly populations in Norway. The data allowed for a comparison between 193 respondents under 65 years old and 208 respondents over 65 years old. The results highlighted significant differences between the two groups about the vehicles, their usability, and the likeliness of using them as public transport if implemented in the future. Traffic safety and personal security were found to be decisive aspects, for respondents over 65 years old being more worried about safety and security than their counterparts. Trust that the authorities will ensure the safe implementation of such vehicles in the current transportation system was also significantly different between the two groups, with the younger generations having more trust in the authorities than the older group. The results shed light on road user opinions about a small modular transport mode, particularly on those over 65 years old, indicating a need for research efforts to better identify how this new form of public transport should be implemented in the future to improve the mobility of all travellers and meet the needs of the seniors.

1 | INTRODUCTION

In times when autonomous vehicles and modular solutions are the focus of technology developers, lawmakers and transport operators, solid knowledge is needed to uncover the requirements for the safe implementation of autonomous transport systems and to understand how they will benefit different road user groups. These technological advancements have a large potential to solve the traffic safety and sustainability challenges of the current transport systems [1] by reducing greenhouse gas emissions and road traffic accidents [2–4].

New autonomous transport solutions range from privately owned autonomous cars [5] to self-driving minibuses or shuttles on dedicated roads or in mixed traffic [6]. For example, two prototypes of modular autonomous electric pods were tested in Dubai in 2017 in a closed area (NEXT Future Transportation Inc.). The innovative modularity of the system allows a pod to automatically detach from the rest of the pod platoon in heavy traffic conditions and re-join it when traffic conditions are improved (Figure 1). El-pods are small cabins (max. 6 seats) and will be therefore used by a limited number of travellers. However, the modularity makes it possible to increase the number of users, by creating trains of pods on roads and travellers will have the opportunity to walk to another pod according to desired destinations with no need to step outside to change pods and travel directions. This functionality will be of high interest by reducing the current travel times with public modes and increasing the accessibility of public transportation for all road users with additional services such as on-demand or door-to-door services. In addition, in case of a virus pandemic such as the recent COVID-19 pandemic, el-pods could be limited to family members or traveller groups. The modular solution may be therefore more attractive than the minibuses by providing a comparable service to taxi pooling. If successfully implemented and operated, this new form of transport can indeed reduce private car traffic whilst benefiting traffic safety and sustainable

FIGURE 1 Images depicting the design of small modular autonomous electric vehicles. *Source*: www.get-next.com (used with permission from Next Future Transportation Inc.).

cities. This research aims to determine whether the modular design is a transport solution that should be considered for road transportation in Norway.

1.1 | Public acceptance of new transport technology

The successful implementation of any new technology relies on public acceptance. Before developing any new mobility and transport solutions, it is important to have a clear understanding of the needs and requirements of the transport users to avoid low public acceptance and overlooked solutions. This is particularly important as low public acceptance can act as a barrier when trying to implement new mobility and transport solutions [7, 8].

Venkatesh et al. [9] developed the Unified Theory of Acceptance and Use of Technology (UTAUT) and showed that the intention to use a new technology and usage behaviour is built on four constructs: performance expectancy, effort expectancy, social influence and facilitating conditions. The UTAUT theory was based on previous models, including the most influential psychological theory regarding the association between beliefs and behaviour, the Theory of Planned Behaviour (TPB). The TPB theory showed that attitude, subjective norms, and perceived behavioural control are decisive for predicting behavioural intention [10]. The UTAUT model was further developed by research studies to be applied to the acceptance of autonomous transport solutions to determine the relevant factors affecting their adoption, even though the highest technology maturity level of these solutions is not always reached.

Previous studies have addressed the public acceptance of autonomous vehicles and indicate differences in acceptance according to the type of autonomous vehicles investigated, for example, between private autonomous cars and autonomous public modes [6, 11–13]. Considering the latter, research has determined the relevant factors influencing the public acceptance of such public modes. These factors are related to the perceived usefulness, usability, reliability, safety, comfort, and trust, and depend on one's personal and cultural background [14–17]. In addition, research on autonomous shuttles provides solid knowledge about other factors that may be decisive for their acceptance. The indicators of user acceptance during trials were found to be willingness to pay, waiting time, vehicle speed, distance, and time to the nearest stop [18]. Users often reported during the pilot studies that the speed of the vehicles was too low [19–21]. How individuals relate to autonomous public modes in regard of trust in automation and perceived risk affects their acceptance level and further their intention to use the mode [22].

1.2 | Demographic differences in the acceptance of autonomous buses

Studies have found significant differences in risk perception between different road user groups [23]. For example, Roche-Cerasi [22] carried out a study in Norway and showed that there are significant differences between genders when the respondents were asked to evaluate the safety and security of autonomous minibuses compared to traditional buses with a driver. Women were found to be more worried than men about the four items: (i) traffic safety (accidents), (ii) security related to violence, robbery, and harassment, (iii) security related to hacking and terrorism, and (iv) security related to data privacy. Previous studies examining differences in concerns about public and private transport modes also found similar results [24]. Trust in automation is a key factor in the intention to use public modes. Previous studies showed that road users preferred to have an operator inside driverless buses to take over control of the vehicle if necessary; women being more worried than men [25]. In addition, shared vehicles with ride-sharing were found to be more likely to be adopted by young individuals and individuals who are more used to multimodal mobility [26]. Roche-Cerasi [22] showed that slightly over half of the respondents in her study in Norway had no trust or low trust in the ability of the authorities to reduce the risk of accidents with driverless minibuses. Results indicated that individuals with higher education and individuals living in densely populated areas had greater trust in the authorities. Roche-Cerasi [22] recommended that the authorities and cities communicate more about how they will ensure the safety of road users and the safe implementation of autonomous buses in mixed traffic. In studies of autonomous shuttles in Germany, the elderly reported the shuttles as less easy to use than their counterparts [27], whereas Roche-Cerasi [22] found that the public thought that the autonomous mode would be useful for increasing the mobility of the elderly (opportunity to travel more) and people with disabilities.

The new concept of small autonomous modular electric vehicles (el-pods) with their modularity component has the potential to ease the current commuting issues in cities (e.g. travel times, flexibility, and comfort) that users of private cars find critical about public modes [28]. The el-pods may completely change the way road users and in particular the elderly think about public transportation. This is promising particularly in the context of population ageing, as it can be argued that the el-pods will be essential to increase the mobility of the elderly and people with disabilities. This is in line with the UN Sustainable Development Goal 11, stating that: "*By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons*". Indeed, accessibility to transport is of high importance to older people [29, 30], and impacts the population's health and well-being [31]. Moreover, Harper, Hendrickson, Mangones, and Samaras [32] predicted a potential increase in the US population travelling with autonomous vehicles for the elderly and people with and without travel-restrictive medical conditions. The results concerning the elderly drivers without medical conditions presented a potential increase of 2.2% in total annual vehicle miles travelled (VMT) compared to the younger population within each gender. We can conclude that the increased automation and future transportation system need to be especially beneficial for the elderly.

Although there can be found a large number of studies addressing public acceptance to autonomous vehicles, including studies focusing on elderly people, the knowledge is scarce when analysing the differences between elderly and non-elderly people and how they assess autonomous vehicles. Moreover, no previous research has investigated the acceptance of el-pods (or autonomous vehicles with the modularity component) of these two different groups. Considering that all road users, particularly the elderly and people with disabilities, may benefit from the implementation of el-pods in the current transport system, research efforts should focus on how to meet the needs of the different road user groups and to develop viable business models for transport service providers. The elderly and the retiree group have different requirements and needs than other age and user groups when it comes to transportation services, and it is important to identify how new solutions can benefit them.

1.3 | Study objectives

To the best of our knowledge, no previous research study focused on the acceptance of non-elderly and elderly populations to implementing el-pods in public transportation systems. In addition and based on the recent pandemic that has afflicted the world, there is today no transport system adapted to major sanitary situations with restrictive social distance. As discussed earlier, the implementation of such el-pods has the potential to address several challenges related to transport, sustainability and social aspects, but there is a need to understand the needs of different groups of road users to avoid social barriers that might hinder their possible implementation. Thus, the present study focuses on evaluating the opinions and views of different groups of individuals on how useful they consider the implementation of such el-pods. As such, the objective of the study is twofold:

- (O1) To explore whether modular autonomous electric pods have the potential to fulfil traveller needs and demand for public transport (e.g. accessibility, safety, security, comfort, and infection protection).
- (O2) To investigate whether there are any differences in how the elderly and non-elderly groups assess different aspects related to the use of autonomous electric pods.

2 | METHOD

To address the knowledge gap, a research study was carried out among the Norwegian population to examine the opinions and views of individuals regarding the usefulness of el-pods. This study makes use of a questionnaire with validated questions and item measurement instruments to address the initial views of a prospective mobility solution. To this end, a web survey to collect data from people concerning their preferences, opinions or factual information [33] has been used. The web survey was based on previous research studies regarding autonomous vehicles. The reliability and validity of the item measurement instrument regarding the transport priorities were previously tested [22, 23]. However, the questionnaire developed for the web-survey was adapted to the services that the particular modular design could offer to travellers. The questionnaire was pre-tested and revised before it was opened for responses. This stage was important to evaluate whether the questionnaire was valid regarding the understanding of the concept and the formulation of the questions.

Based on the variables found in the existing literature, and indicated in Section 1, seven factors were selected for this study: (i) Familiarity with the concept of el-pods, to explore the level of knowledge among the respondents of this particular mobility solution; (ii) Usefulness of the el-pods; (iii) Likeliness to use the el-pods if implemented; (iv) Transport priorities and preferences for the interior design of el-pods, to explore which factors are important to road users when choose and use transport modes, and to uncover preferences for the interior design of the el-pods; (v) Positive effects of using the el-pods; (vi) Safety and security issues when travelling with el-pods, and (vii) Trust in authorities. The following sub-section presents the research questions related to each of these seven factors and their corresponding survey questions. Appendix A presents the complete questionnaire including all the survey questions as presented to the study respondents.

2.1 | Research questions

Table 1 below presents the six research questions addressed in the web survey with the corresponding questions.

TABLE 1 Research questions addressed in the web survey.

RQ	Research questions	Survey questions
RQ1	Familiarity: To what extent are individuals familiar with the concept of autonomous minibuses and modular vehicles?	7, 8, 9, 10, 11
RQ2	Usefulness and likeliness to use: How likely do individuals think they will use the el-pods in the future?	13, 14, 18, 19
RQ3	Transport priorities and preferences for interior design: What aspects do individuals prioritize when they choose travel modes? Which interior design features of el-pods do individuals consider attractive?	6, 22
RQ4	Positive effects: Which positive effects do individuals associate with el-pods?	15, 16, 20
RQ5	Safety and security issues: Which safety and security issues are individuals worried about?	15, 16
RQ6	Trust in authorities: Do individuals trust the ability of authorities to ensure the safe implementation of el-pods?	23

2.2 | Procedure

The web survey was distributed through various communication channels, for example, national organizations such as public transport association, national association of cyclists, retirees, and student organisations, in order to collect data from individuals with different sociodemographic backgrounds. Specific road user groups on popular social media platforms were also invited to participate in the web survey. A total of 401 individuals were recruited: 31.9% via social media group membership, 51.1% via organisation membership, 12.2% via close contact, and 4.7% did not mention how they had access to the web survey. Since 91% of the Norwegian population have access to Internet (SSB, 2018), there was no particular difficulty to reach the older generations. The study was carried out between December 2020 and January 2021.

2.3 | Sample

The sample consisted of individuals between 18 and over 65 years old, individuals who work or are students, under 65 years old (group 1: non-elderly group) and individuals who are over 65 years old (group 2: elderly group). The proportions of females or males were respectively of 47.2% and 51.3% in group 1 and 38.0% and 61.5% in group 2. Group 1 in the sample is mainly composed of individuals working full time (69.9%) and group 2 of retirees (100%). On average, there are 38.6 individuals per age group. The smallest age groups are individuals of 26–35 years ($n = 25$) and 56–65 years old ($n = 33$). About 57.1% of individuals in group 1 live in a city with over 100,000 inhabitants, whereas for group 2, individuals living in large cities is only of 29.3%. Since modular autonomous electric vehicles might be considered more useful in large cities, the spread out of retirees in different city sizes could influence the results obtained for group 2. The results for the two study groups also showed that a large proportion of the respondents reported having a driving licence (89.6% of the respondents in group 1 and 96.2% in group 2). For individuals in group 1, 35.8% stated that they mostly used their car to travel to their work or study place before the COVID-19 pandemic. About 31.1% used public transportation modes, 15.5% cycled and 14.5% walked. A large share of retirees in group 2 stated that they had access to a car (92.3%) and 62.0% stated that the car was also their most used transport mode before the sanitary crisis. Only 16.3% of the retirees used public transport modes ($n = 34$) and 85.3% of those who used public modes reported using them less during the pandemic. Table 2 below shows the distribution for the two study groups.

TABLE 2 Demographic characteristics of the two study groups.

Groups		1 N (%)	2 N (%)
Gender	Female	91 (47.2%)	79 (38.0%)
	Male	99 (51.3%)	128 (61.5%)
	Prefer not to answer	3 (1.5%)	1 (0.5%)
Age groups		−65 years	+65 years
	18–25 years	46 (23.8%)	
	26–35 years	25 (13.0%)	
	36–45 years	44 (22.8%)	
	46–55 years	45 (23.3%)	
	56–65 years	33 (17.1%)	
	+ 65 years		208 (100%)
Education level	Primary school	1 (0.5%)	9 (4.3%)
	Secondary school	31 (16.1%)	66 (31.8%)
	University	161 (83.4%)	133 (63.9%)
Work situation	Full-time	135 (69.9%)	
	Part-time	11 (5.7%)	
	School/student	47 (24.4%)	
	Retired		208 (100%)
Place of residence	Small place (less than 200 inhabitants)	2 (1.0%)	16 (7.7%)
	Small town with 200–1999 inhabitants	16 (8.3%)	38 (18.3%)
	Medium-sized city with 2000–19,999 inhabitants	23 (11.9%)	36 (17.3%)
	Large city with 20,000–100,000 inhabitants	45 (23.4%)	51 (24.5%)
	City with over 100,000 inhabitants	105 (54.4%)	61 (29.3%)
	Prefer not to answer	2 (1.0%)	6 (2.9%)
Driver's license	Yes	173 (89.6%)	200 (96.2%)
	No	20 (10.4%)	8 (3.8%)
Total		**193 (100%)**	**208 (100%)**

2.4 | Questionnaire

Exploratory research was carried out to investigate the citizens' opinions about the new concept of public transportation. The questionnaire was divided into four sections: (1) The first section concerned travel habits; the respondents were asked how often they used the different public and private transport modes (public modes, car, bicycle, motorcycle, and walking) before the COVID-19 situation and whether the sanitary crisis changes their travel habits on a five-point evaluation scale ranging from 'never' to 'very often'. (2) The second section is related to transport priorities based on an 11-factor measurement instrument. The respondents were asked how important the following aspects were for their choice of transit mode: punctuality, frequency, travel time, cost, comfort, flexibility, accessibility, safety, security, and environmental awareness. A five-point evaluation scale ranging from 'not at all important' to 'very important' was used. They also had to evaluate to what extend the interior design of el-pods was important for them. Several design features were proposed: lighting, colours and surfaces, comfortable seats, communication about stops and delays, dynamic information on travel time, access to a Wi-Fi network and mobile charging. (3) The third section concerned the el-pods and their usefulness and benefits for society. First, the respondents were asked if they had had the opportunity to test autonomous shuttles or even el-pods, or if they had heard of them. They were asked to evaluate whether the el-pods would be useful for them for specific daily travels and how likely they thought it was that they would use the el-pods if the vehicles fulfilled their own requirements. In addition, the respondents were asked about the benefits they expect from the inclusion of el-pods in the public transport system. They had to select an answer on a five-point evaluation scale ranging from 'very unlikely' to 'very likely' for four items: fewer traffic accidents, less car traffic and pollution, shorter travel time with public transport, and increased mobility (opportunities to travel more) for the elderly and people with disabilities. They could also choose to answer that they did not see any benefit in this form of transport. (4) The fourth part is related to their concerns about the safety, security, and health issues related to the use of el-pods. They were asked how likely they thought that they would use them in a future scenario where the pods will run on a fixed route and time schedules. In addition, concerning the COVID-19 situation, the respondents had also to evaluate how likely they will use pods during a pandemic with specific infection control measures (pods used by traveller groups or family members). They were also asked how the pods should be operated to prevent infection: Social distancing with limited groups of users in pods, infection tracking with the ability to identify the passengers, contactless payment, and ticketing. (5) In addition, they had to agree to what extent they had trust in the authorities' ability to ensure the safety of passengers travelling with el-pods and a strict regime for control and certification of el-pods. Finally, the respondents were asked about demographic variables including gender, age, income, and education. The complete questionnaire is presented in Appendix A.

3 | RESULTS

3.1 | Analysis strategy

Descriptive statistics were used to reveal the characteristics of the sample. Moreover, to uncover possible differences among both demographic groups (under 65 and over 65), inferential statistical tests were used. For the questions based on a 5-point Likert-type scale in the questionnaire, which is commonly considered to be of the ordinal level of measurement and with data that are not normally distributed, the Mann–Whitney U test was used for evaluating the differences in the two independent groups. Pearson chi-square tests of independence determined whether the associations between the groups were statistically significant. The assessments of statistical assumptions were performed prior to the application of the tests to confirm their suitability. The results were analysed with statistical tests, using the IBM SPSS Statistics 27 software. By convention, the cut-off point for the statistical results is a p-value of 0.05. The confidence level of the sample was 95%. Furthermore, for the interpretation of the results, the discrete response categories were numbered for the strength of agreement. This means that they were numbered from strongly disagree = 1 to strongly agree = 5, for the likeness to use el-pods from very unlikely = 1 to very likely = 5, for the factors of priorities from not important at all = 1 to very important = 5 and for the concern about safety and security from not worried at all = 1 to 5 = very worried.

For comparing the differences between groups for example for the strength of agreement, grouping of responses (e.g. strongly disagree with disagree) have been performed. The following sections present the main findings for the six research questions of the study. Figures depicting the results of the survey questions are colour-coded from negative responses (light green) to positive responses (dark green). The neutral responses (e.g. neither/nor) present a grey colour.

3.2 | Statistical analyses

3.2.1 | Familiarity with the concept of el-pods

El-pods were defined as follows in the survey:

"An el-pod is a modular vehicle designed to transport a maximum of 6 seated people. These el-pods can be connected to other el-pods to allow more passengers to be transported if necessary. It is possible for passengers to move between el-pods when they are connected, so that they can offer an indoor transition to other travel routes. It is expected that such el-pods can be ordered using an app on a smartphone. Note that there will be no driver or host on board, but the el-pod are expected to be remotely supervised by an operator at a traffic control centre." In addition, Figure 1 was also shown in the survey to the respondents.

The respondents were asked if they had heard about autonomous minibuses or el-pods, and if they had tried them.

TABLE 3 Mann–Whitney U test results on differences in likeliness to use el-pods for the two study groups.

		Ranks			Test statistics			
Test variable	**Grouping variable (Age)**	***N***	**Mean rank**	**Sum of ranks**	**Mann–Whitney U**	**Wilcoxon *W***	***Z***	**Asymp. sig. (2-tailed)**
(a) Likeliness to use el-pods if all personal requirements are met	Elderly (65+)	184	151.94	27,957.50	10,937.50	27,957.50	−6.013	<0.001
	Non-elderly (−65)	183	216.23	39,570.50				
(b) Likeliness to use el-pods as part of public transport with fixed route and schedule	Elderly (65+)	187	170.18	31,823.00	14,245.00	31,823.00	−3.119	0.002
	Non-elderly (−65)	186	203.91	37,928.00				
(c) Likeliness to use el-pods for infection control during a pandemic	Elderly (65+)	188	153.99	28,951.00	11,185.00	28,951.00	−5.925	<0.001
	Non-elderly (−65)	182	218.04	39,684.00				

Over 60% of the respondents indicated that they had not heard about el-pods before. Among the ones who answered that had heard of them, few reported that they had even tried an el-pod in the UK or France. The results showed that a large share of the sample was familiar with autonomous minibuses (94%) and 11.2% had even tried one of them. This is not surprising taking into consideration that several pilot studies have been and are being carried out in Norway [34, 35]. We can therefore argue that there was no particular difficulty for the respondents to understand the concept of el-pods. A significant difference was found between the two groups (Pearson chi-square test X^2 (2, $N = 401$) = 28.9, $p < .001$); individuals under 65 years old in group 1 had also more opportunities to try the minibuses than those in group 2. For the el-pods, only 32.2% of the sample had heard about this new concept and no significant difference was found between the two groups.

3.2.2 | Usefulness of el-pods

The respondents were asked how likely they thought the el-pods would be useful for them and for different types of travel: (1) between home and work/study place, (2) between home and traditional public transport, (3) between public transport and work/study place, (4) to travel to leisure, social activities, or shopping centres. For Group 1, 35.8% of the respondents thought that the el-pods would be more useful for them between home and work/study place, 17.6% for travelling to leisure, social activities, or shopping centres, and 14.0% between home and public transport. Around 26.4% thought that the el-pods would be not useful at all for them. For group 2, 56.7% did not think that the el-pods would be useful for them and 27.9% thought that they could use them for travelling to leisure, social activities, or shopping centres. No statistically significant differences were found between the two studied age groups.

3.2.3 | Likeliness to use el-pods

Mann–Whitney U test, which is suitable for testing variables with preference scales, was used to uncover differences between the two study groups (under and over 65 years old). Table 3 below shows the results of the Mann–Whitney U test on the likeness to use the el-pods. The differences between the groups were found statistically significant ($p \leq 0.002$). No significant differences were detected between age sub-groups in group 1. The respondents were asked how likely they thought that they would use the pods (a) if all their personal requirements for such pods were met, (b) if the el-pods provide a conventional public transport system with established routes and schedules (not on-demand service), and (c) as an alternative public transport under a pandemic with infection risk and required social distancing.

Figure 2 below shows the respondents' likeliness to use the el-pods in three scenarios. The results showed that the respondents in group 1 are more likely to use the el-pods than their counterparts in group 2 for the three scenarios: (a) 74.3% of the respondents in group 1 stated that they would use the el-pods if all their personal requirements are met, whereas slightly under half of the respondents in group 2 (48.9%) thought the same; (b) 50.5% of the respondents in group 1 stated that they would use the el-pods as a conventional public transport system, whereas 41.7% of the respondents in group 2 thought the same; (c) 42.3% of the respondents in group 1 stated that they would use the pods under a pandemic, whereas only 20.2% of the respondents in group 2 thought the same. About 63.8% of the respondents in group 2 did not think that they would use the pods during a pandemic.

The COVID-19 pandemic has strongly affected the travel habits of citizens in many cities across the world. To investigate further whether an innovative modular system might be considered by individuals as an alternative transport solution during a pandemic; the respondents were asked if they believed that social distancing could be effectively provided in such a system. The results showed that whereas 53.9% of the respondents in group 1 believed that the modular system would provide effective social distancing, only 33.2% in group 2 believed it. In addition, concerning the application system for infection tracing, and contactless ordering and payment, slightly over half of the respondents in group 1 thought that the application system would provide effective infection tracing (58.5%) or a contactless system (52.3%), whereas there were more uncertainties in group 2 where under 40% evaluated these features in el-pods are effective (31.3% and 34.6%).

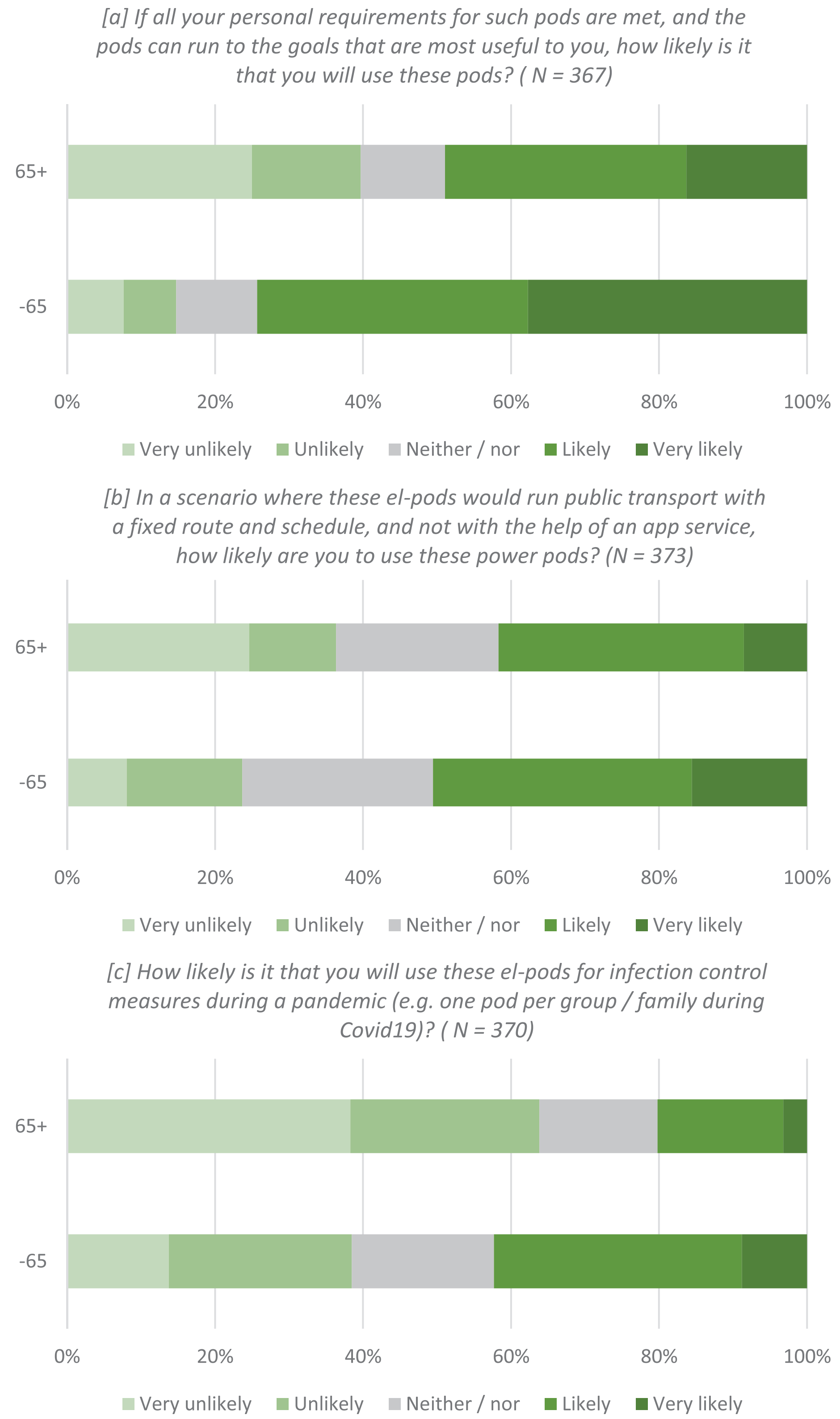

FIGURE 2 Respondents' likeliness to use the el-pods for the two groups: (a) if all personal requirements are met, (b) as part of a conventional public transport system, and (c) for infection control measures during a pandemic.

TABLE 4 Mann–Whitney U test results on differences in transport priorities for the two study groups.

			Ranks			Test statistics			
Test variable	**Group**	**Age**	***N***	**Mean rank**	**Sum of ranks**	**Mann–Whitney U**	**Wilcoxon *W***	***Z***	**Asymp. sig. (2-tailed)**
Punctuality	2	+65	208	187.66	39,034.00	17,298.00	39,034.00	−2.631	0.009
	1	−65	193	215.37	41,567.00				
Frequency	2	+65	208	172.14	35,805.00	14,069.00	35,805.00	−5.653	<0.001
	1	−65	193	232.10	44,796.00				
Travel time	2	+65	208	173.24	36,034.50	14,298.50	36,034.50	−5.423	<0.001
	1	−65	193	230.91	44,566.50				
Flexibility	2	+65	208	189.37	39,389.50	17,653.50	39,389.50	−2.231	0.026
	1	−65	193	213.53	41,211.50				
Accessibility (e.g. access for the disabled)	2	+65	208	228.89	47,609.00	14,271.00	32,993.00	−5.119	<0.001
	1	−65	193	170.94	32,992.00				
Environmental considerations	2	+65	208	189.00	39,312.00	17,576.00	39,312.00	−2.247	0.025
	1	−65	193	213.93	41,289.00				

3.3 | Transport priorities and preferences for the interior design of el-pods

A sub-objective of the research study (RQ4) was to explore which aspects related to the interior design of the el-pods are important for the respondents that they would consider using them. The six proposed features were not solely limited to the aesthetics of the el-pods but also to the capacity to communicate with the el-pods as well as other technological services:

(1) Inside lighting: Satisfactory artificial lighting without blending sources
(2) Aesthetics: Colours on surfaces
(3) Ergonomics: Comfortable seats
(4) Communication with other vehicles and road users (e.g. stops and manoeuvres)
(5) Dynamic information about the el-pod's position, travel time, and delays
(6) Access to free Wi-Fi and the possibility to charge the phone

The results showed that there were no significant differences between the two groups for four of the six features. Respondents in group 1 always found all the features more important than those in group 2. Features 4 and 5 were found the most important features for group 1 and 2 and a significant difference was found with Mann-Whitney U tests (Feature 4: $U = 17{,}543.50$, $N_1 = 193$, $N_2 = 208$, $p = 0.018$; Feature 5: $U = 15{,}188.50$, $N_1 = 193$, $N_2 = 208$, $p < 0.001$). No significant difference was found between age sub-groups in group 1 for the 6 features.

As described in Section 1, 11 factors that are important when road users choose and use transport modes were also examined [28]. Table 4 below shows for which transport aspects, significant differences between the two groups were found. Both groups found punctuality, frequency, travel time, flexibility, and environmental considerations, important or very important. However, respondents in group 1 ranked them as more important than those in group 2. Only the factor, of accessibility, was ranked as important by respondents in group 2 (45.2%), whereas their counterparts in group 1 evaluated this factor as not important (50.2%). There were no significant differences between the groups for the other factors economy, comfort, safety, security (related to violence, robbery, or harassment) and security (related to terrorism).

In addition, significant differences between genders were also found for the sample. Table 5 shows the results for accessibility, safety (accidents), security (violence, robbery, harassment), security (terrorism), and environmental considerations. The results suggest that all these six factors are important to women whereas only three of them, safety, security (violence) and environment are important to men. Men stated that accessibility is not important for them (49.3%) and there was no clear result for safety related to terrorism. The most important factor for both women (81.2%) and men (63.0%) is safety (accidents). There were no significant differences between genders for the factors of punctuality, frequency, travel time, comfort, and flexibility.

3.3.1 | Positive effects of using the el-pods

Another objective of the study (RQ5) was to examine which positive effects the respondents thought the eventual use of el-pods could bring. Figure 3 below presents the results for four proposed effects. Significant differences were found with Pearson chi-square tests between the two groups for the four effects: (1) Increased mobility for elderly and people with disabilities (X^2 (4, $N = 401 = 25.7$, $p < 0.001$), (2) reduced travel time with public transport (X^2 (4, $N = 401 = 25.9$, $p < 0.001$), (3) less car traffic and pollution (X^2 (4, $N = 401 = 43.8$, $p < 0.001$), (4) fewer traffic accidents (X^2 (4, $N = 401 = 25.1$, $p < 0.001$).

TABLE 5 Mann–Whitney U test results on differences in gender for transport priorities.

		Ranks			Test statistics			
Test variable	Group variable (Gender)	*N*	Mean rank	Sum of ranks	Mann-Whitney U	Wilcoxon *W*	*Z*	Asymp. sig. (2-tailed)
Accessibility (e.g. access for the disabled)	Female	170	226.64	38,529.50	14,595.50	40,473.50	−4.252	<0.001
	Male	227	178.30	40,473.50				
Safety (accidents)	Female	170	227.79	38,725.00	14,400.00	40,278.00	−4.568	<0.001
	Male	227	177.44	40,278.00				
Security (related to violence. robbery or harassment)	Female	170	229.15	38,956.00	14,169.00	40,047.00	−4.673	<0.001
	Male	227	176.42	40,047.00				
Security (related to terrorism)	Female	170	235.59	40,050.00	13,075.00	38,953.00	−5.634	<0.001
	Male	227	171.60	38,953.00				
Environmental considerations	Female	170	229.10	38,947.00	14,178.00	40,056.00	−4.720	<0.001
	Male	227	176.46	40,056.00				

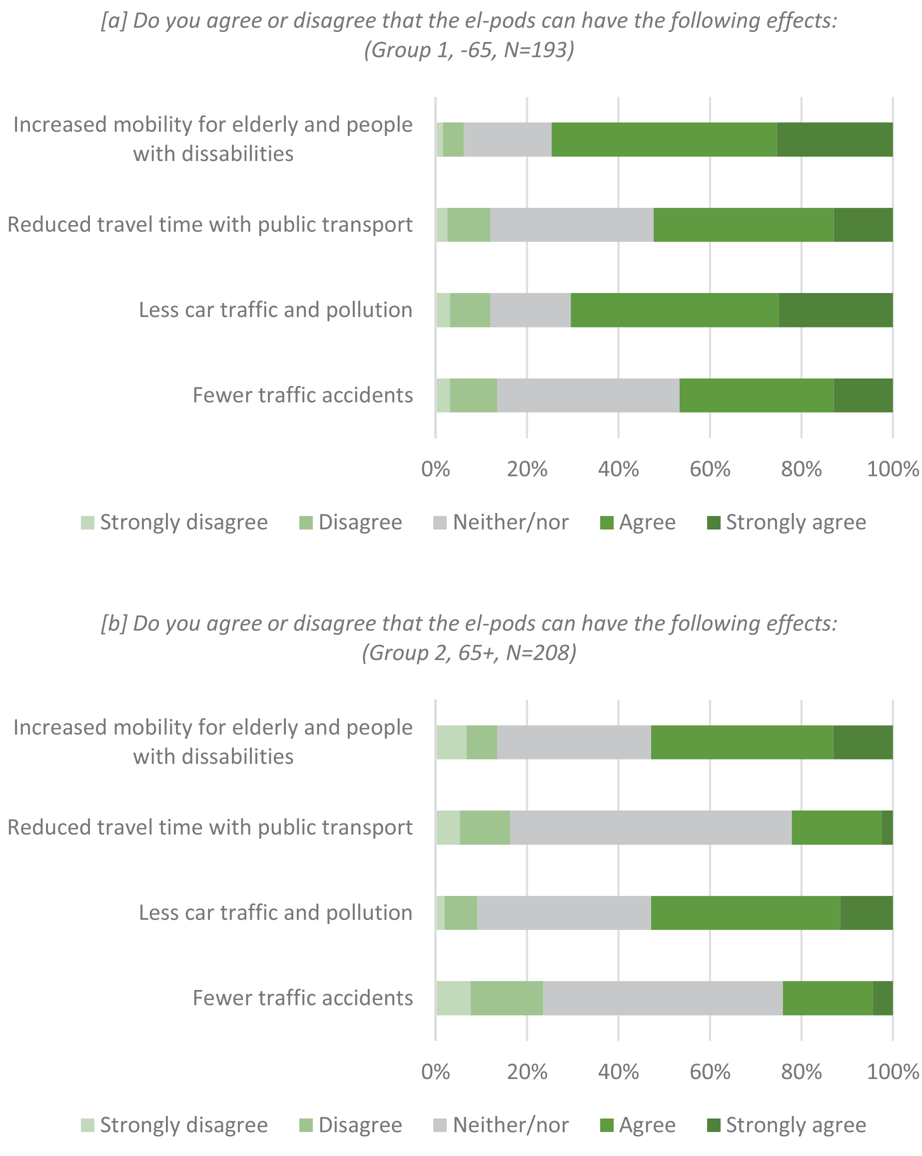

FIGURE 3 Respondents' opinions about possible positive effects of using el-pods for the two groups, (a) group 1, non-elderly and (b) group2, elderly.

Respondents in group 1 agreed or strongly agreed that the el-pods would have four effects if implemented in the future; the strongest effects would be for them (1) increased mobility for the elderly and people with disabilities (74.8%) and (3) less car traffic and pollution (70.5%). The same results were found with the respondents in group 2 with 52.9% agreeing that both effects (1) and (3) are expected to happen. Respondents in group 2 are more uncertain about the effects (2) and (4) with 61.5% and 52.4% of the respondents answering that they neither agreed nor disagreed that these effects would happen. No significant differences were found between the age sub-groups in group 1 for the four effects.

3.3.2 | Safety and security issues

Respondents were asked to evaluate possible safety and security issues when travelling with el-pods. The four issues were: (1) Data protection, (2) security (violence, robbery, and harassment), (3) security (hacking and terrorism), (4) traffic safety.

Mann–Whitney U tests showed significant differences between the study groups for all four issues: Data protection: $U = 16{,}615.00$, $N_1 = 193$, $N_2 = 208$, $p = 0.002$; Security (violence, robbery, and harassment: $U = 14{,}632.50$, $N_1 = 193$, $N_2 = 208$, $p < 0.001$; Security (hacking and terrorism): $U = 16{,}914.50$, $N_1 = 193$, $N_2 = 208$, $p = 0.005$; Traffic safety: $U = 16{,}664.50$, $N_1 = 193$, $N_2 = 208$, $p = 0.002$. For all four issues, the results indicate that respondents in group 2 (65+) are more worried than their counterparts in group 1. Figure 4 shows the distribution of the responses for the two groups.

In addition, a significant difference between genders was found with the Mann–Whitney U test for traffic safety: $U = 16{,}787.00$, $N_1 = 170$, $N_2 = 227$, $p = 0.021$; women being more worried than men. No significant differences were found between genders on security issues and data protection. Figure 5 below shows the distribution of the responses related to gender for traffic safety.

3.3.3 | Trust in authorities

The final research question (RQ6) aimed to explore the level of trust of the respondents in the authorities for the control and certification of the el-pods, and for ensuring that the safety of road users will be their priority. Pearson's chi-square results show significant differences between the two groups for having trust in the authorities that they will have the users' safety as their priority with el-pods, X^2 (4, $N = 401 = 12.4$, $p = 0.015$). Respondents from group 1 (−65) indicated to have a higher degree of trust (72.0%) compared to their counterparts from group 2 (58.1%). A significant difference was not found between the groups for having trust in the authorities that they will have a strict regime for control and certification of the electric pods.

4 | DISCUSSION

4.1 | Limitations of the study

El-pods are not a form of transport that is planned to be implemented in the short term. One could argue that the population would find it hard to understand the concept and the implementation-related issues. However, pilot studies of autonomous minibuses are numerous in Norway and the concept of modular vehicles, and its benefits were explained in the survey by means of texts and pictures. Despite this limitation, the results shed light on the needs and opinions of these el-pods as novel transport technologies divided by age group. The results in turn can serve to formulate new theories and hypotheses for further research efforts focusing on the acceptance of new autonomous transport technologies by different market segments. The data collection of this study was performed before any implementation of such el-pods. As such, further research efforts are encouraged to follow whether the public acceptance of technology changes throughout the years and after implementation.

4.2 | Discussion of the findings

The present study explored the perceptions, opinions, and level of acceptance of modular autonomous electric vehicles (also referred to as el-pods) among two study groups, that is, non-elderly (individuals under 65 years old who work or are students—group 1) and elderly (individuals over 65 years old—group 2). The results showed differences between the two study groups concerning their opinions and views about el-pods.

Concerning the usefulness of el-pods, the results showed no significant differences between the two groups. A large share of respondents in group 2 (56.7%) considered that the el-pods would be not useful for them, and 26.4% in group 1 thought the same. Previous studies have shown that transport mode preferences and whether the respondents have a driving licence or a car at their disposal are decisive factors for transportation mode choice [28]. A large share of elderlies in group 2 (92.3%) had access to a car and 62.0% stated that the car was also their most used transport mode. They did not evaluate this new form of transport as useful. This could be due to their view of the distance between their homes and possible el-pod stations as a barrier, suggesting that the opportunity of having direct routes without getting off the pod and the reduced travel time compared to traditional buses are not enough to induce a modal shift. These results are in line with previous research findings concerning autonomous minibuses [22]. The implementation of such modular modes should not be expected to reduce private car use on their own. Previous studies argued that limiting the possibilities of private car use (e.g. congestion charge) is more effective than improving public transportation when it comes to reducing the pollution from vehicle emissions [36].

Regarding the likeliness to use el-pods as public mode, the results suggest that respondents in group 1 are more likely

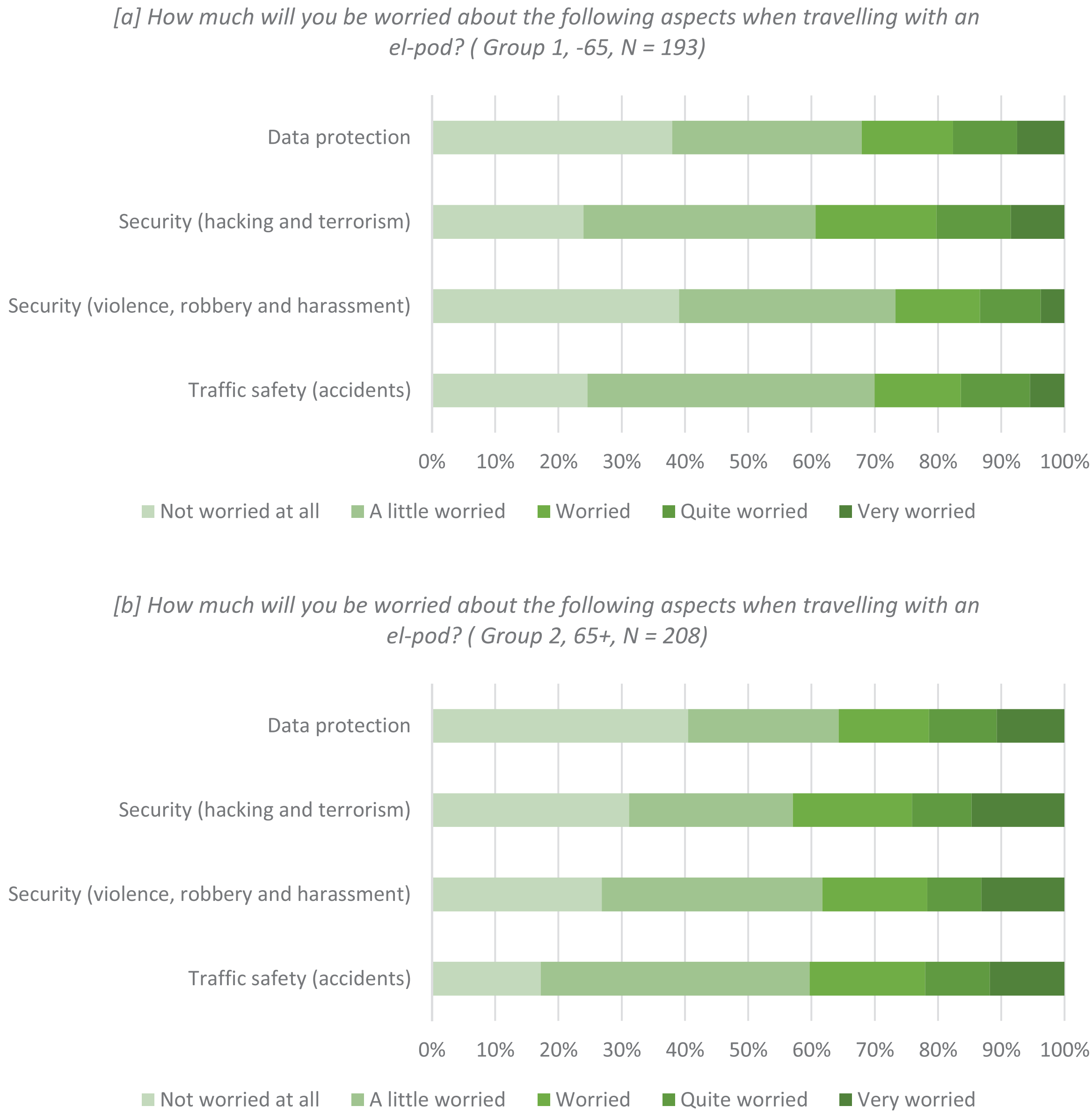

FIGURE 4 Respondents' opinions about possible safety and security issues with el-pods for the two groups, (a) non-elderly and (b) elderly.

to use the el-pods than those in group 2, in all three examined scenarios (i.e. if all personal requirements are met, as part of a public transport network and under a pandemic). These findings are in line with previous research studies indicating that younger individuals have a more positive attitude towards autonomous vehicles [25], or that age is negatively associated with the likelihood of using autonomous buses [37]. As discussed by Nordhoff et al. [38] this could be because the elderly see autonomous public modes as difficult to use. Another reason could be that the lack of human contact may be a major barrier for them and people with disabilities. In addition, the separation of the el-pods when moving on roads may present a large barrier for people with low trust in technology. Further research is needed to understand how to address the barriers that will prevent individuals from using autonomous and modular public modes.

Concerning the transport priorities, results showed differences between the two study groups for six of the eleven factors. The results indicated that individuals in group 1 consider punctuality, frequency, travel time, flexibility, and environmental considerations as more important compared to individuals in group 2. Accessibility (e.g. access for the disabled) was the only factor which was found to be more important to individuals in group 2 than those in group 1. This is not surprising as gait and mobility change as a person ages [39], and difficulties in accessibility to transport services may become a key factor for the use of public transport among the elderly population [40]. A transport solution (el-pods or minibuses) may be therefore more useful for the elderly population if they offer on-demand services from door-to-door; a solution that might exist if the demand is enough and if the services are economically viable. El-pods can be more likely to start being used in niche markets

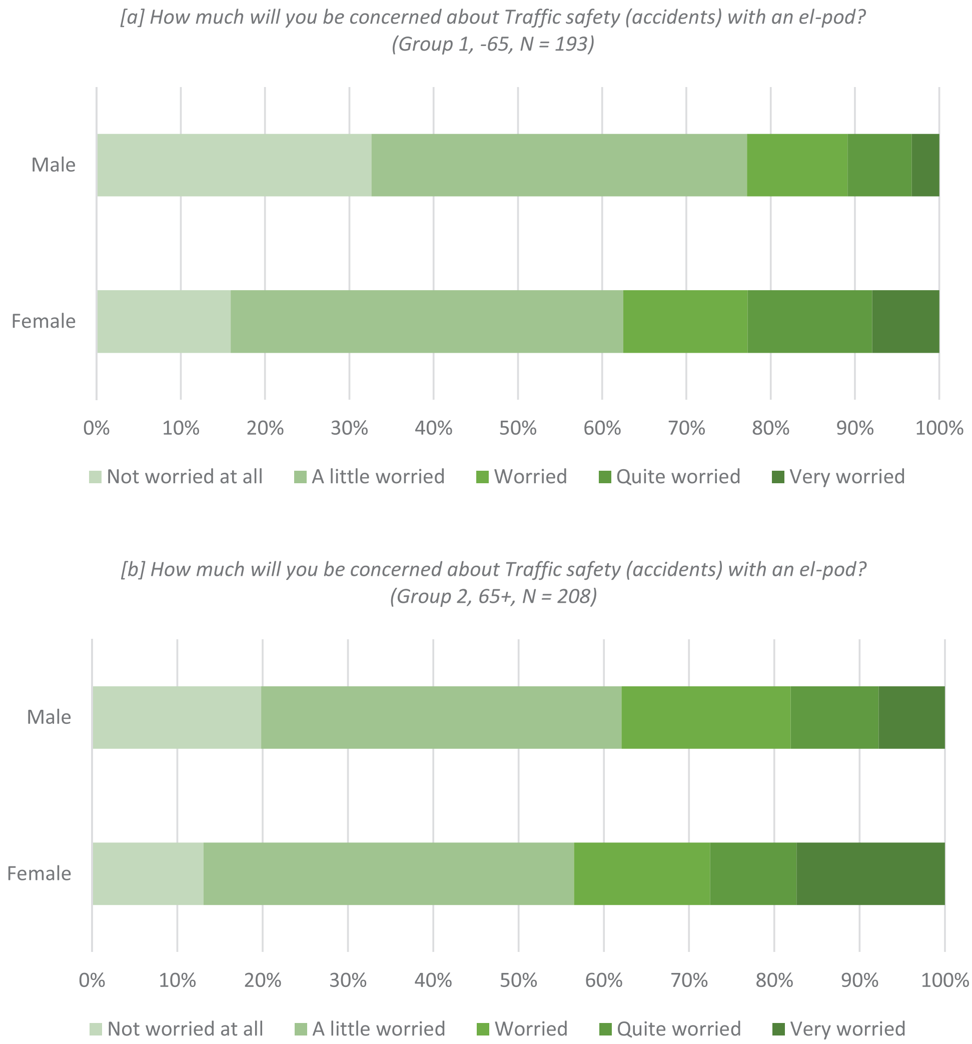

FIGURE 5 Respondents' opinions about traffic safety with el-pods for the two groups, (a) group 1, non-elderly and (b) group 2, elderly.

than in broader markets as it has been the case for minibuses. Services should be developed based on the needs and requirements of the different groups of travellers considering the age and gender groups and living environment (e.g. rural areas vs urban areas). For example, in urban areas, the el-pods have the potential to increase traffic fluidity, whereas in rural areas, it may be more useful to provide mobility to older people who are isolated at home.

The preferences regarding the interior design features of the el-pods were also investigated. Among the six interior aspects presented (ranging from aesthetics to technological features), there was a clear preference for two features, and that for the two groups: (1) Communication with other vehicles and road users (e.g. stops and manoeuvres), and (2) dynamic information about the el-pod's position in the road network, travel time, and delays. These two aspects were particularly more important for individuals in group 2. The results related to the provision of dynamic information are similar to the study carried out by Amanatidis et al. [44] showing that travellers would like to oversee whether an autonomous vehicle takes the most appropriate route thanks to a map with position, route, arrival time, and delays, among other features. Communication with other vehicles and road users (e.g. stops) echoes the results of Tang et al. [45], who found that travellers would like information about traffic situations, including surrounding traffic and traffic signs. Although communication features are reported to be an important aspect in the acceptance of autonomous vehicles [46, 47], further research is needed about both the communication features with other road users outside the vehicle, as well as the provision of information to el-pod passengers. It is not surprising that without an operator on board, the complex modular design will represent a challenge for people to understand at what time and in which el-pod they should move in order to reach their destination. There is a need to examine solutions to make el-pods useful and available to all passengers including persons with disabilities (e.g. visually or hearing impaired).

Concerning the possible positive effects of using el-pods, both study groups agreed on two possible aspects: Increased mobility for the elderly and people with disabilities, and less car traffic and pollution. Group 2 was shown to be more uncertain whether reduced travel time and fewer traffic accidents could be a benefit of using the el-pods. The effect on traffic safety is an indirect effect of reducing private car use and may be difficult to envisage, especially if the respondents do not trust the technology itself. The travel time is expected to be reduced compared to traditional buses. However, it may be difficult for the respondents to visualize that the modular design can satisfy all the possibilities of routes. Simulations based on different scenarios are needed to evaluate how many numbers of el-pods and at what frequency will be necessary to replace the current number of buses and routes. Moreover, group 2 presented a higher level of concern for all four safety and security issues compared to individuals in group 1. Specifically, security (hacking and terrorism) and traffic safety (accidents) are associated with the use of el-pods. Previous studies have shown that gender, age, and education were crucial factors influencing risk assessment of individuals and women rely more on affective evaluations and feel more vulnerable when facing criminality [23, 36, 41]. Indeed, safety (related to accidents) was a factor more important for women (81.2%) than for men (63.0%). This is in line with previous research that pointed out a tendency for women to be more worried about experiencing accidents in both collective and private transportation [23]. These results are consistent with previous studies in Norway about the acceptance of driverless shuttles [22] and concerns about public and private transport modes [24], in which gender differences were also found to be determinants for transport priorities. Safety issues regarding autonomous public transport are unknown and strongly dependent on the technology safety features and the conditions of driving in mixed traffic. Differences in objective and perceived travel risk should be closely followed in connection with the spread of autonomous vehicles. Furthermore, women also tend to be more worried than men about autonomous cars with less intention to use them [11, 42, 43]. This result is also confirmed in the present study with women being more concerned about the safety and security of el-pods. Further research is needed to investigate which safety and security measures could provide the safe environment required by women and the elderly. Concerning the security features, we can assume that the presence of in-vehicle cameras may not be enough for these categories of passengers. To avoid physical harassment or robbery, cameras with AI-based surveillance to detect real-time abnormal behaviour may be a solution. However, it requires that a security service is able to intervene rapidly. Protection measures against terrorism are necessary to increase the feeling of security, such as secure communication protocols with authentication, confidentiality and cryptographic features, and emergency stop and communication buttons.

Finally, although a large proportion of the respondents indicated to have trust in the authorities for both the certification of el-pods and the prioritization of user safety, there was a significant difference between the study groups. Group 1 (72%) showed a higher level of trust that authorities will have the safety of road users as a priority compared to their counterpart (58.2%). Roche-Cerasi [22] showed that 50.9% of the respondents in a study carried out in Norway had no trust or low trust in the ability of authorities to reduce the risk of accidents with driverless minibuses and concluded that distrust towards the authorities needs to be addressed by the authorities and bus operators. Roche-Cerasi recommended that the authorities and cities communicate more about how they will ensure the safety of road users and the safe implementation of shuttles in mixed traffic. She also suggested providing information on the safety and security requirements for the vehicle automation system, laws and regulations, and measures (e.g. infrastructure) put in place to avoid any unexpected events. Norwegian policies have allowed experiments with driverless vehicles on public roads since 2018 [34, 48], allowing the conduction of large-scale pilot projects in mixed traffic on public roads [35]. Norway is considered one of the countries that are the most prepared for autonomous vehicles [49]. The recent pilot studies in Norway and their visibility on Norwegian roads might have contributed to the familiarity of the vehicles, increasing the positive perception of both vehicles and authorities. Thus, the implementation of these el-pods should follow a similar procedure as it was done with autonomous shuttles, in the case of pilot studies with el-pods in Norway: to inform the population about the technology and the benefits this new transport form can bring to the different road user groups and to start showing the vehicles on dedicated roads, and next at low speed in mixed traffic. Demonstrations should be organised to increase knowledge and trust.

In times when technology keeps developing and new autonomous transport modes are being tested and expected to be implemented in the future, further research is needed to provide new transport services and autonomous vehicles based on the needs and requirements of the population divided into different market segments. Indeed, more research efforts are required focusing on the needs of the elderly and the requirements for the safe implementation of autonomous public modes. Although a significant proportion of literature is available concerning driverless buses, other innovative autonomous transport modes should be provided equal attention.

5 | CONCLUSION

The results of the present study reveal clear differences in opinions and needs in relation to modular autonomous electric pods between two study groups: group 1 (non-elderly: individuals under 65 years who work or are students) and group 2 (elderly: individuals over 65 years old and are retired). The study also indicates compelling findings regarding differences between genders.

The findings showed that although the respondents from both groups do not see the el-pods as useful, non-elderly are more likely to use them. For the non-elderly group, the following aspects were important considerations for using the el-pods: punctuality, travel time, flexibility, and environmental considerations. The elderly group responded that an important aspect for them to use such el-pods was the accessibility (e.g. access for the disabled). Given that gait and mobility change as a person ages, these findings are not surprising and underscore the importance of designing and planning transport solutions that include universal design. Moreover, the elderly group were more concerned about the security and traffic safety of the el-pods compared to the non-elderly group. Considering that technology is advancing at a fast pace and pilot studies of small autonomous busses are being held in different countries, future research directions should focus on exploring the level of acceptance of such vehicles after having tried them. Moreover, it is important to examine how this new mobility system can be developed in a way that is useful and beneficial for the elderly group. Further studies should also include different demographic groups, incorporating socioeconomic aspects and regional or cultural differences.

The elderly and people with disabilities should not be excluded from the development of intelligent and autonomous transport modes. Yet, in the present study, the elderly showed a lower level of trust in the authorities for the implementation of the el-pods and a lower level of likeliness to use the el-pods compared to their younger counterpart. We recommend that public transport planners and authorities develop specific measures for supporting the acceptance of autonomous vehicles and covering the needs of this particular age segment concerning accessibility, communication, transport and mobility. This could in turn have implications for the planning and operations of new intelligent transport systems that are expected to be part of public transport systems.

AUTHOR CONTRIBUTIONS

Claudia Moscoso: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; visualization; writing—original draft; writing—review and editing. **Isabelle Roche-Cerasi**: Formal analysis; methodology; validation; writing—original draft; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Claudia Moscoso https://orcid.org/0000-0003-4965-4155

REFERENCES

1. National Highway Traffic Safety Administration (NHTSA): Preliminary statement of policy concerning automated vehicles. https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/automated_vehicles_policy.pdf (2013). Accessed July 2024
2. Igliński, H., Babiak, M.: Analysis of the potential of autonomous vehicles in reducing the emissions of greenhouse gases in road transport. Procedia Eng. 192, 353–358 (2017)
3. Greenblatt, J., Shaheen, S.: Automated vehicles, on-demand mobility, and environmental impacts. Curr. Sustainable Energy. Rep. 2(3), 74–81 (2015)
4. Greenblatt, J., Saxena, S.: Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles. Nat. Clim. Change 5, 860–863 (2015)
5. Davidson, P., Spinoulas, A.: Autonomous vehicles—What could this mean for the future of transport? In: AITPM 2015 National Traffic and Transport Conference. Brisbane, Queensland (2015)
6. Pakusch, C., Bossauer, P.: User Acceptance of Fully Autonomous Public Transport. In: ICE-B, pp. 52–60. (2017)
7. Jardim, A.S., Quartulli, A.M., Casley, S.V.: A Study of Public Acceptance of Autonomous Cars. p. 156. Worcester Polytechnic Institute, Worcester, MA (2013)
8. Othman, K.: Public acceptance and perception of autonomous vehicles: A comprehensive review. AI Ethics 1, 355–387 (2021)
9. Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D.: User acceptance of information technology: Toward a unified view. MIS Q 27(3), 425–478 (2003)
10. Ajzen, I.: The theory of planned behavior. Organ Behav. Hum. Decis. Process 50(2), 179–211 (1991)
11. Hulse, L., Xie, H., Galea, E.: Perceptions of autonomous vehicles: Relationships with road users, risk, gender and age. Saf. Sci. 102, 1–13 (2018)
12. Jenssen, G., Moen, T., Johnsen, S.O.: Accidents with automated vehicles—Do self-driving cars need a better sense of self? In: 26th ITS World Congress. Singapore. (2019)
13. Myklebust, T., Stålhane, T., Jenssen, G., Wærø, I.: Autonomous cars, trust and safety case for the public. In: 2020 Annual Reliability and Maintainability Symposium (RAMS). Palm Springs, CA (2020)
14. Alessandrini, A., Alfonsi, R., Delle, P., Stam, D.: Users' preferences toward automated road public transport: Result from European surveys. Transp. Res. Procedia 3, 139–144 (2014)
15. Bazilinskyy, P., Kyriakidis, M., De Winter, J.: An international crowdsourcing study into people's statements on fully automated driving. Procedia Manuf. 3, 2534–2542 (2015)
16. Becker, F., Axhausen, K.: Literature review on surveys investigating the acceptance of automated vehicles. Transportation 44(6), 1293–1306 (2017)
17. Gkartzonikas, C., Gkritza, K.: A literature review on surveys for autonomous vehicles. In: Transportation Research Forum Annual Conference. Chicago, IL (2017)
18. Christie, D., Koymans, A., Chanard, T., Lasgouttes, J.M., Kaufman, V.: Pioneering driverless electric vehicles in Europe: The City Automated Transport System (CATS). Transp. Res. Procedia 13, 30–39 (2016)
19. Alessandrini, A., Cattivera, A., Holguin, C., Stam, D.: CityMobil2: challenges and opportunities of fully automated mobility. Road vehicle automation, pp. 169–184. (2014)
20. Lervåg, L.E.: Automated shuttle services in public transport. Lessons learned from the smart feeder research project in Norway. In: European Transport Conference 2020. (2020)
21. Mäkinen, S., Kantala, T., Haapamäki, T., Olin, J., Kyyrö, M.Å. (eds.): User experience and impact on public transport. In: SOHJOA Baltic project. The Roadmap to Automated Electric Shuttles in Public Transport. (2020)
22. Roche-Cerasi, I.: Public acceptance of driverless shuttles in Norway. Transp. Res. Part F Traffic Psychol. Behav. 66, 162–183 (2019)
23. Roche-Cerasi, I., Rundmo, T., Sigurdson, J., Moe, D.: Transport mode preferences, risk perception and worry in a Norwegian urban population. Accid. Anal. Prev. 50, 698–704 (2014)
24. Nordfjærn, T., Simsekoglu, Ö., Lind, H., Jørgensen, S., Rundmo, T.: Transport priorities, risk perception and worry associated with mode use and preferences amond Norwegian commuters. Accid. Anal. Prev. 72, 391–400 (2014)
25. Liljamo, T., Liimatainen, H., Pöllänen, M.: Attitudes and concerns on automated vehicles. Transp. Res. Part F Traffic Psychol. Behav. 59, 24–44 (2018)
26. Krueger, R., Rashidi, T., Rose, J.: Preferences for shared autonomous vehicles. Transp. Res. Part C Emerging Technol. (2016);69, 343–355
27. Nordhoff, S., van Arem, B., Merat, N., Madigan, R., Ruhrort, L., Knie, A., et al.: User acceptance of driverless shuttles runninf in an open and mixed

traffic environment. In: 12th ITS European Congress. Strasbourg, France (2017)
28. Roche-Cerasi, I., Sigurdson, J.F., Rundmo, T.:. Risk perception, worry and transport mode preferences in the Norwegian public. In: Rundmo, T. (ed.) Perception of Transport Risk and Urban Travel Mode Use. Rotunde, Trondheim, Norway (2011)
29. Alessandrini, A., Campagna, A., Site, P.D., Filippi, F., Persia, L.: Automated vehicles and the rethinking of mobility and cities. Transp. Res. Procedia 5, 145–160 (2015)
30. Su, F., Bell, M., Schmöker, J.D.: Mode choice of older people before and after shopping. J. Transp. Land Use. 2(1), 29–46 (2009)
31. Transportation Research Board: Transportation in an Aging Society: Improving Mobility and Safety for Older Persons—Volume 1 and Volume 2. The National Academies Press, Washington, DC (1988)
32. Harper, C.D., Hendrickson, C.T., Mangones, S., Samaras, C.: Estimating potential increases in travel with autonomous vehicles for non-driving, elderly and people with travel-restrictive medical conditions. Transp. Res. Part C Emerging Technol. 72, 1–9 (2016)
33. Nayak, M., Narayan, K.A.: Strengths and weaknesses of online surveys. IOSR J. Humanit Soc. Sci. 24(5), 31–38 (2019)
34. Hansson, L.: Regulatory governance in emerging technologies: The case of autonomous vehicles in Sweden and Norway. Res. Transp. Econ. 83, 100967 (2020)
35. Jenssen, G., Moen, T.: Traffic safety for automated vehicles. In: Smart-Feeder: Experiences from Norwegian pilots with self-driving minibuses. SINTEF Community, Trondheim, Norway, p. 84. (2020)
36. Rundmo, T., Sigurdson, J.F., Roche-Cerasi, I.: Travel mode use, transportatio priorities, and risk perception. In: Rundmo, T. (ed.) Perception of Transport Risk and Urban Travel Mode Use. pp. 9–29. Rotunde Publication, Charlottesville, VA (2011).
37. Mouratidis, K., Cobeña-Serrano, V.: Autonomous buses: Intentions to use, passenger experiences, and suggestions for improvement. Transp. Res. Part F. Traffic Psychol. Behav. 76, 321–335 (2021)
38. Nordhoff, S., De Winter, J., Van Kyriakidis, M., Arem, B., Happee, R.: Acceptance of driverless vehicles: Results from a large cross-national questionnaire study. Adv. J. Transp. 1, 22 (2018)
39. Cruz-Jimenez, M.: Normal changes in gait and mobility problems in the elderly. Phys. Med. Rehabil. Clin. N. Am. 28(4), 713–725 (2017)
40. Burkhardt, J., McGravock, A., Nelson, C.: Improving public transit options for older persons. Technical Report Transit Cooperative Research Program Report No. 82. Transportation Research Board, Washington, DC (2002)
41. Salonen, A.: Passenger's subjective traffic safety, in-vehicle security and emergency management in the driverless shuttle bus in Finland. Transp. Policy 61, 106–110 (2018)
42. Hohenberger, C., Spörrle, M., Welpe, I.: How and why do men and women differ in their willingness to use automated cars? The influence of emotions across different age groups. Transp. Res. Part Policy Pract. 94, 374–385 (2016)
43. Kyriakidis, M., Happee, R., De Winter, J.: Public opinion on automated driving: Results of an international questionnaire among 5,000 respondents. Transp. Res. Part F Traffic Psychol. Behav. 32, 127–140 (2015)
44. Amanatidis, T., Langdon, P., Clarkson, P.J.: Needs and expectations for fully autonomous vehicle interfaces. In: Companion of the 2018 ACM/IEEE International Conference on Human-Robot Interaction, pp. 51–52. (2018)
45. Tang, P., Sun, X., Chao, S.: Investigating user activities and the corresponding requirements for information and functions in autonomous vehicles of the future. Int. J. Ind. Ergon. 80, 103044 (2020)
46. Deb, S., Carruth, D.W., Strawderman, L.J., Stanton, N.: A survey study to explore comprehension of autonomous vehicle's communication features. In: Advances in Human Factors of Transportation. AHFE 2019: Advances in Intelligent Systems and Computing. vol. 964. Springer, Cham (2019)
47. Deb, S., Strawderman, L.J., Carruth, D.W.: Investigating pedestrian suggestions for external features on fully autonomous vehicles: A virtual reality experiment. Transp. Res. Part F Traffic Psychol. Behav. 59, 135–149 (2018)
48. Norwegian Parliament: Law on the testing of self-driving vehicles (LOV-2017-12-15-112). (2017)
49. KPMG: 2020 Autonomous Vehicles Readiness Index. Assessing the preparedness of 30 countries and jurisdictions in the race for autonomous vehicles. (2021)

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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