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Research Paper

Willingness to use driverless cars: Young consumers' perspective

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Abstract

Despite the benefits of driverless cars, much is still to be learned about consumers' willingness to use driverless cars particularly when such cars are still primarily in the development phase and not widely available for consumers to experience. This study examines the extent to which the benefits of driverless cars are discernible to motivate adoption. Survey results of 191 young consumers suggest that a long-term orientation is required to discern the economic, safety and time benefits of driverless cars. A long-term orientation is particularly crucial to prevent consumers from being bogged down by the various immediate technical and safety concerns associated with driverless cars and focus on the long-term economic, safety and time benefits instead. While most new technologies give rise to anxiety, anxiety is found to strengthen the motivating effects of the economic benefits of driverless cars on willingness to use. Such findings provide implications for educating consumers about ongoing developments in resolving the various immediate concerns about driverless cars.

Keywords: Long-term orientation, Benefits, Anxiety, Willingness to use, Driverless vehicles, Young consumers.

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Introduction

In order for commuters to be relieved of their daily driving routines, vehicles need to be in a position to mimic fundamental human driver's behaviours like responding to traffic signals and safely navigating while detecting and responding to pedestrians, other road users, obstacles, weather conditions and unpredictable circumstances on the road. Driverless vehicles need to be capable of learning and deciding in a complex environment. To date, most of the technological solutions to the design, applications, testing and verification for driverless vehicles are proprietary; either little is known about these technological solutions or those that are known require more time to mature (Hussain and Zeadally, 2019).

Besides technical challenges, several concerns about driverless cars are still unresolved. For instance, how the new business model of the automobile, transportation and insurance industry as well as traffic safety are still uncertain especially in the absence of a holistic approach in the infrastructure and legal framework to support use of driverless vehicles on a commercial basis. The economy can also be adversely affected with the displacement of public transport drivers and decrease in the demand for privately owned vehicles as driverless vehicles promote ride-sharing. Further, driverless vehicles capture and make available user-identifiable data that reveal consumers' private information like location and travel history, which can be sold to third parties for business and marketing purposes (Hussain et al., 2018).

Despite the several concerns, driverless vehicles play a significant role in closed environments like airports, golf courses, retirement villages and university campuses while the driverless function is expected to become a standard feature in most vehicles by 2050s (Litman, 2017). Driverless vehicles have the potential to resolve the problem of ever-increasing number of vehicles on the road, which is expected to reach 30 billion by 2030, together with the corresponding increase in the demand for new infrastructure as well as accidents and fatalities (Hussain et al., 2018). Since driverless cars can be shared, cars in a rental fleet can be optimized for each usage scenario; for example, small cars for short trips within the city and vans for family trips. Ride-sharing increases utilization rate for each vehicle, optimizes use of transportation infrastructure, promotes cost savings, conserves energy and combats climate change in the long run. Further, driverless cars never tire, do not drink, have no emotions and thus no erratic behaviours on the road, which minimizes accidents attributable to human errors (see Hars, 2010; Hussain et al., 2018; Ruggeri et al., 2018).

Acceptance of driverless vehicles receives ample attention in recent literature, especially when wide acceptance and use of driverless vehicles are required for the potential benefits to the economy, society and environment at large to materialize. Using a variety of research methods ranging from questionnaire survey of mass consumer market to field experiments and case studies in closed settings like use of driverless shuttles in university campuses and cities, empirical findings suggest that benefits like the physically impaired are empowered to travel, comfort, having free time while travelling, safety from accidents attributable to human errors and safety from crime while travelling have been found to promote acceptance of driverless vehicles (Kaur and Rampersad, 2018; Nordhoff et al., 2018; Panagiotopoulos and Dimitrakopoulos, 2018; Salonen, 2018; Xu et al., 2018; Zmud et al., 2016). Drawbacks like loss of privacy, susceptibility to targeted marketing and software related security flaws like viruses and malwares that can undermine the functionality of driverless vehicles have also been examined and found to discourage use of driverless vehicles (Kaur and Rampersad, 2018).

There are bound to be proponents and opponents of driverless vehicles. Young, highly educated males living in urban areas who drive regularly tend to be positive about driverless cars in light of the possibility of doing other things while travelling, whereas older people living in less densely populated areas who enjoy conventional driving are afraid of the prospect of losing their driving pleasure and thus tend to be negative about driverless cars (Ruggeri et al., 2018; Nielsen and Haustein, 2018). Regardless of whether one is positive or negative about driverless cars, media portrayals can change one's position about driverless cars (Anania et al., 2018).

While younger consumers are more receptive of driverless cars compared with their older counterparts (Ruggeri et al, 2018; Nielsen and Haustein, 2018; Ho et al., 2020), much is to be learned how best to promote widespread adoption of driverless cars. This study sheds light on whether young consumers' orientation constitutes a differentiating factor that makes the benefits of driverless cars more apparent, which in turn, promotes acceptance and adoption. A better understanding of young consumers' orientation is pertinent especially in developing engagement programs to promote early adoption. In addition, this study also posits that anxiety can undermine young consumers' ability to appreciate the benefits of driverless cars and thus adversely affect willingness to use driverless cars.

The remainder of the paper is organized as follows. The second section provides a review of literature. The third section develops the hypotheses. The fourth section details the methodology. The fifth section presents the results. The sixth section discusses the results and concludes the discussions.

Literature Review

Extant literature suggests that younger consumers are more receptive of self-driving cars (Ruggeri et al, 2018; Nielsen and Haustein, 2018; Ho et al., 2020). By contrast, older consumers demonstrate a higher level of resistance towards new technologies in general. For driverless cars to realize its full potential and subsequently benefit the society and the environment in long run, efforts in pushing for widespread acceptance should begin by engaging young consumers who are more technology savvy. Factors that motivate adoption of driverless cars among young consumers receive little attention in extant literature.

Based on Deloitte's survey on 22,000 Millennials from 17 countries in 2016 and 2017, Dewalska-Opitek's (2017) study is among the few that focuses on young consumers. In Dewalska-Opitek's (2017) study, close to one-half of the Millennials surveyed are found to be in favour of a full self-driving car despite safety concerns. However, the study demonstrates geographical variations in young consumers' acceptance of driverless cars. A higher percentage of the Millennials surveyed from Asian emerging markets—i.e. 64% from China and 62% from India—are found to be in favour of fully autonomous vehicles. While Dewalska-Opitek's (2017) study sheds light on how demographic factors contribute towards cross-country variations in driverless car adoption among young consumers, much is to be understood how young consumers' cognitive traits affect their evaluation of driverless cars' value propositions.

This study intends to bridge the gap in extant literature by examining the extent to which young consumers' long-term orientation affects their evaluation of driverless cars' benefits. Various benefits and concerns associated with the implementation of driverless cars have been widely discussed in the academic as well as practitioner literature (see Hussain and Zeadally, 2019). The various benefits and concerns can be categorized into economy, safety and time, which are discussed as follows.

Economy

Conventional privately owned vehicles are costly to acquire and maintain especially in high-density urban areas where parking spaces are at a premium. Conventional cars are typically multi-purpose and accommodate for a variety of usage scenarios, such as commuting to work alone, short distance shopping trips as well as long distance family vacations. Yet, conventional cars frequently sit idle in the garage or paid parking spaces and thus underutilized. By contrast, driverless cars can ferry one passenger to the city centre for work and other passengers around the city for appointments, meetings and errands while waiting for the former to return home at the end of the work day rather than lying idle in paid parking spaces. Driverless cars, which facilitate car-sharing, enhance utilization rate by a factor of at least five, which reduces capital costs per kilometer while ensuring choice of cars is optimized for each usage scenario; for example, smaller cars are used for work in densely populated cities while bigger cars capable of travelling off-road are used for holiday in the countryside (Hars, 2010).

Driverless cars are foreseen to alleviate various sources of stress attributable to population growth like traffic congestions, environmental pollutions and increasing demand for new infrastructure while bringing about a wide range of economic benefits from fuel efficiency to lower maintenance costs, increased lifespan of vehicles, and other resource conservation benefits (Hars, 2010; Hussain et al., 2018; Zmud et al., 2016). Driverless cars are also foreseen to boost the economy via new business opportunities like mobility-as-a-service while stimulating growth of related industries like technology, artificial intelligence and communication especially when driverless cars require a complex distributed system with computation, communication and storage capabilities in order to make decisions and mimic fundamental human driver's behaviours (Hussain et al., 2018; Hussain and Zeadally; 2019).

Using established theories of technology acceptance like the Techology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) and UTAUT2 (Venkatesh et al., 2012), empirical research concentrates on understanding consumers' attitude towards driverless vehicles, especially in terms of perceived usefulness, perceived ease of use and trust, which in turn determine consumers' behavioural intention to use driverless vehicles (e.g. Kaur and Rampersad, 2018; Nordhoff et al., 2018; Panagiotopoulos and Dimitrakopoulos, 2018; Xu et al., 2018). Consumers in these studies have limited understanding and experience with driverless vehicles to begin with especially when driverless vehicles are not widely available and these studies were primarily conducted in closed settings. Extant literature suggests that conventional cars are preferable over driverless cars (Nielsen and Haustein, 2018; Zmud et al., 2016). The potential to resolve the problem of being unfit to drive attributable to physical impairments, old-age, fatigue and being under the influence of drugs or alcohol, is cited as the major reason for the acceptance of driverless cars (Zmud et al., 2016). In other words, primarily consumers who are unfit to drive find driverless cars appealing.

Much is to be learned about driverless cars for consumers to focus beyond the potential of being able to travel despite being unfit to drive to perceive and appreciate the economic benefits of driverless cars. However, the costs of production, installation, repair and maintenance of driverless cars together with intricate components like sensors and navigation devices can only become economical and affordable to middle-income families with mass production (Hussain and Zeadally, 2019; Litman, 2017), which does little to enable consumers to have a more extensive experience of driverless cars in order to perceive the associated economic benefits in the near term.

Safety

Consumers are conscious of the safety benefits of driverless cars in light of the potential of keeping unfit drivers off the road and thus minimizes accidents and fatalities attributable to human errors. In addition to safety on the road, which is the key selling point of driverless cars, other aspects of safety such as risks of hardware and software failures, car theft, car hacking, remote access and control of the car, safety from crime especially with ride-sharing arrangement, and the presence of safety features like fire alarm systems, emergency buttons and channels for reporting anything suspicious while on board have been found to affect the acceptance of driverless vehicles (Kaur and Rampersad, 2018; Liu et al., 2018; Nordhoff et al., 2020; Salonen, 2018; Xu et al., 2018). As driverless cars create new safety issues of concern, consumers require driverless cars to be four to five times safer than conventional cars to be acceptable (Liu et al., 2018).

Further, machine-learning and artificial intelligence-based techniques that are indispensable for driverless cars to detect and respond to unforeseen circumstances on the road are found to demonstrate erroneous behaviours when tested under diverse traffic and environmental conditions (Hussain and Zeadally, 2019). More time and rigorous tests are required to ensure driverless cars are in a position to function completely independently and safely on the road. Hence, driverless vehicles are not necessarily safer than conventional cars in the short term.

Time

The maximum speed of driverless cars is limited and kept lower than that of their conventional counterparts for as long as machine-learning and artificial intelligence-based techniques are yet to be mature enough for driverless cars to function completely independently and safely. Google’s driverless cars has a maximum speed of 40 km/h (Miller, 2014). Driverless feeder buses in the City of Vantaa, Finland, have a maximum speed of 13 km/h (Salonen, 2018). While low speed is not an issue of concern for consumers who prioritize road safety (Nordhoff et al., 2020), much is to be understood about consumers who do not have the privilege of ample travel time and whether time spent engaging in work and other activities while travelling can compensate for driverless cars’ low speed.

In order for driverless cars to travel at a speed comparable with that of their conventional counterparts, driverless cars need to communicate and coordinate effectively with other road users. Traditionally, communication between road users like human drivers, pedestrians and cyclists are non-verbal such as nodding, eye contact and hand gestures. Such well-proven traditional means of communication and coordination are no longer applicable with the inclusion of driverless cars in the traffic environment (Vissers et al., 2016; Nordhoff et al., 2020). Currently, human road users have a limited understanding about driverless cars, let alone communicate and coordinate effectively with such vehicles (Botello et al., 2019; Nordhoff et al., 2020). More time is required for human road users to get to know driverless cars to identify effective means of communication and coordination on the road. Alternatively, if human road users like manually-driven cars, pedestrians and cyclists are separated in a manner that does not impede the traffic flow of driverless cars, the speed of driverless cars can be increased (Botello et al, 2019). However, separation of human road users from driverless vehicles on the road is not without its challenges and thus not readily attainable in the short-term.

Hypotheses Development

The several technological concerns discussed are believed to be not insurmountable and not a major obstacle in the journey towards commercialization of driverless cars (Shariff et al., 2017). Past vehicle technology deployment suggests that decades are required for the reliability, performance and price of a technology to attain an acceptable level. The economic, safety and time benefits of driverless cars are expected to materialize in the 2050s where driverless cars are expected to become available on a commercial basis (Litman, 2017). However, biases in media coverage about accidents and fatalities involving driverless cars tend to be disproportionately sensationalized to attract attention, which adversely affect consumers' willingness to use driverless cars while encouraging public policies that limit widespread adoption (Anania et al., 2018; Shariff et al., 2017).

Long-term Orientation

This study hypothesizes that a long-term orientation is required to focus beyond short-lived technical glitches common to most technologies to appreciate the economic, safety and time benefits of driverless cars in the long-run. Long-term orientation directs attention to the future where emphasis is on values oriented towards future rewards like persistence, thrift and ethics (Hofstede, 1980; 1991; Bearden et al., 2006). Consumers with a long-term orientation are in a better position to understand that persistence is required for the manufacturing, installation, repair, testing and maintenance standards of driverless cars to attain a level equivalent to that of aircraft components, which is particularly important especially when safety is a priority (Litman, 2017). Consumers with a long-term orientation places great importance on the safety of driverless vehicles, which are attainable in the long-run and thus are tolerant of highly publicized setbacks in the short-term. When safety has attained a level that enables driverless cars to travel at a higher speed, travel time can become comparable, if not shorter, than that of conventional, manually driven cars.

Values associated with long-term orientation like thrift and ethics motivate conscious choices that favour resource conservation and other economic benefits. As driverless cars relieve consumers of their driving routines, resource conservation benefits like emission reductions and energy savings can be elusive if consumers choose larger vehicles for their daily commute to serve as mobile offices or facilitate other on-the-road recreational activities to make the most of the free time available while travelling (Litman, 2017). Consumers also need to forgo car ownership and embrace the culture of ride-sharing for resource conservation and other economic benefits of driverless vehicles to materialize. Even consumers in countries rated as most trustworthy in the world find personal safety a concern with ride-sharing (Salonen, 2018). Emphasis on the various concerns associated with population growth and climate change in the long-term guides thrifty and ethical consumers to perceive the importance of choosing an appropriate vehicle for each trip and embracing the culture of ride-sharing. Choices that prioritize personal interests at the expense of the greater good of the economy, environment and society hold negative long-term consequences, which when revealed over time tend to be ego-bruising to consumers with a long-term orientation (Hofstede, 1980; 1991; Bearden et al., 2006). In this manner, long-term orientation deters choices that prioritize personal interests for short-term gains.

Economic, safety and time benefits of driverless cars are future benefits. There is a trade-off between some of these future benefits, especially when personal safety can be at risk with ride-sharing although ride-sharing is for the greater good of the economy and environment in the long-run. It is an empirical question whether these future benefits are more prominent to consumers with a long-term orientation. The first set of hypotheses is as follows.

H1a Long-term orientation is positively related to economic benefits.

H1b Long-term orientation is positively related to safety benefits.

H1c Long-term orientation is positively related to time benefits.

Economic, Safety and Time Benefits

While driverless cars have yet to become as widely accepted as their conventional, manually driven counterparts, extant literature suggests that consumers are particularly enthusiastic about the safety benefits of driverless vehicles, especially the potential to minimize accidents and fatalities attributable to human errors (Hars, 2010; Nielsen and Haustein, 2018; Zmud et al., 2016). Besides safety benefits, driverless car enthusiasts who primarily live in densely populated cities and have ample driving experience in congested traffic conditions appreciate the possibility of conserving energy and minimizing carbon emissions with ride-sharing as well as doing other things while travelling (Nielsen and Haustein, 2018); driverless car enthusiasts are also conscious of the economic and time benefits.

By contrast, sceptics who are primarily proponents of conventional cars are afraid to lose the excitement and freedom associated with driving and thus focus on the problems and downplay the benefits of driverless cars (Nielsen and Haustein, 2018). Extant literature suggests that being able to perceive the benefits enhances willingness to use driverless cars (Hohenberger et al., 2017). In a similar manner, this study hypothesizes that consumers who are better able to perceive and appreciate the economic, safety and time benefits of driverless cars are more willing to use driverless cars. The second set of hypotheses are as follows.

H2a Economic benefits are positively related to willingness to use.

H2b Safety benefits are positively related to willingness to use.

H2c Time benefits are positively related to willingness to use.

In summary, sceptics are more conscious of the technical glitches and other short-term problems of driverless cars. Sceptics tend to discount the benefits of driverless cars, which require time to materialize. Such short-term orientation motivates prioritizing personal driving pleasure, excitement and other short-term gains. By contrast, enthusiasts with a long-term orientation are more conscious of the greater good of the economy, environment and society and thus appreciate the economic, safety and time benefits of driverless cars.

The Stimulus-Organism-Response model provides a conceptual basis for the mediating role of the perceived economic, safety and time benefits in shaping willingness to use driverless cars. In the model, Russell and Mehrabian (1974) defined "organism" as an individual's internal cognitive and affective reactions. In particular, an organism acts as an intermediary that links the stimulus to the response. In this study, long-term orientation is the internally driven stimulus, perceived economic, safety and time benefits are the organism or cognitive reactions, while willingness to use driverless cars is the response as a result of cognitive reactions.

Subscribing to the S-O-R model, this study posits that perceived economic, safety and time benefits constitute the mechanism that connects long-term orientation with willingness to use. Ho, Leow and Leung's (2020) study provides support to the mediating role of perceived benefits in Singaporean's willingness to use driverless cars. More specifically, the study found that affect—i.e. feelings or emotions—influences willingness to use driverless cars directly as well as indirectly via perceived benefits. This study hypothesizes that consumers with a long-term orientation are more conscious of the economic, safety and time benefits and thus more willing to use driverless cars. Failure to perceive the economic, safety and time benefits does little to motivate use of driverless cars. The third set of hypotheses are as follows.

H3a Economic benefits mediate the relationship between long-term orientation and willingness to use.

H3b Safety benefits mediate the relationship between long-term orientation and willingness to use.

H3c Time benefits mediate the relationship between long-term orientation and willingness to use.

Anxiety as a Moderator

As driverless cars have yet to become widely available on a commercial basis, an overall lack of understanding and experience with driverless cars can give rise to anxiety especially when confronted with technical glitches and other shortcomings. History suggests that computerization and indeed most technological innovations tend to give rise to anxiety when first introduced, which can undermine the effectiveness of computerization and hinder widespread adoption (Doronina, 1995; Kim, 2019). The fact that consumers require driverless cars to be four to five times safer than conventional cars even when safety is the key selling point of driverless cars (Liu et al., 2018) reflects a certain degree of anxiety among the public at large.

Hohenberger et al. (2017) demonstrated that anxiety deters use of driverless cars despite positive evaluations of driverless cars in terms of benefits; positive perception of the benefits diminishes as the level of anxiety increases. This study posits that positive perception of the benefits constitutes a strong motivator for willingness to use driverless cars among individuals with a low anxiety level. A high anxiety level weakens the effect of positive perception of driverless cars' benefits as a motivator for willingness to use. This study hypothesizes that anxiety moderates the relationship between perceived benefits and willingness to use, where the relationship becomes weaker when anxiety is high. The fourth set of hypotheses are as follows.

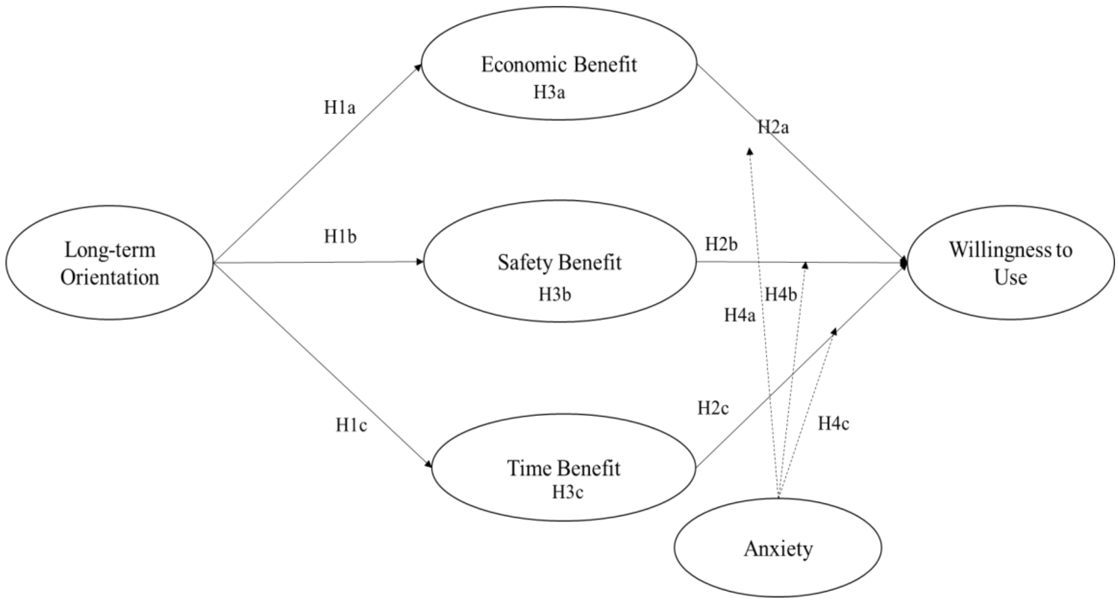
H4a Anxiety moderates the relationship between economic benefits and willingness to use, where the relationship becomes weaker when anxiety is high.

H4b Anxiety moderates the relationship between safety benefits and willingness to use, where the relationship becomes weaker when anxiety is high.

H4c Anxiety moderates the relationship between time benefits and willingness to use, where the relationship becomes weaker when anxiety is high.

Figure 1 depicts the hypothesized relationships as discussed in this section.

Figure 1: Research model



Methodology

Data Collection Procedure

Prior to the main survey, a pilot test was performed to verify the validity of the measurement items using 10 young consumers via face-to-face survey in Malaysia. As part of the pilot test, a video of approximately 5 minutes was first shown to the respondents to allow them to fully understand the general idea of driverless car. Based on results of pilot test, minor modifications like sentence and grammar structures were made to clarify the measurement items in the questionnaire.

Using Google forms, an online questionnaire was created and the link to the questionnaire was shared with the respondents. Respondents were first informed of the main purpose of the study and respondents' consent to participate in the survey was recorded. The first part of questionnaire consists of demographic questions and the second part includes questions to assess the main constructs of this study. Purposive sampling was employed to ensure that target respondents are suitable for this study. The questionnaire also contains the definition and picture of driverless car to provide respondents with a better understanding. Unlike past studies (e.g. Kaur and Rampersad, 2018), young consumers living in Selangor, Malaysia inclusive but not limited to those living in closed settings like university campuses, were invited to participate in this study. Further, a survey by Accenture (2019) indicated that this cohort of respondents is generally more comfortable with the idea of using automation features to take control of driving than older generations. In fact, young consumers are well-educated, technology savvy, and tend to show a great desire and willingness to pay for innovative technologies (Woisetschläger, 2016; Ng et al., 2019).

Within a period of six months, 200 responses were received. After evaluating the multivariate outliers and missing responses, nine responses were eliminated. Consequently, the statistical analysis was conducted using 191 responses. The size of the existing sample is considered appropriate from post-hoc analysis with an effect size of 0.05 and power level of 80% (Faul et al., 2007). As shown in Table 1, 66.5% female and 33.5% male consumers responded to the survey. Most of the respondents were 18-24 years old (78%), had completed a bachelor degree (80.1%), and earned less than RM 4,000 per month (72.3%).

Table 1: Respondents' profile

Demographic variable		n	%
Gender	Female	127	66.5
	Male	64	33.5
Age	18 - 24 years old	149	78
	25 - 34 years old	42	22
Highest Academic Qualification	Bachelor	153	80.1
	Certificate or lower	17	8.9
	Diploma	8	4.2
	Masters and above	13	6.8
Household Income (Monthly)	RM 2,000 or under	105	55
	RM 2,001 - RM 4,000	33	17.3

Demographic variable		n	%
	RM 4,001 - RM 6,000	22	11.5
	RM 6,001 - RM 8,000	8	4.2
	RM 8,001 - RM 10,000	7	3.7
	RM 10,000 or more	16	8.4

Measures

Multiple-items scales were adapted from previous transportation studies to fit the driverless car context. A six-point Likert scale, ranging from point 1=totally disagree and 6=totally agree were employed to measure all the items. To be specific, the five constructs (i.e., willingness to use, anxiety, economics benefits, safety benefits and time benefits) were measured using a three-item scale taken from Hohenberger's et al. (2017) study. The items measuring long-term orientation was measured using a six-item scale validated in Yoo's et al. (2011) study.

Results

Partial least square (PLS-SEM), a second-generation data analysis approach was used in this study. Owing to its composite modelling approach, PLS-SEM mainly focuses on estimating path coefficients and maximizing the variance explained (R2) by the exogenous variables (Hair et al., 2019; Sarstedt et al., 2014). Compared to other SEM approaches, PLS-SEM is viewed as the "most fully developed system" (Chin, 1988; McDonald, 1996) and termed the "silver bullet" (Hair et al., 2011), which is capable of estimating sophisticated theoretical models (i.e. composed of moderators and mediators). SmartPLS version 3.3.2 was thus adopted to analyze the data and facilitate the examination of factors that impact consumers' willingness to use driverless cars.

Common Method Bias

Given that a single source of information can introduce spurious relationships among constructs, it is important to test for common method bias (CMB) prior to analyzing the proposed relationships. Accordingly, Harman's Single Factor Technique (Podsakoff et al., 2013) was employed. The principal component factor analysis results illustrated that the variance explained by the first factor is 38.52 percent (<40%), indicating that CMB is not a concern in this study (Babin et al., 2016). Next, full collinearity assessment, a post-hoc analysis was applied to further assess this issue (Kock and Lynn, 2012). Overall, all variance inflation factors' (VIFs) value were found to be less than 3.33 (Kock and Lynn, 2012) (see Table 2), when a dummy variable was regressed against all the variables in the model. Again, this concluded that there are no serious issues related to CMB in this study.

Measurement Model

A series of rigorous tests were conducted to estimate the measurement model. First, the internal consistency was assessed using the Cronbach's Alpha (CA) and composite reliability (CR). As reported in Table 2, CA and CR exceed the threshold value of 0.70

(Hair et al., 2019), which means that internal consistency is met. Subsequently, outer loadings and average variance extracted (AVE) were evaluated for convergent validity. All indicators are loaded highly on their respective construct (i.e., >0.708) and are able to account for more than 50% of the constructs' variance (Hair et al., 2019); convergent validity is supported statistically.

Table 2: Measurement model

Construct	Item	Outer Loading	Full Collinearity	CA	CR	AVE
Economic Benefits	EB1	0.757	1.491	0.699	0.830	0.620
	EB2	0.827				
	EB3	0.776				
Long-term Orientation	LTO1	0.814	1.914	0.903	0.925	0.674
	LTO2	0.850				
	LTO3	0.857				
	LTO4	0.790				
	LTO5	0.798				
	LTO6	0.815				
Safety Benefits	SB1	0.891	1.665	0.894	0.934	0.824
	SB2	0.928				
	SB3	0.903				
Time Benefits	TB1	0.781	1.674	0.765	0.864	0.680
	TB2	0.823				
	TB3	0.868				
Willingness to Use	WTU1	0.904	1.639	0.905	0.940	0.840
	WTU2	0.938				
	WTU3	0.908				
Anxiety	A1	0.918	1.176	0.913	0.943	0.846
	A2	0.905				
	A3	0.936				

All constructs exhibit discriminant validity based on Fornell and Larcker's (1981) guidelines (see Table 3). HTMT's values for all constructs are below 0.85, which confirm discriminant validity (Henseler et al., 2015; Kline, 2011) (see Table 4).

Table 3: Fornell and Larcker's criterion and descriptive statistics

	Mean	SD	1	2	3	4	5	6
1. Anxiety	4.007	1.400	0.920					
2. Economic Benefits	4.202	1.039	-0.168	0.787				
3. Long-term Orientation	4.180	1.014	-0.238	0.513	0.821			
4. Safety Benefits	4.220	1.195	-0.325	0.424	0.477	0.908		
5. Time Benefits	4.421	0.987	-0.101	0.402	0.568	0.481	0.825	
6. Willingness to Use	4.443	1.137	-0.298	0.440	0.519	0.497	0.432	0.917

Table 4: HTMT results

	1	2	3	4	5	6
1. Anxiety						
2. Economic Benefits	0.213					
3. Long-term Orientation	0.259	0.617				
4. Safety Benefits	0.350	0.528	0.525			
5. Time Benefits	0.120	0.521	0.676	0.576		
6. Willingness to Use	0.308	0.541	0.575	0.544	0.515	

Structural Model

A five-step approach was used to assess the results of the structural model. The collinearity between the constructs was assessed by means of their variance inflation factors (VIF). Table 5 demonstrates that VIF values are below 3, indicating collinearity is not a severe threat (Becker et al., 2015). The path coefficient was analyzed using a bootstrapping technique with 5,000 sub-samples. The results show that long-term orientation has a positive influence on economic benefits; each one standard deviation change in long-term orientation is accompanied by slightly more than half a standard deviation change in economic benefits ($\beta=0.513$; $p<0.001$). Long-term orientation also has a positive influence on safety benefits; each one standard deviation change in long-term orientation is accompanied by close to half a standard deviation change in safety benefits ($\beta=0.477$; $p<0.001$). Long-term orientation has a positive influence on time benefits as well; each one standard deviation change in long-term orientation is accompanied by slightly more than half a standard deviation change in time benefits ($\beta=0.568$; $p<0.001$). Thus, H1a, H1b, and H1c are supported. Furthermore, the results also reveal that economic benefits ($\beta=0.233$; $p<0.001$), safety benefits ($\beta=0.306$; $p<0.001$) and time benefits ($\beta=0.191$; $p<0.001$) are significant predictors of willingness to use driverless car. As predicted, H2a, H2b, and H2c are supported (see Table 5).

In terms of explanatory power, long-term orientation explains more than 20% of the variance in economic, safety, and time benefits respectively ($R^2 = 0.263$, $R^2 = 0.227$ and $R^2 = 0.322$ for economic, safety and time benefits respectively). Approximately 33.7% of the variance in willingness to use ($R^2 = 0.337$) is explained by economic, safety, and time benefits. Table 5 details that long-term orientation has a large effect size on economic benefits ($f^2= 0.356$) and time benefits ($f^2= 0.476$), and a medium effect size on safety benefits ($f^2= 0.294$); according to Cohen's (2013) criterion for effect size, $f^2 \geq 0.35$ constitutes large effect size while $f^2 \geq 0.15$ constitutes medium effect size. In explaining willingness to use, all predictors—economic benefits ($f^2= 0.063$), safety benefits ($f^2= 0.099$), and time benefits ($f^2= 0.040$)—have a small effect size; according to Cohen (2013), $f^2 \geq 0.02$ constitutes small effect size. Using blinding procedure, the Q^2 values for all endogenous constructs are greater than zero, indicating the presence of the model's predictive relevance (Geisser, 1974; Stone, 1974).

Mediation and Moderation Analysis

Based on Preacher and Hayes' (2004; 2009) guidelines, the mediating effect was assessed using bootstrapping technique. Results show that economic ($\beta=0.120$; $p<0.01$), safety ($\beta=0.146$; $p<0.01$), and time benefits ($\beta=0.109$; $p<0.05$) significantly mediate the paths between long-term orientation and willingness to use (see Table 5), which is in line with H3a, H3b, and H3c.

For moderator assessment, a two-stage approach was applied to estimate the interaction terms. Findings reveal that anxiety significantly moderates the relationship between economic benefits and willingness to use (β=0.115; p<0.05). Specifically, the relationship was found to be stronger for high anxiety individuals (see Figure 2), which runs counter to H4a; H4a is not supported. As can be seen in Figure 2, the slope for high anxiety individuals is more positive than low anxiety individuals. The slope for the low anxiety group is close to a flat line indicating no relationship, which suggests that low anxiety individuals are not driven by economic benefits. However, the relationships between safety (β=-0.026; p>0.05) and time benefits (β=0.045; p>0.05) on willingness to use are not moderated by anxiety. H4b and H4c are not supported.

Figure 1: Interaction plot for anxiety and economic benefits

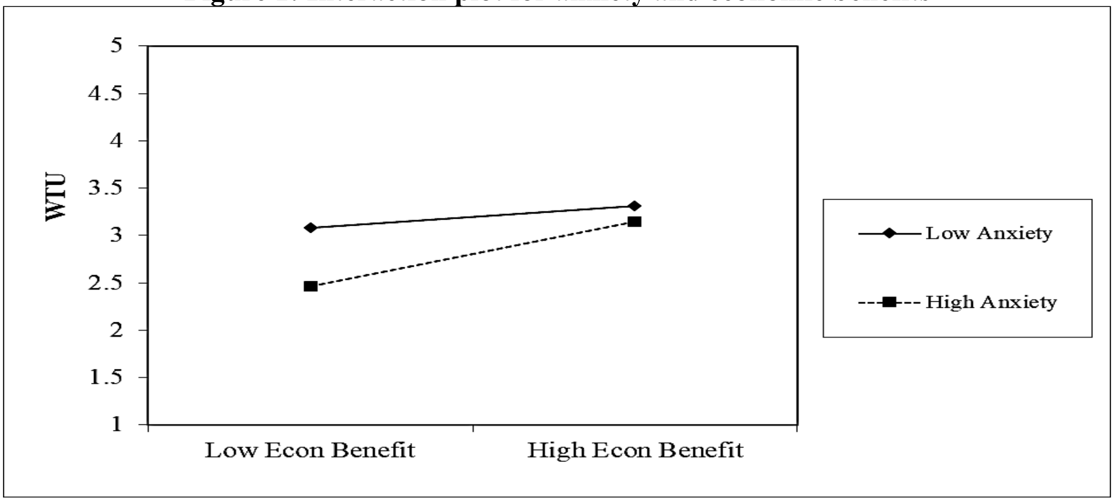


Table 5: Structural model

Path Relationship	Direct Effect	Indirect Effect	Std Error	t-value	p-value	VIF	R^2	F^2	Q^2
H1a: LTO -> Economic Benefits	0.513		0.059	8.744***	<0.001	N/A	0.263	0.356 (L)	0.149
H1b: LTO -> Safety Benefits	0.477		0.077	6.229***	<0.001	N/A	0.227	0.294 (M)	0.183
H1c: LTO -> Time Benefits	0.568		0.059	9.608***	<0.001	N/A	0.322	0.476 (L)	0.206
H2a: Economic Benefits -> WTU	0.233		0.073	3.189***	<0.001	1.300	0.337	0.063 (S)	0.264
H2b: Safety Benefits-> WTU	0.306		0.094	3.245***	<0.001	1.418		0.099 (S)	
H2c: Time Benefits -> WTU	0.191		0.089	2.147*	0.016	1.387		0.040 (S)	
H3a: LTO -> Economic Benefits -> WTU		0.120	0.043	2.804**	0.005				
H3b: LTO -> Safety Benefits-> WTU		0.146	0.052	2.787**	0.006				
H3c: LTO -> Time Benefits -> WTU		0.109	0.054	1.998*	0.046				
H4a: Economic Benefits*Anxiety -> WTU	0.115		0.062	1.846*	0.033				

Path Relationship	Direct Effect	Indirect Effect	Std Error	t-value	p-value	VIF	R^2	F^2	Q^2
H4b: Safety Benefits*Anxiety -> WTU	-0.026		0.086	0.298	0.383				
H4c: Time Benefits*Anxiety -> WTU	0.045		0.088	0.508	0.306				

Generally, young consumers in this study expressed a moderate level of willingness to use driverless cars (mean = 4.443, see Table 3), which is consistent with that of Dewalska-Opitek's (2017) study where half (47%) of the Millennial respondents reported their willingness to own a full self-driving car. As shown in Table 3, consumers with a long-term orientation perceive more benefits in driverless cars than their high-anxiety counterparts; correlations between long-term orientation and economic (b=0.513), safety (b=0.477) and time benefits (b=0.568) are higher compared with the correlations between anxiety and the three benefits (economic, b=-0.168; safety, b=-0.325; time benefits, b=-0.101). The negative correlation between anxiety and willingness to use driverless cars (b=-0.298) as shown in Table 3 is consistent with Hohenberger's et al. (2017) findings. The age profile of respondents in Hohenberger's et al. (2017) study was of a wider range from 20 to 60 years old. By contrast, respondents in this study were relatively younger, i.e. between 18 to 34 years old. While young consumers are deemed technology natives who are receptive of new innovations (Woisetschläger, 2016; Ng et al., 2019), results of this study suggests that anxiety is still capable of deterring these technology natives from trying out new technologies in intelligent transportation.

Discussion

This study examines the extent to which young consumers perceive the economic, safety and time benefits, which in turn determine willingness to use driverless cars using partial least square (PLS-SEM). Results of PLS-SEM suggest that consumers with a long-term orientation, who appreciate values like persistence, thrift and ethics, are in a better position to look beyond the setbacks of driverless cars in the short-term to appreciate the economic, safety and time benefits in the long run. Being able to perceive the economic, safety and time benefits, in turn, motivates willingness to use driverless vehicles. Results of this study concur with findings of past studies that shed light on how various benefits motivate willingness to use driverless vehicles (Nielsen and Haustein, 2018; Hohenberger et al., 2017). This study contributes by shedding light on the extent to which values oriented towards the future like persistence, thrift and ethics (Hofstede, 1980; 1991; Bearden et al., 2006) enable consumers to appreciate the long-term economic, safety and time benefits of driverless cars.

This study has found that anxiety enhances the motivating effect of perceived economic benefits on willingness to use driverless cars, which runs counter to the hypothesized moderating effect of anxiety. In other words, an appreciation of the economic benefits is particularly crucial for consumers with a high level of anxiety to be motivated to use driverless vehicles especially when confronted with various setbacks in the short-term. Such findings lend support to Liu's et al. (2019) notion of benefit-risk tradeoffs in the context of driverless cars. In Liu's et al. (2019) study, perceived environmental benefits increases respondents' acceptable risk level and thus enhances willingness to use driverless vehicles. In this study, the interplay between economic benefits and anxiety results in enhanced willingness to use driverless cars among young consumers indicating that economic benefits compensate for anxiety. In other words, anxious consumers find the uncertainties, technical glitches and other shortcomings pertaining to driverless cars in the short-run more tolerable and become more willing to use driverless cars when consumers are conscious of the economic benefits in the long run; an understanding of the long-term economic benefits can overcome anxiety.

While acceptance of driverless vehicles receives ample attention in extant literature, prior studies are primarily conducted in closed settings such as university as that will be the place driverless vehicles are rolled out before releasing to public routes, where consumers have limited experience and thus understanding about driverless vehicles to begin with (Kaur and Rampersad, 2018; Nordhoff et al., 2018; Panagiotopoulos and Dimitrakopoulos, 2018; Salonen, 2018; Xu et al., 2018; Zmud et al., 2016), let alone appreciate the economic, safety and time benefits that require time to materialize. Results of this study suggest the importance of knowing driverless vehicles well enough to the extent of being able to appreciate the associated economic, safety and time benefits. Such benefits of driverless vehicles are future rewards. Decades are required for the commercialization of driverless vehicles to materialize in order to resolve the problem of ever-increasing number of vehicles on the road together with the corresponding accidents and fatalities attributable to human errors as well as optimal use of infrastructure and energy consumption in an effort to combat climate change. As such, the economic, safety and time benefits of driverless vehicles are not readily discernible in the short run.

Before consumers are in a position to enjoy such future rewards, consumers need to accept driverless vehicles' slow speed and occasional mishaps until machine-learning and artificial intelligence-based techniques are mature enough for driverless vehicles to function completely independently and safely. Consumers also need to get used to risks of hardware and software failures, car theft, car hacking, and other new safety issues of concern attributable to driverless vehicles. Values associated with a long-term orientation like persistence, thrift and ethics on the part of consumers are pertinent in the face of discomfort and inconveniences until comprehensive solutions are in place to address such immediate issues of concern. Consumers need to resist the temptation to revert back to the comfort of conventional, manually driven vehicles when confronted with short-term problems associated with driverless vehicles.

Practical Implications for Asian Business

Driverless vehicles' short-term problems like hardware and software failures, and having to embrace the culture of ride-sharing are not unique and will eventually become a commonplace in line with the growth in mobile Internet technology, Global Positioning System (GPS) and cloud computing, which drive the sharing economy (Wang et al., 2019). While young consumers are deemed digital natives and thus receptive of innovations like intelligent transportation particularly in emerging Asian countries (Dewalska-Opitek, 2017), these young consumers are not spared the anxiety over driverless vehicles' various immediate issues of concern. This study offers insights into the importance of cultivating a long-term orientation in order to appreciate the benefits of driverless vehicles in the long run.

This study sheds light on the importance of keeping young consumers informed of ongoing efforts aimed at resolving driverless vehicles' various immediate issues of concern. Rather than sensationalizing accidents and tragedies that involve driverless vehicles (Anania et al., 2018; Shariff et al., 2017), the media can play a more constructive role by focusing on the technological solutions and ongoing refinements that enable driverless vehicles to function completely independently and safely. For example, current automobile technologies like lane-departure warnings, pedestrian detection, parking assist and adaptive cruise control are already yielding significant safety benefits. While driverless vehicles are not necessarily superior to an alert human driver under most circumstances, growing technological sophistications in driverless vehicles like advanced sensor suite capable of calculating and recalculating in response to changing circumstances on the road in frictions of a second are bound to have significant positive impact (Thierer and Hagemann, 2015).

The media can keep consumers informed about the extent to which developments in technological sophistications and capabilities in driverless vehicles can reduce human errors, accidents and fatalities on the road, traffic congestion, travel times, as well as the resultant rippling effects on many economic sectors like insurance, healthcare, highway concession and public transport. Like the introduction of most innovations in the past, short-term discomfort, inconvenience and even disruptions associated with the use of driverless vehicles are unavoidable (Thierer and Hagemann, 2015). However, the business model of the automobile, transportation and insurance industry will evolve over time and so do the infrastructure and legal framework to accommodate for the use of driverless vehicles on a commercial basis. Similarly, displaced public transport drivers and mechanics will be reskilled and redeployed over time. New skills will be required and new career as well as business opportunities will become available in line with the increase in the use of driverless vehicles over time.

For as long as consumers are informed of ongoing developments and initiatives aimed at addressing the various immediate issues of concerns and disruptions pertaining to driverless vehicles, consumers will become certain that such issues of concern are indeed short-lived. The belief that short-term discomfort and inconvenience associated with driverless vehicles will eventually be resolved motivates consumers to focus on the long-term benefits of driverless vehicles instead. In this manner, consumers are in a better position to transition into intelligent transportation and the culture of ride-sharing with confidence in line with the sharing economy.

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