



# An International Survey on Automated and Electric Vehicles: Austria, Germany, South Korea, and USA

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**Abstract.** As development of automated vehicles and adoption of electric vehicles continue to grow, there is an increasing interest in the public opinions on these technologies. We conducted an international online survey to gather information about people's hopes and concerns for automated and electric vehicles from a total of 866 people from four countries – Austria, Germany, South Korea, and USA. Results revealed some differences across countries in the perceptions of automated and electric vehicles. However, differences between the same countries have shrunk compared to our previous survey completed in 2012. Results are discussed with limitations and future work.

**Keywords:** Automated vehicles · Electric vehicles · Cultural differences Survey

## 1 Introduction

The landscape of the automobile market is currently undergoing a dramatic evolution. A number of researchers have predicted autonomous vehicles [1–3] and electric vehicles [4] to be increasingly adopted in the future. It is likely, we will soon witness the rapid introduction and development of autonomous vehicles as well as the further adoption of electric vehicles. Along with these technology-driven changes come many questions about how the public will receive these technologies, such as: What are the barriers to widespread adoption of autonomous and electric vehicles? What features do drivers want in their future vehicles? Are opinions consistent across countries and cultures? To answer these questions we conducted an international survey, collecting data from six countries: Austria, China, Germany, South Korea, Taiwan, and USA.

## 2 Methods

Following up on a 2012 international survey on vehicle area network services in three countries [5], we have updated and expanded the survey questions, and repeated the data collection in 2016 in the original participating countries (Austria, Korea, and USA) plus Germany, China, and Taiwan. The English version was first created and reviewed by the consortium members. Then, the survey was translated by researchers in each country. The survey containing 72 questions was distributed online (<http://www.pervasive.jku.at/VANSurvey2015/>). This paper will focus only on preliminary results pertaining to autonomous and electric vehicles from four countries: Austria, Germany, South Korea, and USA.

### 2.1 Recruitment

Volunteer participants were recruited either by word of mouth or the university participation recruitment system. Data collection is ongoing as of the time of this writing. Our preliminary results include 866 participants from four countries between February 2016 and May 2016: Austria (383), Germany (78), South Korea (81), and USA (324).

## 3 Results

### 3.1 Demographics

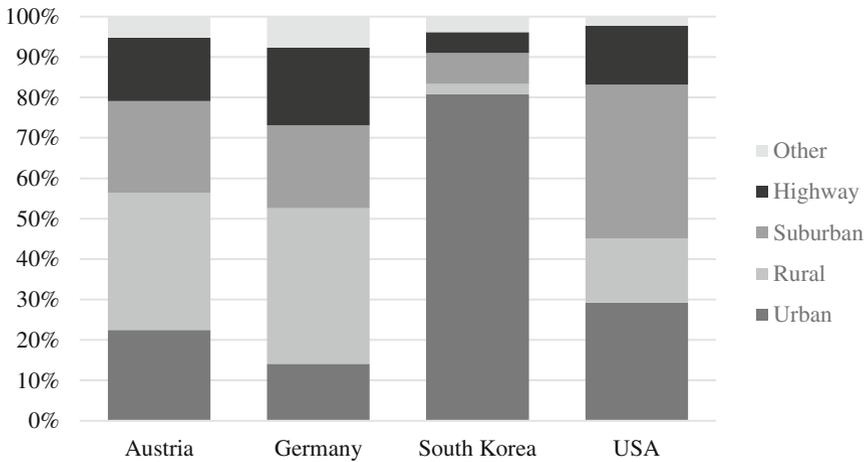
**Age.** The mean age for all respondents was 27.9 years ( $SD = 10.2$ ). There were large differences among countries. Korea ( $M = 38.4$ ;  $SD = 9.3$ ), Germany ( $M = 35.0$ ;  $SD = 11.4$ ), and Austria ( $M = 30.7$ ;  $SD = 9.7$ ), had older respondents than USA ( $M = 20.3$ ;  $SD = 3.4$ ).

**Gender.** The overall gender split was 510 males (59.6%) and 345 females (40.3%). The gender distribution was similar for each country: Austria ( $M: 60.7\%$ ;  $F: 39.3\%$ ), Germany ( $M: 54.5\%$ ;  $F: 45.5\%$ ), Korea ( $M: 70.4\%$ ;  $F: 29.6\%$ ), and USA ( $M: 57\%$ ;  $F: 43\%$ ).

**Driving Experience.** Average years of driving was 9.7 years ( $SD = 9.0$ ). Given the age differences, there were large differences in experience. Germany ( $M = 17.3$ ;  $SD = 11.2$ ), Korea ( $M = 12.5$ ;  $SD = 9.5$ ), and Austria ( $M = 12.3$ ;  $SD = 9.1$ ) had more experience than USA ( $M = 4.1$ ;  $SD = 3.31$ ).

**Driving Environment.** Overall, respondents drive in a broad range of environments: Urban (252), Suburban (229), Rural (212), Highway (125), Other (36). However, the distribution of driving environments was unbalanced across countries (Fig. 1). It appears that Austria and Germany are very similar. USA shows a somewhat similar distributions to the European countries, but less rural and more suburban driving environments. Korea has a distinctly high percentage of urban driving (81%). This may be a result of the

geographic distribution of the recruited samples, but we cautiously infer that this distribution reflects the country population.



**Fig. 1.** Distribution of driving environments per country.

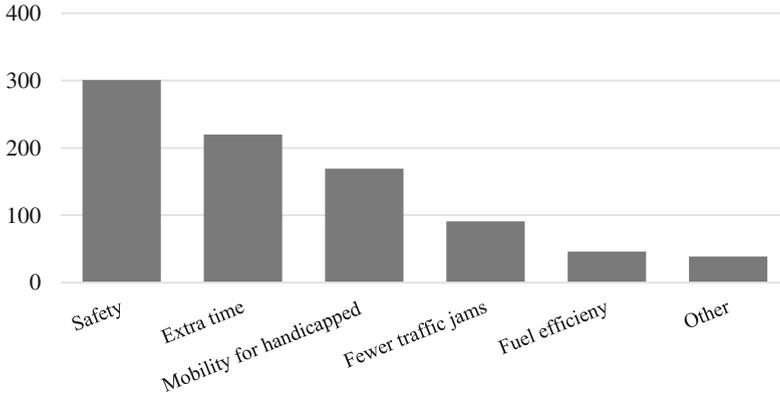
**Transmission Type.** There were large differences in the transmission type among countries, with USA and Korea being dominated by automatic transmissions (84% and 93%, respectively), and with Austria and Germany (82% and 78%, respectively) by primarily manual transmissions. Interestingly, populations of using automatic transmission increased across countries, compared to 2012 (USA 76%, Korea 83%, and Austria 4%).

### 3.2 Autonomous Vehicles (AVs)

We asked participants about familiarity of AVs, perceived benefits, preferred activities, critical issues, and best approaches.

**Familiarity with Autonomous Vehicles.** Most participants stated that they had either heard of autonomous vehicles (29%), or were familiar (59%) with the concept. A Chi-squared test of homogeneity showed that familiarity with AVs differed by country  $\chi^2(12, 865) = 47.24, p < .001$ . Respondents from Korea (56% never heard of AVs or are unfamiliar) appear to be relatively less familiar with AVs compared to other countries, especially Germany (20% never heard of AVs or are unfamiliar).

**Perceived Benefits of Autonomous Vehicles.** Responses from all countries revealed that the biggest perceived benefit of AVs was safety, followed by increased free-time, and assistance for people who are unable to drive (Fig. 2).



**Fig. 2.** Frequencies of benefits of AVs across countries.

There were some differences among countries in what they perceived to be the biggest benefits of AVs,  $\chi^2(15, 866) = 71.20, p < .001$ . Responses suggest that Koreans may perceive fewer benefits in safety (12%), or seem to be less interested in safety, compared to other countries (Austria 37%, USA 39%, Germany 28%). Instead, they perceive relatively more benefits in increasing free time (44%) compared to other countries (Germany 31%, Austria 23%, and USA 22%).

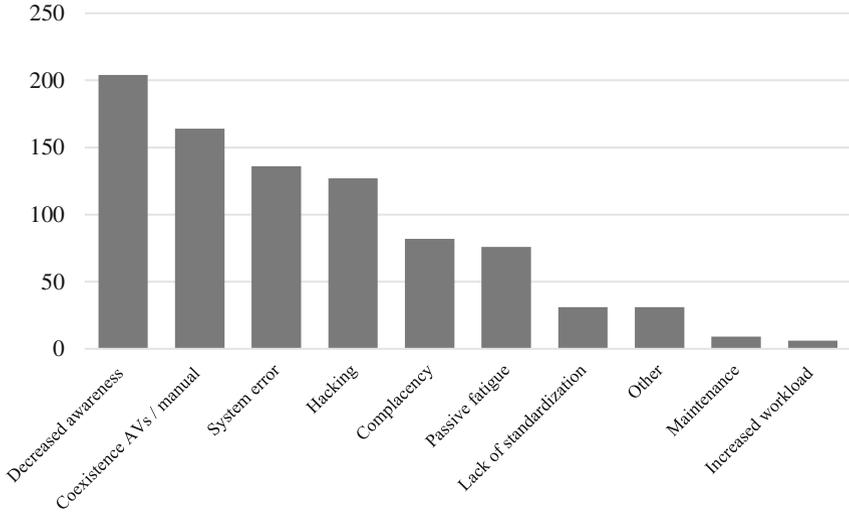
**Preferred Activities in Autonomous Vehicles.** Respondents showed that they would prefer to sleep, eat, do office work, and monitor in-vehicle operations above other things with their free time in an autonomous vehicle (Table 1).

**Table 1.** Percentage of preferred activities in AVs.

Activity	N	Percent
Sleep	424	50%
Eat	424	50%
Office work	423	50%
Monitoring vehicle operation	415	49%
Phone call	354	41%
Watch TV	238	28%
Social networking	227	27%
Other	71	8%

**Critical Issues with Autonomous Vehicles.** Overall, respondents answered that decreased situation awareness is their biggest concern with autonomous vehicles (Fig. 3). These data resonated with responses from the participants who assume that driver takeover will be necessary in some driving environments. Responses also showed

strong differences among countries  $\chi^2(27, 866) = 226.46, p < .001$ . Koreans showed more concern about abrupt system errors (49%) than other countries (Austria 13%, USA 13%, and Germany 8%). Americans showed greater concern over decreased situation awareness (38%) than other countries (Germany 17%, Korea 16%, and Austria 14%).



**Fig. 3.** Frequencies of critical issues in AVs across countries.

Responses from all countries suggest that earning drivers’ trust is the biggest obstacle facing AVs, as indicated by 47% of all respondents selecting it as the biggest barrier followed by legal issues at 24% of respondents. The collected data show that country did influence perceptions of which barriers are biggest for autonomous vehicles  $\chi^2(15, 866) = 75.07, p < .001$ . Americans generally thought driver trust is a bigger barrier (60% selected as biggest barrier) to AVs than other countries (Germany 41%, Austria 39%, and Korea 37%).

**Best Approach to Autonomous Vehicles.** We asked respondents for their opinions on the best approaches to future autonomous vehicles. The most popular response across all countries was to develop a fully autonomous, self-driving car, but allow the driver to takeover whenever he/she wants (83%) (Table 2). Results also showed that 41% of participants were afraid of the potential for others “hacking” and taking control over the self-driving vehicle.

There were small differences across countries,  $\chi^2(15, 866) = 32.49, p = .001$ , especially between Austria and Korea with regard to the use of limited self-driving in vehicles. In Austria, a much higher percentage (25%) prefers to have automated vehicles with limited self-driving ability, such as automated on highway only, compared to Korea (7%). This difference may reflect the difference in driving environments, which shows that Korean respondents overwhelmingly drive in urban environments, whereas

Austrian respondents drive more in rural and highway environments, for which limited automation may be sufficient.

**Table 2.** Percentages of preferences for design of AVs.

Statement	N (agree)	Percent (agree)
Takeover whenever I want	710	83%
Afraid of others being able to control	350	41%
Want car to autonomously drive in critical situations	206	24%
Could own a car without driving controls	151	18%
Want to prohibit manual driving on public roads	118	14%
Other	25	3%

### 3.3 Electric Vehicles (EVs)

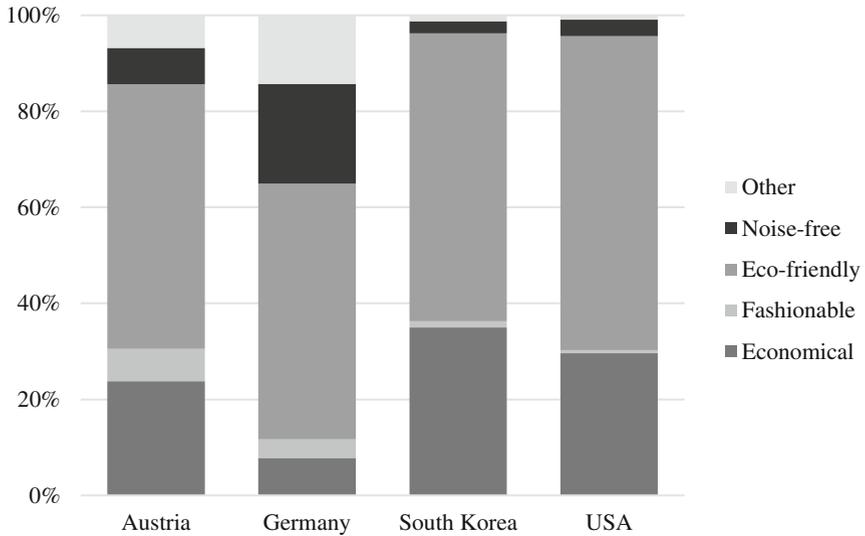
Similar to AVs, we asked participants about familiarity and barriers of EVs, and other EVs-specific questions, such as acceptable ranges and battery recharge times.

**Familiarity with Electric Vehicles.** A high portion of respondents (62%) stated that they were familiar with EVs or heard of EVs (15%). Chi-square analysis showed that the distribution of responses was different among countries  $\chi^2(12, 865) = 75.51, p < .001$ . Koreans reported much less familiarity with EVs (38%) compared to Germans (19%), Austrians (14%), and Americans (8%).

**Benefits of Electric Vehicles.** The most frequently cited benefit of electric vehicles was their ecological “friendliness” (59%), followed by the fuel economy benefits (26%). We also saw country differences  $\chi^2(15, 865) = 108.44, p < .001$  (Fig. 4). Further analysis suggests that Germans were more likely to consider the reduced noise of electric vehicles as the primary benefit (21%) compared to Austrians (8%), Americans (3%), and Koreans (3%). Germans also reported the economic benefits of EVs to be less (8%) than other countries (Korea 35%, USA 30%, and Austria 24%). Further research will consider electricity prices in each country.

**Barriers to Electric Vehicles.** The most frequently selected concern was limited vehicle range, followed by recharge time (Table 3). Given that the biggest issues of respondents across all countries were vehicle range and battery recharging time, we will focus on what respondents consider acceptable ranges, and recharge times.

**Acceptable Vehicle Ranges.** Overall responses suggest that participants find ranges between 151–240 miles (37%) acceptable, and another 36% desire a range over 241 miles. Chi-square analysis showed a significant difference among countries,  $\chi^2(30, 866) = 78.49, p < .001$ . A closer look shows respondents from Korea were much less tolerant of vehicles with low ranges (6%) compared to Germans (31%), Austrians (25%), and Americans (20%) (Fig. 5).



**Fig. 4.** Distribution of benefits of EVs by country.

**Table 3.** Barriers to EVs.

Issues with electric vehicles	N	Percent
Range	591	69%
Recharging time	498	58%
Availability of an electric plug	406	47%
Vehicle cost	350	41%
Dead battery	301	35%
Need to plan recharging	272	32%
Battery cost	242	28%
Cost of service for battery runout	153	18%
Uncertainty of possible savings	104	12%
Performance	89	10%

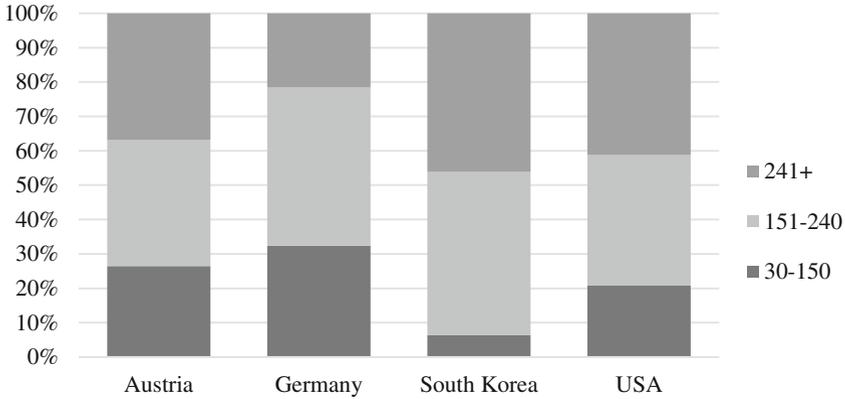


Fig. 5. Distribution of preferred ranges for EVs by country.

**Acceptable Battery Recharge Times.** Responses across all countries suggest that drivers want their EV batteries to recharge within two hours (45%), or four hours (29%) (Fig. 6). Analysis by country reveals significant differences,  $\chi^2(12, N = 865) = 240.12$ ,  $p < .001$ , and suggests Koreans were more likely to tolerate long recharge times – 54% accept recharge times of over eight hours - which other countries were less likely to accept (USA 8%, Germany 6%, and Austria 3%). This is in line with results showing Koreans are less tolerant of low EV ranges. Although we need further investigation, it seems that Koreans want to recharge their EVs at one time (e.g., at night) for long distance, perhaps, due to lack of battery charging stations.

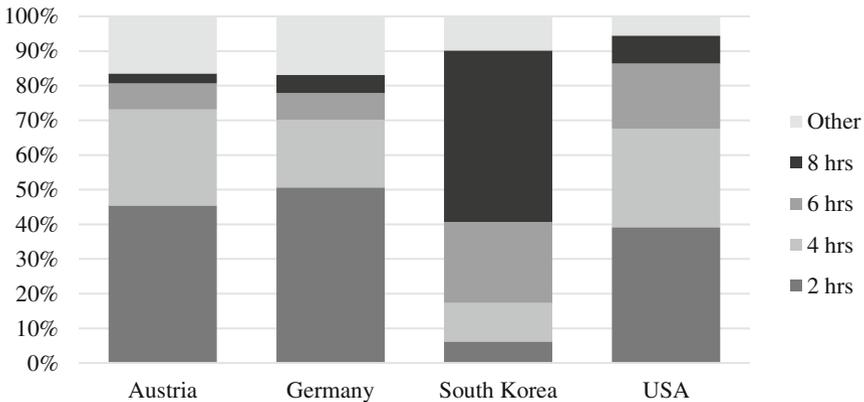


Fig. 6. Recharge rates for EV batteries by country.

## 4 Discussion and Future Work

Advances in the development of autonomous and electric vehicles leave us with many questions about public perception and acceptance of these technologies and what they hope future autonomous and electric vehicles will look like. We conducted a global survey to answer some of those outstanding questions. We found that people are excited for the safety improvements through autonomous vehicles and for gaining free time to do other activities, such as sleeping, eating, and working. Respondents also think that earning drivers' trust and sorting out legal issues will be essential to the widespread adoption of autonomous vehicles. Electric vehicles are desired for their eco-friendliness and cost savings, but respondents find low vehicle ranges and long battery recharge times as inhibitors for adoption. They generally prefer vehicle ranges over 150 miles and recharge times under 4 h.

These results suggest that vehicle manufacturers should focus on the design of in-vehicle information systems with the intention of earning driver trust in the performance of autonomous vehicles; the survey also highlights range and recharge milestones for developers of electric vehicles. In our previous survey [5], Austrians seemed to be more conservative compared to Americans and Koreans. However, those differences are disappearing. While a one-time survey presents limitations, this cross-cultural study triggers discussions on how to design systems. Should they be culturally adapted, standardized, or customizable? Moreover, industry might get some hint where to test their novel vehicles. While these results are not yet generalizable, we will continue to collect data from more representative and heterogeneous populations with the evenly distributed number of participants across countries, age and gender. Furthermore, we propose to discuss ways to identify the underlying mechanisms of the cultural differences in the AutomotiveUI community.

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