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Autonomous Vehicles - Engineers Perspective

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Abstract- The future of personal transportation will include a form of autonomy in vehicles, whether it is fully autonomous electric vehicles or conventional petrol vehicles equipped with autonomous technology. This paper is an attempt to explain how companies involved in the development of autonomous vehicles, (AV), fails to communicate the salient features of AV technologies to the customer and fully incorporate customer needs. The study surveyed engineers involved with the development of AV or AV-related technologies. The purpose of this study is to explore automotive engineers' perspective on the awareness, demand and trust on AVs in the current sharing infrastructure with conventional vehicles. The study concluded that most of the people are not aware of the AV technologies that are currently present in existing vehicles and think that their needs are not incorporated. Currently, the market demand for AVs is not very high, although the people has trust in AV which lead to the fact that that companies developing AV are not meeting their customer's needs in their product. The study suggests that it will be more than 25 years before autonomous vehicles would be in the majority on the road, while engineers with less than 20 years of experience are more likely to buy an AV than their senior counterpart. Finally, engineers are of the opinion that the data security is the most important challenge in the wide adoption of AVs.

Keywords- *Autonomous Vehicles, Customer Requirements, Challenges, Demand, Awareness, Trust*

I. INTRODUCTION

Change is difficult to come, but when it happens, it also brings issues that were usually not very well thought off by the change agents. In the early 19th century, it took about twenty years for cars to replace horse-drawn carriages, although the change was faster in cities compared to rural areas. The automotive industry is witnessing several changes. While we are all enjoying the benefits of hybrid vehicles, the promised Electric cars are bound to replace internal combustion engines cars. Now the industry is promising the autonomous vehicles. These new autonomous vehicles will replace driver-driven cars of today, and we will see a paradigm shift in the way we all commute. This will be more prominent and significant as it affects the way we commute today while changing the habit of owning and driving a vehicle.

Autonomous vehicles (AV) have quickly transformed from a futuristic means of transportation to an instant reality where both technology and automobile companies are racing to develop and sell fully autonomous vehicles to the public, [1]. The investment on the technology required for a vehicle to be fully autonomous has drastically increased while becoming more readily available for adaptation, [2]. In fact, the technology is evolving at such a fast rate that the current transportation infrastructure needs to play "catch-up" to adapt to the future of AV's, [2]. AV's will also lead to improved fuel consumption and decreased congestion on the roadways thus affecting the environment positively. AV's will gradually penetrate the market while conventional vehicles (CV) are still being used every day; therefore, AV's must be developed in a way that they can coexist with CVs. Therefore, AV's will be able to anticipate other vehicles and drive efficiently by providing ample space while still traveling smoothly

Currently, the big selling point for AV is safety. In 2015 Fagnant & Kockelman, [2] reported that driver error is believed to be the main reason for over 90% of all automobile crashes, while in 2017 Techworld, [3], said that human error caused 94 percent of all accidents. Human errors are almost a common cause of most Industrial accidents like Challenger, Deepwater Horizon in the Gulf of Mexico, or the sinking of Taiwan's Ocean Researcher or plane crashes. The automotive industry is trying Artificial Intelligence (AI) solutions to solve this problem. However, the industry has always rejected the use of AI as a potential solution to mitigate human error, [4].

This study is a part of a broader research that targets the design and development engineers involved in the automotive industry and seeks their views about the AV, its underline technologies and challenges, its demand and adoption in masses, the benefits AV brings to the society/ individual along with the changes that need to take place for acceptance with masses. This paper only present result about AV demand, awareness and trust as perceived by automotive engineers.

The remaining portion of the paper will first outline a literature review that identifies some current trends in AV as they relate to the customers, followed by definition of some common terms used with AV. Next session will define the research problem, the research questions and research methodology. The study concludes by analyzing the data and provides some conclusions about AV readiness and adaptation.

II. LITERATURE REVIEW

Since 2010, AV and semi-autonomous vehicles are getting popularity and plenty of investments. The newer Silicon Valley-based tech firms and traditional Detroit-based vehicle

firms are working on creating new solutions to achieve AV and AV-related technologies. Several researchers have documented these reasons for such popularity including safety, technology (both hardware and software), economic feasibility, etc. [1]. There is a projected high demand for AVs. According to a 2014 survey by BCG, [6], 55% of the USA car drivers would likely to buy a partially autonomous car, Figure 1.

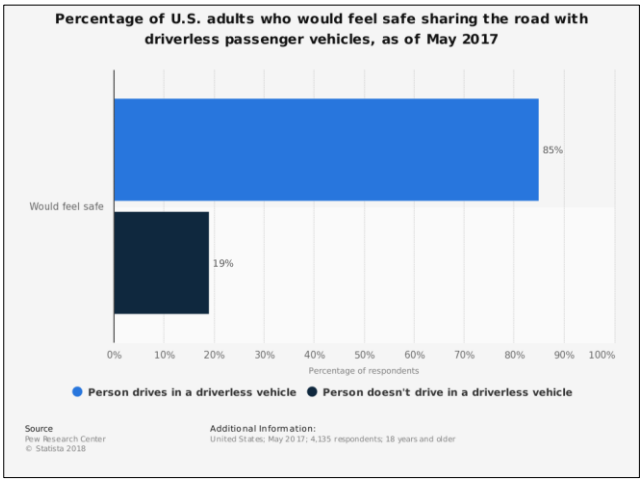

Figure 1. Percentage of drivers who feel safe sharing roads with AV

Although AV is currently marketed as a way to reduce or eliminate human errors thus making transportation safe, however, in a 2017 Pew Research Center research, [7], found that 81% of USA adults driving a conventional vehicle does not feel safe sharing road with an AV, figure 2.

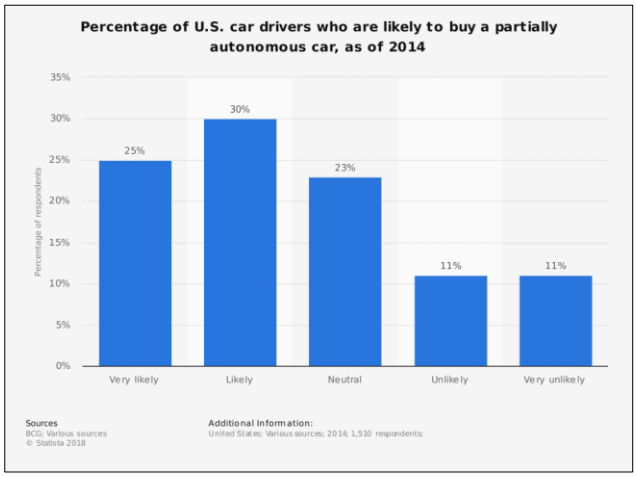

Figure 2. Percentage of drivers likely to by AV

Bonnefon et al. [8] also concluded that in theory, people support autonomous vehicles programmed to save others, but they would not want to drive or ride in one, thus posing a "social dilemma" for AVs. In a 2016, Munich Re survey, [9], of risk managers in the USA, found that regulatory, safety and security of technology are the main challenges to the widespread adaptation of AVs, figure 3.

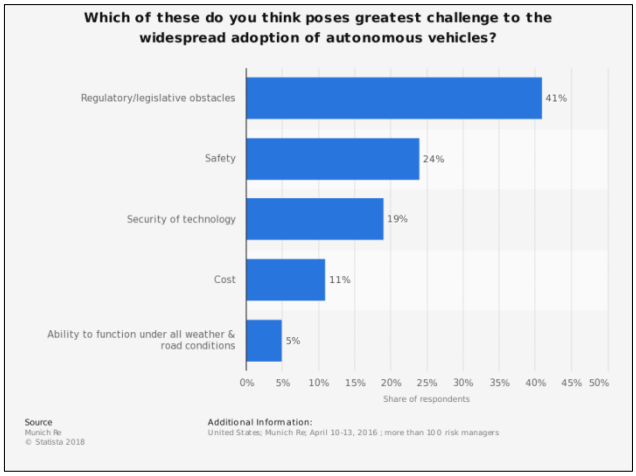

Figure 3. AV adoption challenges

Currently, the major automotive OEM, the mobility companies, and tech companies are the major players in the development of AV and AV technologies. These companies have very different outlooks and strategies for the design development and usage of AV and AV technologies. For example, some companies are looking to introduce a taxi-like service for their application while others are looking to launch "consumer bought" vehicles for their applications. A.T Kearney, [10], review on customer needs for AV, as perceived by 150 executives, reveals an increasing AV utilization within sizeable urban population, and car ownership is becoming less relevant than car sharing.

Another problem for the autonomous vehicles (AVs) is the fact that they are designed and developed for today's environment. These AV will coexist with existing infrastructure, pedestrians, and humans operating vehicles. This coexistence imposes an extra burden on the AV technology development. Eg. If a driver intentionally tries to have an accident with an AV; the current AI algorithms should be able to avoid such accidents by safeguarding not only its passengers but also the ensuring the safety of the other car driver.

A. Definitions, Abbreviations, and Acronyms

- AV levels: The U.S. Department of Transportation's National Highway Traffic Safety Administration defines five levels of autonomy ranging from Level 0 to Level 5. Level 5 being fully autonomous and what this paper will focus on [5].
- AV: Autonomous Vehicle
- CV: Conventional Vehicle
- EV: Electric Vehicle
- VAS: Virtual Assistant Support
- AV-OEM: Companies involved in the design and development of AV.

III. Research Statement

While the companies are in full throttle mode to design and develop their AVs, little is done to understand customer requirements and needs for such technologies. The usual customer requirements arguments about AVs are safety, cost, and comfort, [11]. Others have used the reasoning provided by the CEO of major corporations and their perspective on the use of AV and AV technologies. [12]. While some relate to the fact on how self-driving cars will positively impact the industry by creating a better customer experience, through route optimization, GPS tracking, Virtual Assistant Support (VAS), and autonomous delivery, [13].

The AV-OEMs are seeking incentives to promote the AV development, rather discussing issues related to infrastructure, regulations etc. In the 2017 Consumer Electronics Show, CES, [14] panel discussion, Tomi Gerber, Enterprise Holdings' assistant vice president of Corporate Government & Public Affairs, suggested that "Consumers should dictate the winners as mobility business models and technology evolve," said Gerber. "We must let innovation and responsiveness to consumer needs determine which businesses thrive in the market. And incentives should encourage the use of transportation that achieves public interest goals, versus subsidizing individual businesses." Although he insisted on giving the customers the last say to select winner and loser, he still calls for incentives to encourage the use rather subsidiaries. Goldman Sachs, [15], in a recent megatrend study portraits a dismissive future of autonomous vehicles and argue that the social, economic, and regulatory changes needed to make this happened have not yet come to reality.

The big questions, related to customers, remained unsolved; does the customer needs a full level 5 AV, do they see their requirements meet in new AV concepts, are they aware of the AV technologies being introduced in their current CV and do they trust the current technology? This study will present the point of view of engineers about AV, AV technologies, its awareness & demand, and people's trust in the technology.

A. Purpose and Research Question

The purpose of this study is to explore automotive engineers' perspective on the awareness, demand and trust in AVs in the current sharing infrastructure with conventional vehicles. Specifically, the study will focus on the following research questions:

RQ1: Are people ready to adopt fully AV's?

a. Are they reluctant to buy a level 5 AV currently?

b. Will people prefer full or partial AVs?

c. Will people wait for technology to mature before buying AV?

d. What are the significant issues AV has to overcome before their mass acceptance?

RQ2: Is there a difference of opinion among engineers with varying experience about current and future AV adaptability?

RQ3: Will people buy and pay extra for AV?

RQ4: Does the current AV concepts fulfill their requirements/need?

B. Methodology & Data Collection

This study has used the qualitative research approach, where the phenomenology leads to theoretical perspective, [16]. The phenomenological approach helps researchers to understand the meaning in events and in human interactions using the context to interpret the data. In the qualitative research, the researchers' main task is to extract the similar meaning to situations that other people have described to them [17]. This research will use a convenient sample of engineers in the automotive industry, who are involved with the design and development of AV and AV technologies. These characteristics make the research design a cross-sectional one, one sample at a one-time point.

A survey instrument was developed to collect data. The survey has 15 questions and six demographic, gender, and education questions. The 13 survey questions used the following Likert scale: 5 points = Strongly Agree; 4 points = Agree; 3 points = Undetermined; 2 points = Disagree and 1 point = Strongly Disagree. This instrument covers three essential characteristics of AV and AV technologies. They include the awareness of AVs and AV technologies, their market demand and finally their trust with the public. Each statement in the survey represents an independent item that covers an aspect of one of the larger three dimensions of the construct.

This study deals with the question that is directly related to engineers associated with the automotive industry, who are involved with AV or AV technology development. However, due to a vast diversity of this population concerning engineering fields, (information system, information technology, Computer science, electrical engineering, electronic engineering, mechanical engineering, etc.), along with the people involved in policymaking it was decided to reduce the scope of the study. The study was thus limited to automotive engineers in the tri-county region of Michigan that contain one of the largest populations of engineers in the USA.

C. Reliability & Validity

Before the establishment of the decision of adopting a given survey or questionnaire, items comprising the study, the survey itself must possess good psychometric properties, reliability, and validity. The computation of the reliability analysis generates a number referred to as Cronbach Alpha describing how closely all items on a test or survey are related. Nunnally, [18], have recommended that an alpha level of 0.7 or higher is good to establish the reliability of surveys for research rather than applied decision-making purposes.

To start the reliability and validity of the survey, five senior engineers working in the automotive industry evaluated the questionnaire to ensure its clarity, language, and accuracy. On their recommendations changes were made in questions language.

After ensuring the clarity of the survey questions, its face validity was established. A thorough evaluation of the questionnaire reliability and validity was conducted through a

pilot study. Twenty students from the College of Technology with working experience in the automotive industry tested the pilot study. Cronbach Alpha of 0.9 was calculated using SPSS, Table 1, indicating the internal consistency of the instrument, reliability. The instrument was distributed to the subjects for the study. The same process of validating the questionnaire was followed once the data is collected from the general population.

TABLE I. PILOT STUDY RELIABILITY ANALYSIS

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.903	.926	13

The survey was distributed via email primarily to engineers residing in Southeast Michigan and are working on AV or AV technologies using LinkedIn, Facebook and University's alumni database. This method allowed the questionnaire to reach a broad audience quickly and efficiently. The data was collected using LimeSurvey, hosted on the Department's website, the. LimeSurvey is a free and open source on-line statistical survey web app. LimeSurvey tabulated the results in real time, and this data was analyze by SPSS.

IV. Data Analysis

A. Demographic Characteristics of Participant

128 people participated in the survey, of which 103 were engineers and 79 were engineers who have worked or currently working on AV and AV technologies. Table II provides the Demographic characteristics of participants. Participants average age was 41.1 years, were predominately male 93.5%, 45%, were educated at the Bachelor level and had a mean of 18 years of engineering experience.

TABLE II. Demography Statistics

		Frequency
Gender	Male	93.5%
	Female	6.5%
Age	25-29	30.4%
	30-39	17.5%
	40-49	23.9%
	50-59	21.7%
	60+	6.5%
Education Level	Bachelor	45%
	Master	40%
	Doctorate	15%
Years of Experience	Less than 10	32%
	11-20	23%
	21-30	28%
	30 plus	17%

B. Testing Reliability and Validity of the Questionnaire

The survey data was used to ensure its reliability and validity. Using SPSS on the 13 items and 79 responses, the Cronbach alpha was calculated to be 0.712 indicating acceptable reliability score, Table III.

TABLE III. STUDY RELIABILITY ANALYSIS

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.712	.728	13

C. Individual response analysis

In Likert scale data analysis, responses are generally treated as ordinal data because although the response levels do have a relative position, one cannot presume that participants perceive the difference between adjacent levels to be equal (a requirement for interval data). So firstly, each specific question's (or "item's") response was analyzed separately, later they were summed with other related items to create an interval score for a group of statements.

The thirteen survey questions represent automotive engineers' perspective about the acceptance, demand and readiness of AVs and AV technologies, Table IV.

TABLE IV. Research Variables & Questions

Variables Definition
V1: During the past year, I have seen a fully autonomous vehicle on the road
V2: There are probably autonomous cars on the road, but I have never seen one
V3: My vehicle has several autonomous technology features
V4: I have never seen a vehicle with autonomous technology
V5: I would like to purchase an autonomous car for my next vehicle
V5a: I would purchase an partial autonomous vehicle
V6: I would not want to buy an autonomous vehicle
V7: I do not wish to pay extra to have autonomous features
V8: I don't trust any autonomous technology
V9: I have no problem being in the first Level 5 fully autonomous vehicle
V10: I would try a Level 5 autonomous car at least once
V11: I would never get into a Level 5 autonomous car
V12: Once Level 5 autonomous vehicles are out for a few years I would try one out
V13. The current AV concepts that are marketed or I have read about, does meet my requirements for an AV

A majority of participants think that there might be several AV currently on the road, but they have not seen them. The majority of the respondents have not seen AV on the road but have seen vehicles with autonomous technologies either in the newsprint or in auto shows, Table V.

Majority of the respondent are not ready to buy AV shortly; however, they seem to be divided on the question if they will ever buy an AV. When comparing with full autonomous vehicles, 66% would prefer buying a partial autonomous vehicle. Majority of the respondents are not willing to pay extra for AV technologies.

TABLE V. ITEMS RESPONSE ANALYSIS

Variables	1	2	3	4	5
V1:	56%	9%	6%	1%	28%
V2:	11%	11%	24%	33%	20%
V3:	52%	14%	4%	20%	10%
V4:	65%	18%	5%	9%	4%
V5:	59%	15%	15%	9%	1%
V5a:	8%	7%	19%	31%	35%
V6:	17%	14%	24%	18%	27%
V7:	9%	29%	14%	28%	20%
V8:	30%	23%	20%	18%	9%
V9:	33%	15%	33%	10%	9%
V10:	6%	1%	14%	32%	47%
V11:	47%	34%	14%	4%	1%
V12:	3%	14%	15%	37%	32%
V13:	42%	33%	9%	9%	7%

Although the majority of respondents trust the AV technologies, they have problems being the first to own a level 5 fully autonomous vehicle; however, they are willing to try it at least once. The respondent overwhelmingly agrees that once level 5 autonomous vehicle is out in the market for a few years, they will try it. AV and AV technologies are current discussion topics in almost every engineering forum; however, 63% of the respondent agrees that it will take more than 20 years before we can see all AVs on the roads, Table VI.

TABLE VI. NUMBER OF YEARS FOR AV TO BE ON ROAD

How many years until all vehicles are AV's?			
A. 0-5	B. 6-11	C. 12-20	D. Over 21
0%	9%	28%	63%

Using t-test it was concluded that on average, it would take more than 25 years before the majority of vehicles on roads will be AVs, Table VII.

TABLE VII. INDEPENDEDNT T-TEST FOR AV YEAR TO MARKET

	Test Value = 20			
	t	df	Sig. (2-tailed)	Mean Difference
YearToMarket	7.099	78	.000	5.86957

75% of the respondent agrees that AVs available in the market or mentioned as concepts does not meet their requirements and needs.

According to survey, Figure 4, the most important customer requirements for the AVs is a good infotainment system and connectivity among vehicles as well as inside the vehicle. The percentage of infotainment and connectivity is 20% higher among the engineers with less than 20 years of experience, which is in line with the millennium and their association with internet and connectivity.

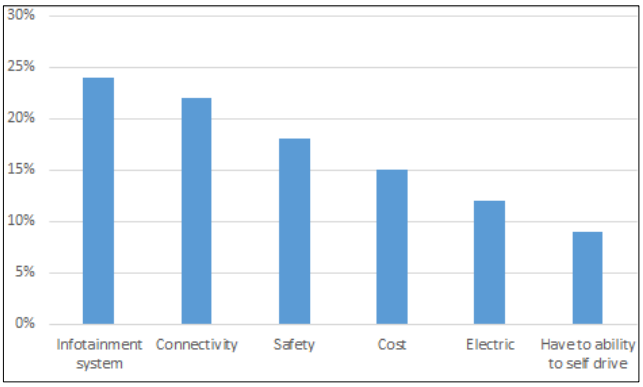

Figure 4. Customer requirements for AV

Although safety and cost are included as major customer requirements in this research, it also resolves that customer needs the ability to take control of the AVs when needed. The survey suggest that the top three challenges for the mass adaptation of AVs are the uncertainty in technology, new regulations needed for AV and uncertainty about AV usage including how it will be owned or shared, Figure 5.

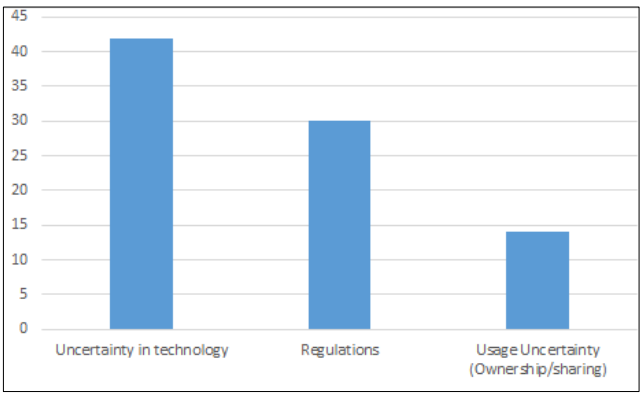

Figure 5. Major challeges for mass adoption of A

The biggest uncertainty in technology comes from data security and privacy, followed by battery, transmission and electric charging stations, all related to Electric Vehicles. This correlates to the fact that customer need AV to be electric.

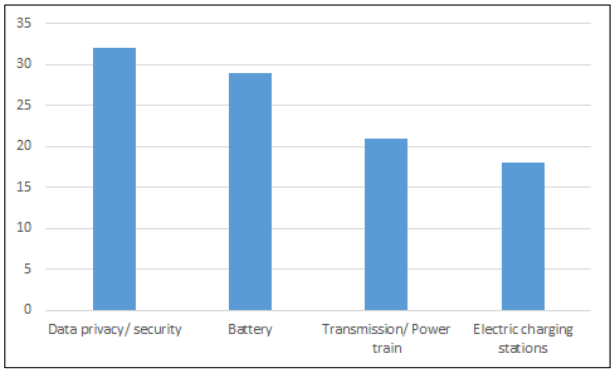

Figure 6. Major challenges in the uncertainity in technology

Next, data analysis was conducted to discover if there are the differences of opinions among engineers with varying experiences. The Mann Whitney U test is performed on these non-parametric data to determine if the mean of the groups are different from each other. This method is used to test the null hypothesis that there is an equal probability that an observation from one group will exceed a view from the other group—essentially stating that the two samples come from the same population. The groups are defined as engineers with less than 20 years of experience (G1), and one with more than 20 years of experience, (G2).

H0: $\mu_{G1} = \mu_{G2}$

H1: $\mu_{G1} \neq \mu_{G2}$

Table VIII indicates that for following three scenarios, the null hypothesis is rejected at 0.05 significance, thus indicating that engineers with less experience have the difference of opinions from their counterparts (engineers with 20 and more experience) for the following,

- never seen a vehicle with autonomous technology
- would not want to purchase an autonomous car
- would never get into a Level 5 autonomous

TABLE VIII. MANN WHITNEY U TEST

	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)	Asymp. Sig. (1-tailed)	
V1	763.5	-.131	.896	.448	Accept
V2	690.0	-.862	.389	.194	Accept
V3	769.5	-.063	.949	.475	Accept
V4	623.0	-1.757	.079	.039	Reject
V5	764.5	-.121	.904	.452	Accept
V6	584.5	-1.911	.056	.028	Reject
V7	677.5	-.987	.324	.162	Accept
V8	636.0	-1.402	.161	.080	Accept
V9	686.5	-.906	.365	.183	Accept
V10	708.0	-.712	.477	.238	Accept
V11	588.0	-1.985	.047	.024	Reject
V12	657.5	-1.207	.227	.114	Accept

Next multiple Likert question responses are summed together to define three different average variables. These variables now represent interval data so parametric can be performed on it. The normality assumption would not be applied as the sample size is greater than 20. The three new variables are

1) Awareness = mean value of V1, V2, V3, and V4

2) Demand = mean value of V5, V6, and V7 and

3) Trust = mean value of V8, V9, V10, and V11.

Based on the "one sample" statistical testing of these three new variables, all three hypotheses were rejected. This analysis, in Table XI, suggests that for the population, Awareness value would be less than 3 (mostly neutral or disagreeing or strongly disagreeing), Demand value is also less than 2 (mostly disagreeing or strongly disagreeing), and Trust value is greater than 4, (mostly agreeing or strongly agreeing).

TABLE IX. PAIRED SAMPLE T-TEST

Awareness	Demand	Trust
H_0: $\mu_{Awareness} = 3$ H_1: $\mu_{Awareness} \neq 3$	H_0: $\mu_{Demand} = 2$ H_1: $\mu_{Demand} \neq 2$	H_0: $\mu_{Trust} = 4$ H_1: $\mu_{Trust} \neq 4$
t = -4.633	t = 5.584	t = 0.528
df = 78	df = 78	df = 78
Sig (2 tailed) = 0.000	Sig (2 tailed) = 0.000	Sig (2 tailed) = 0.000
Mean Diff = -0.346	Mean Diff = 0.806	Mean Diff =0.7787
Reject Ho.	Reject Ho	Reject Ho

While a majority of people do not want to purchase or pay extra for autonomy, nearly 80% of the participants agreed that they would at least try a Level 5 AV. This point is interesting as it shows people are curious about the technology but are not willing to commit to purchase an AV as 70% of participants rated their willingness to buy an AV as very low.

To test if there is a difference between people who will not buy an AV and those who would not pay extra for AV, T-paired test was conducted that suggests that there is no difference between, people who would not buy an AV and one who does not want to pay extra for AV, Table X.

TABLE X. T-TEST COMPARE GROUPS NOTBUYAV VS NOTPAYEXTRA

Pair	Paired Differences					
	Mean	SD	Std Error Mean	t	df	Sig.(2-tailed)
WouldNotBuyAV - WouldNotPayExtra	.0434	1.6324	.2406	.181	78	.857

The analysis also concluded that there is a significantly strong correlation between the people who would not buy AV and one who does not trust AV and AV technologies. Table XI.

TABLE XI. CORRELATION - GROUPS NOTBUYAV VS NOTPAYEXTRA

		WouldNotBuyAV	DontTrustAV
WouldNotBuyAV	Pearson Correlation	1	.601**
	Sig. (2-tail)		.000
DontTrustAV	Pearson Correlation	.601**	1
	Sig. (2-tail)	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

The regression among these populations is also significance, Table XII.

TABLE XII. ANOVA - DEPENDENT NOTBUYAV & PREDICTOR NOTPAYEXTRA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	30.793	1	30.793	24.846	.000[b]
Residual	54.533	77	1.239		
Total	85.326	78			

Correlation and regression analysis was also conducted on Demand, Awareness and Trust. Table XIII, suggests that:

- Demand and Awareness have a statistically significant linear relationship ($p < 0.1$) and the strength of this positive association is very weak.
- Demand and Trust have a statistically significant linear relationship ($p < .05$) and has a moderate negative association.
- Awareness and Trust have no statistically significant linear relationship and a positive weak association.

TABLE XIII. CORRELATIONS ANALYSIS

	Variable	Demand	Awareness	Trust
Pearson Correlation	Demand	1.000	.167	-.545
	Awareness	.167	1.000	.050
	Trust	-.545	.050	1.000
Sig. (1-tailed)	Demand	-	.071	.000
	Awareness	.071	-	.330
	Trust	.000	.330	-

ANOVA was also performed on these three variables. Table XIV. The regression model predicts the dependent variable significantly well. Here, *p* is 0.0005, which is less than 0.05, and indicates that, overall, the regression model, statistically, significantly predicts the outcome variable (i.e., it is a good fit for the data).

TABLE XIV. ANOVAA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	43.846	2	21.923	19.098	.000[b]
	Residual	87.242	76	1.148		
	Total	131.089	78			

a. Dependent Variable: Demand
b. Predictors: (Constant), Trust, Awareness

The regression analysis can now be used to predict the Demand. If AV-OEM can improve, people trust and awareness of AV and AV technologies, it will significantly increase the AV demand and people willingness to buy one.

V. CONCLUSIONS

Many autonomous technologies are on the roads today, while fully autonomous cars are on the horizon. There are many barriers in the development path of AV's and there is still a long way the technology must progress before it is widely accepted to be safe for the general public. As the technology evolves and people see more AVs on the road, their perception about the AVs are changing. Compared to the 2014 survey, [6], where 55% of the USA car drivers would likely to buy a partially autonomous car, this study suggests otherwise. During the past year, several accidents involving AV might have effected this perception. Some of the important conclusion of this study of engineers involved in the design and development of AV and AV technologies are:

- People are unaware of AVs or AV technologies presence on the road. This can be linked to the small number of AVs present on the road and/or AV-OEM not doing a good job in marketing these technologies.
- Although people trust AV technologies, they are still very reluctant to buy or ride an AV. Demand for AVs are currently very low, while the trust in the technology is very high. This trust can be linked to public expectation about AV and hype created around it by the information and technology companies.
- People would try a level 5 AV once the technology matured. Automotive engineers are very conservative in their opinions about technologies. This relates to their years of designing experience in delivering vehicles with working technologies, which requires them to be cautious when making any prediction about future technologies.
- People perceived that AV and AV technologies would be "charged" extra by the AV-OEM. Customers are not willing to pay for it. People think that AV should be included within standard car buying package.
- Currently, most of the AVs' technologies present in the conventional vehicles, (CV), are sold as "extra /special features", while people perceived them as standard part of CV just like anti-lock braking system (ABS).

- A vast majority think that it will take more than 25 years before the majority of vehicles on the road would be autonomous.
- People do not like the features offered in the current AVs and think that companies have not gathered their inputs (customer requirements) for the AV design.
- Although the literature review, suggest safety and cost as challenges to AV adaptation, this study concludes that the most important customer requirements are infotainment system and connectivity followed by safety and cost.
- An interesting finding of the study is the customer requirement where driver should be able to take control of the AV if needed.
- Engineers involved in the design and development of AV has a very different opinion about the challenges that AV faces for its wide adaptation. With the news of data breaches and hackings appearing daily, these engineers perceive data privacy and security to be the most perplexing issue in the development of AV.
- AV and AV technologies are popular with the younger generation. Engineers with less than 20 years of experience have a very different opinion than engineers with 20 plus years of experience. Young engineers are more aware of the AV and AV technologies and are more likely to purchase or ride in one.
- Although the actual cost of AV is still unknown, the general perception is that AVs and AV technologies will be costly.
- There is a high correlation between people not willing to buy an AV and people not trusting them. The regression among these type of populations is also significant, suggesting that people who would not buy AVs are the same as people who do not trust them.

Potentially Autonomous vehicles will forever change the automotive industry; however, by incorporating customer needs and requirements into AV designs while ensuring that they are informed about the safety aspect of AVs, the companies can expedite this change.

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