Factors Affecting the Shift to Autonomous Vehicles: A Safety Perspective Survey in Munich

Kunwar Muhammad, Katrakazas Christos*, Theofilatos Athanasios, Antoniou Constantinos

Chair of Transportation Systems Engineering, Department of Civil, Geo and Environmental Engineering, Technical University of Munich, Arcisstrasse 21, Munich 80333, Germany

*Corresponding author: c.katrakazas@tum.de

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Extended Abstract

Nearly 1.3 million people die in road accidents each year and with an average of 3,287 deaths happening per day and around 20-50 million people getting injured or disabled due to road accidents per year around the globe (ASIRT 2018). The evolution of automated safety systems is envisioned to decrease the number of road accidents-based casualties and injuries (NHTSA 2017). In 2018, many new cars have built-in capability to assist drivers and warn them, such as lane-change warning reverse assistant for letting the driver know of cars and obstacles, automatic braking or slowing of vehicle to avoid collision with a car or some other object that is detected to be too close (NHTSA 2017). These new technologies, which combine high-tech car sensors, such as cameras, radar systems, LiDAR systems and state of the art software helps the cars to recognize safety risks and either timely warn the driver or take automated actions to avoid car accidents (NHTSA 2017).

Before testing self-driven cars in real world scenarios, it will be a priority for car manufacturers and developers to know about the user demands and their perspectives regarding these vehicles. Moreover, it would be essential to identify which characteristics users would like to be found in these cars in order to shift to self-driven cars from standard nowadays vehicles.

The dominant questions are: i) How much safer would Autonomous Vehicles (AVs) be as compared to the conventional human driven vehicles and ii) would automated cars be safe enough for public to switch to autonomous vehicles once they are widely available in the market?

The expectations of zero deaths when AVs are the dominant mode in traffic, are unreal but self-driven cars will drive safer than a middle-aged driver (Sivak 2015). Moreover, according to the same study there is a possibility that road safety might get worse during the transition phase, when there will be mixed traffic on the road with both conventional and self-driven cars. There is still a need of a strategy which identifies challenges and future work required for the safety approval of the autonomous. This is a challenging task considering the multiple disciplines that are associated with the performance of self-driven cars which include safety engineering, hardware reliability tests, software

validation, robotics, security, vehicle testing, human-vehicle interaction, social acceptance and a legal framework (Koopman and Wagner 2017).

Consequently, the field of autonomous driving is an emerging field and plenty of research work has already been done and is still in progress. The research made in the field as reviewed by the literature lacks a safety-based approach which points out the different parameters that will influence the mode shift.

This paper focuses on the parameters to understand the safety perspective of autonomous driving. It aims at finding the important factors that affect the willingness of people to shift from their conventional vehicles to AVs, with considerations to the safety perspective for the city of Munich. Therefore, the aim of the present paper is to investigate user perspective with regards to the safety of AVs in the city of Munich.

In order to fulfill the aim of the present research, the following objectives need to be fulfilled:

• Review of the literature with regards to AVs, their safety and the user perspective with regards to safety
• The development of a survey that could reach out to the inhabitants of the city of Munich to collect their opinions about the safety of self-driven cars.
• Identification of factors influencing the shift to AVs using statistical analysis.
• Evaluation of the results of the survey and the statistical analysis for drawing useful conclusion for research and businesses.

The following figure (Figure 1) briefly illustrates the overall methodological approach of the present study as it is a flow-chart diagram in (Figure 1) that depicts the different stages of work and the necessary steps to get the results at the end. It includes the construction of the questionnaire which involves the demographics section (questions related to the person), transport section (questions related to general driving experience), safety section (questions related to general road safety) and safety section concerning AVs (questions related to safety aspects of autonomous cars).

After the construction of the survey, it was distributed online through social media and specially Facebook groups in Munich. The questionnaire was kept online for one month to collect as much data as possible. In this time period, 272 responses were gathered. After the collection of the data, results were obtained using different statistical models (i.e. Ordinal Logistic Regression and Factor Analysis). Finally, after the analysis and interpretation of results from those models, conclusions were drawn.

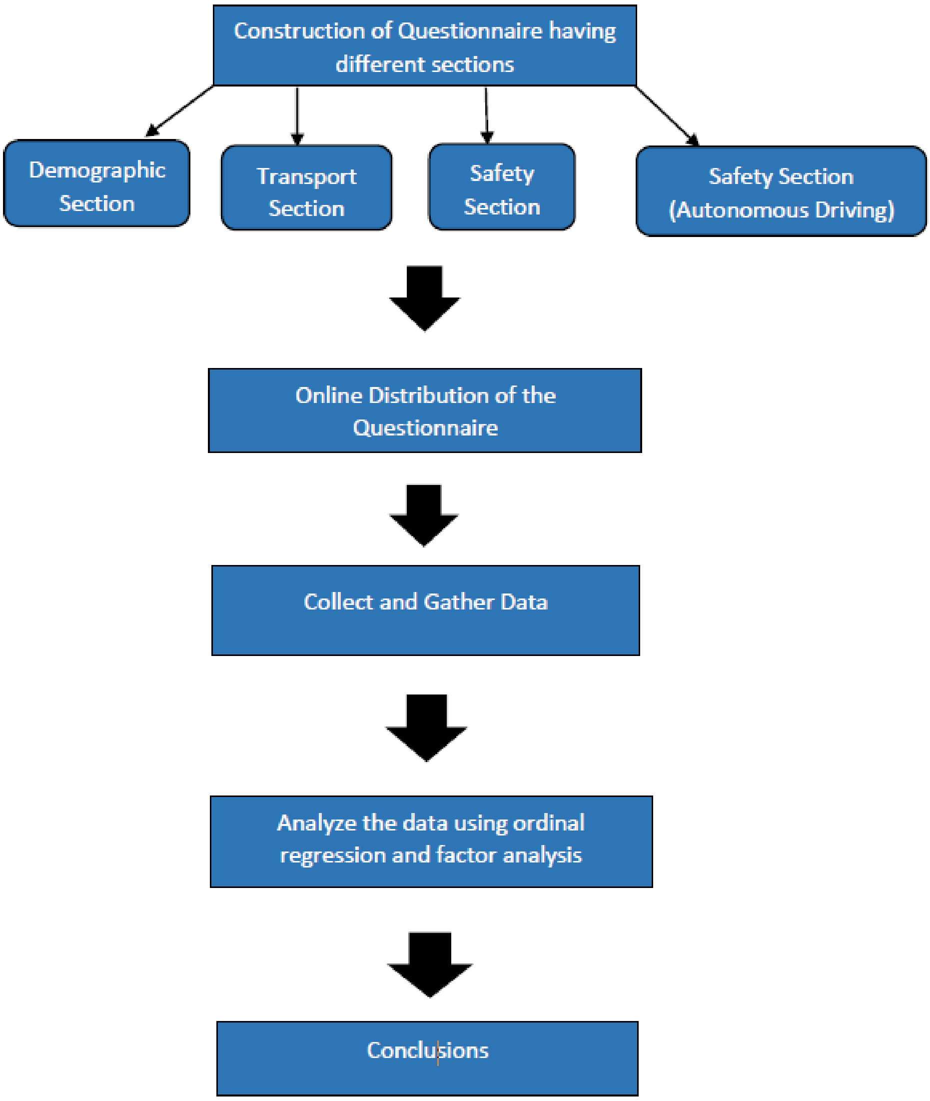

Figure 1: Flowchart representing the methodology of the study.

In this study there are a total of 200 respondents out of which 64% belong to the age group of (18-31 years) old and 33.5% belong to the age group of 31-50 years while just 1.5% belong to the age group of 51-70 years and the rest didn't prefer to answer or greater than 70 years old. Furthermore, the study consisted of 54% male respondents and 43% female respondents out of the total 200 respondents while 2% didn't prefer to answer. The survey questionnaire shows that the majority of the respondents (26.5%) prefer partially automated cars closely followed by highly automated (25%) and fully automated (23.5%) while the minorities selected driver assistance (17.5%) and non-autonomous vehicles (7%).

After selecting the independent and dependent variables from the questionnaire it was necessary to see the correlation among all the variables so that the variables which are strongly correlated with each other could be neglected. Therefore, a correlation matrix was created using R Studio to detect the correlated variables as shown below in Figure 2. The visualization of the correlation matrix is a better way of sorting out the variables. It shows that there are no independent variables which are strongly correlated with each other. Hence, all the selected variables were chosen to be included in potentialmodels.

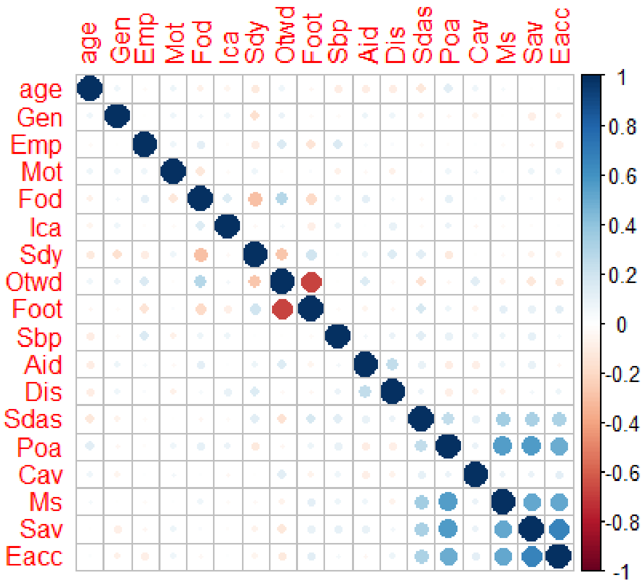

Figure 2: Correlation Matrix

The second technique used to perform ordinal logistic regression was to screen the variables depending on their t-values and p-values from the first model. The same arbitrary threshold used for the first model are used in this model as well with the variables lying in the interval of ($t>1.96$) and ($p<0.05$) are selected from the full model and this model includes those variables. The results are presented in Table 1 that follows:

Table 1: Mode shift using the variables selected through p values and t values

Coefficients:	Value	Std. Error	t value	p value
age. L	-6.686	1.136	-5.884	0.000
age. Q	4.519	1.107	4.080	0.000
age. C	13.063	0.392	33.328	0.000
age^4	10.601	0.822	12.888	0.000
employment. L	2.556	0.908	2.804	0.004
preference.of.automation. L	3.725	0.499	7.460	0.000
preference.of.automation. Q	-0.658	0.335	-1.966	0.030
Intercepts:				
	Value	Std. Error	t value	p value
1= Very unlikely|2= Rather unlikely	1.569	0.608	2.579	0.007
2= Rather unlikely|3= Moderately	2.677	0.587	4.556	0.000
3= Moderately|4= Rather likely	4.291	0.573	7.490	0.000
4= Rather likely|5= Very likely	6.327	0.591	10.697	0.000
Residual Deviance: 516.365				
AIC: 554.365				
BIC: 617.034				

In this model there are three independent variables. As the variables selected in this model are already the ones that are statistically significant. The effect of the values of coefficients could be interpreted in terms of which ordinal category has the more influence than the other categories. For this model , with one unit increase in the most statistically significant age group determined with t-value and p-value, the predicted likelihood of observing the mode shift towards AVs “very likely” against the other ordinal categories of “very unlikely, unlikely, moderate and likely” change with a factor of exp (-13.063) = 2.1×10^{-6}.

The second variable is the employment status. With one unit increase in the employment status, the likelihood of observing the mode shift towards AVs “very likely or likely” against the mode shift “very unlikely, unlikely or moderately” changes with a factor of exp(-2.556) = 0.077.

The last variable is the preference of automation. The model output shows that with one unit increase in the preference of automation, the probability of the switch to AVs “likely or very likely” against the switch to AVs “unlikely, very unlikely or moderately” changes with a factor of exp(-3.725) = 0.024.

It can be concluded from the model results that there are certain human behaviors and specific vehicle characteristics which play a vital role in this transition from standard vehicles to self-driven cars. The most important of these factors are age and employment status. It is shown that younger people and fully-employed citizens are more probable to shift to automated driving, while people that usually combine driving with other tasks, tend to believe that AVs will be safer than human drivers and will eliminate accidents. However, more advanced models and a larger sample size, would provide more insight into the safety perspective and the preferences of users towards AVs.

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