

Expectations for Automated Vehicles – Methodology Description

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1. Introduction

Automated vehicles (AVs) may represent the most profound technological change in road transport since the rise of vehicle mass production, with reductions in energy demand being one of the many anticipated benefits. This project has explored expectations regarding the potential energy-saving benefits of AVs among two groups – ‘professionals’ and the general public.

The project has used a Delphi study design. The Delphi method offers an exploratory, flexible and iterative technique to obtain insights into what futures might look like when uncertainty is large. This is the case with AVs as much remains unclear if and when fully autonomous vehicles will be introduced on the UK roads and how automation may interact with electrification and a possible shift away from individual ownership towards forms of shared ownership and use. Delphi studies typically consist of several rounds of surveys that are increasingly conducted online in which participants receive feedback between rounds and can adapt their responses and views based on that feedback. Two separate Delphi studies, each consisting of three rounds, were conducted sequentially in 2019-2020.

Delphi studies have traditionally been used to build consensus among participants but this often marginalises more radical imaginings of the future and may underappreciate controversies around future developments. This project has, therefore adopted a dissensus-oriented Delphi, which cultivates divergence of views and is particularly appropriate for emergent topics such as the expected effects on transport and energy of vehicle automation.

2. Delphi study among professionals

The Delphi study among professionals was undertaken first, with three rounds held in 2019 and 2020 (Table 1). Over the course of the study the share of open-ended questions increased. Questions were varied across the three rounds because the researchers wanted to respond to feedback by participants on earlier rounds and ask more specific questions, for instance about how automation might interact with electrification and a shift towards car sharing, as the study progressed. Each round contained questions about both passenger and freight vehicular transport. The specific questions in each round can be found in the PDF documents entitled ‘ExpAV_Professional_Delphi_Round[1][2][3]_Questions’. In all rounds, the 2018 version of the Society of Automotive Engineers’ (SAE) levels of vehicle automation were used to develop a common understanding of what vehicle automation entails. The online platform provided by Calibrium (www.calibrium.org) was used for the study.

The original ambition was to recruit ~150 individuals who worked in a professional capacity in some dimension of automated vehicle innovation in different domains (transport, energy, environment, AI/robotics), sectors (public, private, third) and kinds of road transport (passenger, freight). Recruitment

was extremely challenging and many people who were invited to participate declined due to topic fatigue, perceived lack of expertise, uncertainty about the method, lack of time and professional or personal pressures (see also Hopkins and Schwanen (2022, 2023)). The original target had to be adjusted significantly, and in the end 25 participants were recruited for Round 1, 15 for Round 2 and only four for Round 3. The surveys were programmed in such a way that responses of individuals across rounds can be lined to each other. The participant's ID codes offer the key for linking the responses across survey rounds.

Table 1: Key characteristics of Delphi study among professionals

	Round 1	Round 2	Round 3
Timing	May-June 2019	Sept-Nov 2019	Dec 2019-Jan 2020
Number of participants	25	15	4
Key topics covered	- Expectations around AV introduction on UK roads - Expected benefits and negative externalities of AVs - Barriers to and facilitators of AV diffusion - Expertise and demographic characteristics	- Expectations around propulsion systems - Expectations around vehicle ownership models - Expected benefits of shared electric and automated vehicles	- Actions needed and responsibility for maximising benefits of vehicle automation and transition to shared ownership - Infrastructure needed for vehicle automation - Equity of AV benefits in freight sector

The recruited panel is nonetheless diverse in terms of participants' age, domain of expertise and sector, although there is a clear overrepresentation of men which is perhaps to be expected given the topic of the study. The attrition between the first and second round has also been stronger for participants whose expertise lies outside the transport sector (see also Hopkins and Schwanen, 2023).

Table 2: Diversity of the professional panel, by round

		Round 1 (n=25)	Round 2 (n=14)
Age (years)	Below 40	28%	33.3%
	40 or over	32%	33.3%
	Unknown	40%	33.3%
Gender	Men	56%	46.7%
	Women	16%	13.3%
	Unknown	28%	40.0%
Area of expertise ¹	Passenger transport	40%	33.3%
	Freight transport	28%	26.7%
	Energy	<10%	<10.0%
	Environment	12%	0%
	Artificial intelligence	<10%	0%
	Robotics	<10%	0%
Domain of expertise	Technical & engineering	24%	26.7%
	Policy	20%	13.3%
	Social science	12%	13.3%
	Other	44%	46.7%
Sector	Business	25%	36.4%
	Consultancy	25%	27.3%
	Government	10%	0.0%
	Academic	30%	36.4%
	Trade association/NGO	10%	0.0%

¹ Percentages do not add up to 100% as separate yes/no questions were asked per area of expertise

3. Delphi study among the public

The Delphi study among members of the public was undertaken after that with professionals had been completed, so that insights obtained from the latter could inform the questions included in that for members of the public. Three rounds were again held, all in 2020. As with the professionals, the questions differed across the round and those in later rounds became more specific (Table 3). For instance, questions about vehicle automation in the first round did not consider intersections with shared mobility and electrification, which were introduced in rounds two and three, respectively. The specific questions in each round can be found in the PDF documents entitled 'ExpAV_Public_Delphi_Round[1][2][3]_Questions'. In contrast to the professional Delphi, the researchers decided not to introduce the 2018 Society of Automotive Engineers' (SAE) levels of vehicle automation in the public Delphi. This was done to minimise cognitive burden on participants. Where relevant, the automated vehicle capabilities were explicitly explained in the question in easy-to-understand language, which had been piloted beforehand. The online survey platform JISC was used for the public Delphi because this is GDPR compliant and recommended by University of Oxford IT services.

All three waves took place in 2020 during the COVID-19 pandemic. The first round was planned to start in March but was postponed by two months until the first wave of infection had significantly subsided. Overall, the pandemic did not affect response patterns much. This was in large part because a market research company, Toluna (www.tolunacorporate.com), was hired to aid with the recruitment of an online sample that was representative of the population of Great Britain and Northern Ireland. The target number for the first round was set at 1,200 and an attrition rate of 40% was assumed, resulting in target numbers of 720 for the second and 430 for the third round. The company was asked to provide a(n online) sample that was representative of the UK's population in terms of age, gender and distribution over the individual countries.

Table 3: Key characteristics of Delphi study among the public

	Round 1	Round 2	Round 3
Timing	May-June 2020	July-Aug 2020	Sept-Oct 2020
Number of participants	1210	710	496
Key topics covered	• Sociodemographic background and current car use • Awareness of and familiarity with vehicle automation • Expectations about introduction and effects of AVs • Worldviews and general views on transport	• Importance of technologies in solving transport problems • Views on car sharing • Suitability of different roads for AVs • Views on sharing road with automated vehicles • Use of in-vehicle time now and in automated future	• Views on electric vehicles, car sharing and shared taxis now and in automated future • Current vehicle ownership • Expected rebound effects due to future AV use • Perceived priorities for transport policy

As Table 3 shows, the target numbers were met for the first round, almost reached for the second round, and exceeded for the final round. Table 4 also suggests that the sample is broadly representative of the UK population in 2020 in terms of distribution across the countries of the UK, even if the number of participants from Northern Ireland is very low. The sample is also diverse in terms of gender and household income although it includes more women and has a lower household income than the UK population. The age comparison is difficult to make because the age for the population also includes people below the age of 18; once these are excluded the sample is probably slightly younger than the UK adult population.

Table 4: Representativeness of the round 1 panel

		Round 1 panel	UK population in 2020 ¹
Average age (years) ²		45.5	40.3
Gender	Men	551 (45.5%)	33.1m (49.4%)
	Women	655 (54.1%)	33.9m (50.6%)
	Other	4 (0.3%)	--
Country	England	1025 (84.7%)	56.6m (84.3%)
	Scotland	108 (8.9%)	5.5m (8.1%)
	Wales	54 (4.5%)	3.2m (4.7%)
	Northern Ireland	23 (1.9%)	1.9m (2.8%)
Gross household income ³	Up to £36,400	707 (58.4%)	27.1m (40.4%)
	£36,400 to £52,000	216 (17.9%)	14.6m (21.8%)
	£52,000 or more	287 (23.7%)	25.2m (37.9%)

¹ data from Office for National Statistics (www.ons.gov.uk)

² the sample only consisted of adults aged 18 or above, while the UK population number for 2020 also includes 0-17 years old.

³ boundaries are £35,000 and £50,000 for the ONS data

References

Hopkins, D., Schwanen, T., 2022. Recruiting research participants for transport research: reflections from studies on autonomous vehicles in the UK. *Journal of Transport Geography* 102, 103377. DOI: 10.1016/j.jtrangeo.2022.103377.

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