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Delegating Decision-making to Autonomous Products: A Value Model Emphasizing the Role of Well-Being

Brief running title: Perceived value of autonomous products

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Delegating Decision-making to Autonomous Products: A Value Model Emphasizing the Role of Well-Being

Abstract

Given the rapid growth of autonomous technologies it is important to understand how consumers attribute value to them. Such technologies require consumers to give up control to a machine by delegating decision-making power. To better understand value perceptions, and ultimately adoption, this paper proposes a conceptual model that explains the value attributed to autonomous cars as an archetypal consumer autonomous technology. The model is developed from literature around the theme of autonomy and two qualitative studies, which identify consumers' perceived individual benefits (Freeing Time, Overcoming Human Weaknesses, Outperforming Human Capacities), risks (Loss of Competencies, Security and Privacy risk, Performance risk) and their proximal antecedents (Perceived Expertise, Attitude toward the Delegated Task, Previous Engagement in Delegation). The model is tested on a national sample of French drivers using a quantitative methodology and Structural Equation Modelling (SEM). This research contributes to literature on technological forecasting of autonomous technologies by developing and testing a conceptual model, which includes salient predictors of perceived value and highlights the mediating role of improvement in subjective well-being that consumers anticipate from adoption. The model can be used by managers to predict how users are likely to react to their products and communications about them.

Keywords: perceived value, autonomous cars, autonomous products, well-being, consumers

1. Introduction

Technological advances in artificial intelligence and autonomous technologies are rapidly disrupting existing markets and impacting heavily upon consumers' daily lives. With rapid development consumers have more and more opportunities to delegate decision-making to products that will accomplish daily tasks that they used to do themselves. Through such delegation consumers let machines take decisions, and these machines can perform jobs, often more accurately, freeing time and enhancing well-being through increased productivity and lifestyle benefits. However, consumers are being faced with the possibility of having products perform more and more complex tasks for them. The level of autonomy in cars, for example, has been characterized by SAE International (SAE International 2018) from no driving automation (level zero) to full driving automation (level five) and consumers will soon have the opportunity to drive cars with a high level of autonomy. Such autonomous technologies can enhance consumer well-being but may also pose significant risks to consumer safety (Hulse, Xie, and Galea, 2018) and may lead to anxiety due to a loss of control (Greenaway, 2015; Koo et al., 2015), particularly at higher levels of autonomy. These effects have been observed for autonomous cars, which indicates a need to better understand issues around consumer unease for such products (Hohenberger, Spörrle, and Welpe, 2017), particularly in situations which pose a significant risk to consumer safety like driving a car. Feelings of control are also linked to risk and benefit perceptions (Raue et al., 2019). Yet, despite some initial research around public opinion and attitudes towards autonomous products (e.g., Hulse, Xie, and Galea, 2018; Penmetsa et al., 2019), there is little research which explains how consumers perceive and value autonomous products. This is surprising as acceptance of technologies such as autonomous cars, may depend less on technical challenges than on how consumers *perceive* such technologies and other innate characteristics (Coughlin et al., 2019; Hohenberger, Spörrle, and Welpe, 2017). The car industry is expected to go through a period of transformation as autonomous technologies disrupt existing business models. This had led to a burgeoning literature to uncover the drivers and barriers to its future development (Bridgelall and Stubbing, 2021; Gurumurthy and Kockelman, 2020; Merfeld, Wilhelms, Henkel and Kreutzer, 2019; Skeete, 2018).

Literature around innovation adoption (e.g. Davis, 1989; Rogers 2003) is vast and identifies the antecedents to consumer innovation adoption decisions. However, the majority of this literature is based around technologies where consumers exercise a high degree of control over how the product functions. For autonomous products, consumers accept that the system carries out tasks without their full knowledge or they exert only a supervisory role (Richards and Stedmon, 2016). Guidance on how consumers evaluate innovations where they need to delegate decision-making to a machine is sparser and often focuses on ergonomics and the human-machine interface (e.g., Richards and Stedmon 2016) rather than adoption, although some notable examples exist (Baccarella et al., 2020; Hohenberger, Spörrle, and Welpe, 2017). The user's desire for control is seen as an important factor in influencing consumer appreciation of typical domestic autonomous products such as vacuum cleaners and lawn mowers (Rijsdijk and Hultink 2003). Given rapid technological development and growth in the area of autonomous technology (Chen et al., 2017), and the increased likelihood of using such technologies in situations with a high degree of personal risk, there is a need to understand how consumers attribute value to autonomous vehicles and the consequences this has on their evaluations (Baccarella et al., 2020).

This research studies autonomous cars as an archetype of a product class which involves significant risk to humans and involves delegation of decision-making. We chose an autonomous car as it requires the delegation of driving, which is a complex activity integrating decision-making that potentially involves every level of human cognition (Bellet, et. al. 2009). In addition, it is the most intensively publicized autonomous product in industry reports and in the press (e.g., BBC 2019) and attracts huge investment from various industry players - $4.4 billion between 2014 and 2017 according to Bloomberg NEF (Gardner, 2018). Gartner forecasts more than 740,000 new vehicles which enable autonomous driving without human supervision annually in 2023 (Gartner, Press release, Nov. 2019). and this rapid increase in the adoption of such technologies is likely to have significant societal impacts, including increased land demand, for example (Bridgelall and Stubbing, 2021). Specifically, the aim of this research is to develop and test a conceptual model of perceived value in relation to user perceptions of autonomous cars as an archetypal autonomous technology. In doing so we first identify and validate the individual benefits and risks attributed to autonomous cars and then develop and test a conceptual model which shows how these benefits and risks translate into perceived value through the mediating role of the anticipated improvement in well-being. This is consistent in its approach to other important work in the area where perceived benefits are seen as a key driver of adoption (Hohenberger, Spörrle, and Welpe, 2017).

There are at least three reasons for developing such a model: First, the spectrum of tasks that may be delegated to products is getting larger and larger. However, innovation literature has not yet developed a model around delegation of decision-making to machines in high-risk situations like driving. Yet the emergence of such contexts is likely to increase rapidly (Salkever 2018). Second, the emergence of artificial intelligence and the increased number of autonomous products has introduced radical changes to consumer attitudes to this technology and these changes are not well understood. Third, one of the chief reasons for the development of autonomous products is that they can take on tasks currently handled by humans. Thus, understanding the motivational forces that guide the intention to delegate (or not) decision-making to machines is of paramount importance for companies which make substantial investments in developing autonomous innovations. As such, this research makes a contribution to the consumer innovation adoption literature and the results should lead to insight for managers about the levers that can be used to influence consumer perception of risky autonomous products such as cars. While this study is aligned to the work of Hohenberger, Spörrle, and Welpe (2017), it also builds on it further through the identification of the inherent perceived benefits and risks of delegating to a machine, and shows how these influence perceived improvement in well-being as a mediator to perceived value. In doing so, this article also complements the recent study conducted by Yuen, Wong, Ma and Fang (2020) which uses a different and more generic adoption framework, namely diffusion of innovations theory (Rogers, 2003). More generally, it provides a complementary perspective to research explaining positive behavioural intentions towards autonomous driving based on technology acceptance models (Baccarella et al. 2020; Nastjuk et al., 2020).

This paper is structured as follows. First, previous research about perceived value and value perception of autonomous products is outlined. This is followed by an exploratory qualitative study of car experts from industry (Study 1a) who provide insights about consumer perceptions of the benefits and risks of autonomous cars. The findings from the car industry experts are validated with a confirmatory qualitative study of car users (Study 1b). The findings from these studies are then integrated with literature from the area of perceived value to provide a conceptual model and hypotheses for testing. The conceptual model is then tested using a nationally representative sample of French consumers (Study 2). Implications for theory and practice are then discussed in relation to autonomous cars specifically and autonomous technologies more generally.

2. Related Research

Autonomous products have been around for some time (e.g., robotic lawnmowers and robotic vacuum cleaners) and many products have some degree of automation (e.g., cruise control etc.). Initial research around consumer perceptions of product autonomy suggests that autonomy is an important element in consumer evaluations. For example, Rijsdijk and Hultink

(2003) use Rogers' (2003) Innovation Diffusion Theory to show that consumers perceive autonomous products as more risky and complex than non-autonomous products and that these perceptions influence their appreciation of them. As it is often the case with new technologies they also find that consumers weigh up their advantages (e.g., benefits) against their disadvantages (e.g., risks) when evaluating autonomous products. Product autonomy is a dimension of product smartness and has been shown to be associated with higher perceived risk and also higher levels of relative advantage and observability (Rijsdijk and Hultink 2009). Specifically, higher levels of product autonomy are perceived positively by consumers, unlike multifunctionality, which is perceived as a disadvantage. Ray, Mondada, and Siegwart (2008) explore consumer perceptions of domestic use robots. Among the findings they ascertain that consumer attitudes are generally positive towards robots and typically focus on the utilitarian aspects of a robot's ability to help us in our day-to-day lives. Typical benefits from respondents include time saving, simplification and improved livelihoods and well-being. More recently there has been an increasing amount of research on delegating decision-making to autonomous products given the need to better understand how humans interact with machines that make decisions for them. In a review of prior empirical research around automation, Hoff and Bashir (2015) highlight the important role of trust in the technology, identifying dispositional, situational and learned trust as different dimensions, which impact the level and nature of the interaction. Schaefer et al. (2016) quantitatively analyze how human factors, environmental factors and automation related factors influence trust in the automated technology and find a moderate global effect of these factors on trust. Kruusimagi, Sharples and Robinson (2017) explore user experiences with autonomous spatiotemporal home heating systems. Their research highlights the importance of context in understanding such autonomous heating systems and also emphasizes the important role of privacy in user evaluations of an autonomous system. However, outside of the ergonomics and human machine interaction domains of research there is little other research around the area of consumer evaluation and adoption of autonomous products.

While the literature on autonomous products is broad and encompasses a range of different categories (e.g., robots, cars, household products, air travel etc.), the dominant technology in the area is the autonomous car and research around human interactions with autonomous cars has received a good deal of attention recently. For example, Raue et al. (2019) explore how feelings about traditional driving impact consumers' acceptance of this technology and find that positive feelings of enjoyment leads to higher benefit perception while negative affect induces higher risk and higher benefit perception. Hohenberger, Spörrle, and Welpe (2017) identify three major perceived benefits linked to autonomous cars, including economic benefits (e.g., diminished maintenance cost), safety benefits (e.g., reduced number of traffic deaths) and time benefits (e.g., reaching the destination faster) and show how the relationship between anxiety and adoption is moderated by an individual's self-enhancement. In a study of public opinion, Hulse, Xie, and Galea (2018) reveal that autonomous cars are perceived as "somewhat low risk" for pedestrians but higher risk for passengers; thus, perceptions depend to a large extent on the perspective of the "user". Consumers were also concerned about software hacking/misuse of data, legal issues and safety. This is consistent with Penmetsa et al. (2019) who examine vulnerable road user opinion and conclude that user acceptance of autonomous vehicles will enhance as users begin to experience greater interaction with those vehicles. Recently, Steck et al. (2018) provide empirical evidence that autonomous driving may lead to a reduction in the "value of travel time savings" which represents the willingness to pay to reduce travel time. Thus, consumers seem to see the value in autonomous cars when it comes to time saving. While useful to assist our initial understanding of public perception of autonomous cars, and the various factors that are important to different user groups, research has so far been largely descriptive in nature and primarily about public opinion. Research which has developed theoretical models of user interactions with autonomous products has on the other hand been about low risk autonomous products such as vacuum cleaners and small robots.

Our research takes a value-based perspective to better understand how consumers attribute value to autonomous products, similar to other research around adoption of autonomous products (e.g., Daziano, Sarrias, and Leard, 2017; Hohenberger, Spörrle, and Welpe, 2017). We adopt this approach, rather than other approaches like the Technology Acceptance Model (TAM, Davis 1989) for three reasons but believe our approach complements the TAM conceptualization (Baccarella et al., 2020). First, the TAM assumes the consumer is in a position to evaluate concepts such as ease of use. With products such as autonomous cars most consumers are not yet in a position to make such an evaluation. However, it is reasonable to expect them to be able to develop a perception around the likely benefits and risks of such products as the concept is no longer new to them. The second reason is more directly related to the specific nature of autonomous products. We define autonomy as "the extent to which a product is able to operate in an independent and goal-directed way without interference of the user" (Rijsdijk and Hultink, 2009, p26). The autonomy of products means that consumers delegate decision-making to them in a goal-directed way. Delegation theories (e.g., Castelfranchi and Falcone, 1998) derive from a common idea; that is, it is efficient to delegate if the benefits of delegation exceed its costs. This is analogous to the notion of perceived value (Zeithaml, 1988). Among the wide range of literature which defines perceived consumer value (for a list of definitions see Kim et al., 2015), one major stream emphasizes that customer value results from a trade-off between benefits and sacrifices for acquiring a product or service. In this respect, the perceived value framework fits well with situations where a consumer has to decide whether to delegate decision-making tasks or not. Third, looking at innovation adoption through the lens of perceived value can be seen as complementary to models such as the TAM

(Davis, 1989), where ease of use represents the effort required to perform a particular behavior (e.g., costs) and usefulness represents the utility of the decision (e.g., benefits).

Perceived value refers to the “customer's overall assessment of the utility of a product based on perceptions of what is received and what is given” (Zeithaml, 1988 p.14). Day (1990) proposes that perceived customer value represents the difference between “customer’s perceived benefits” and “customer’s perceived costs”. Customer benefits involve tangible and intangible attributes of the product (e.g. Monroe, 1990). The sacrifice components of perceived value, include monetary and nonmonetary factors (e.g. Zeithaml, 1988). Bauer (1960) defines perceived risk as the consumer’s feeling of uncertainty about the consequences of transactions. Kogan and Wallach (1964) define its two components as a cost dimension and a probability dimension. Perceived risk is considered a multidimensional construct, the dimensions being likely to vary according to product categories (e.g. Jacoby and Kaplan, 1972). Therefore, we begin by conducting two studies to identify the salient benefits and risks that are attributed to autonomous cars.

3. Study 1a: Identifying the Benefits and Risks of Autonomous Driving

A first qualitative exploratory focus group study was conducted with experts from the car industry to inform our understanding of the benefits and risks that consumers perceive around delegation to autonomous cars. Autonomous cars are a radically new technology, which are likely to involve significant behavior change (O’Connor, 1998). Such technologies have the ability to transform existing markets or create new ones. In light of this, it was felt that these experts, who were all involved in innovation roles, would be appropriate participants to explain the nature of the benefits and risks involved in autonomous cars and also to project consumer reactions given their involvement in consumer research about these technologies. Indeed, it is typical within innovation processes that managers integrate information obtained from consumers in the early stages of the product development process. This practice is consistent with other studies in the innovation area which use managers as raters based on their collective wisdom about customers (e.g., Dziallas, 2020; Lee and O'Connor, 2001; Merfeld, Wilhelms, Henkel and Kreutzer, 2019). Earlier research has also shown that consumer and manager forecasts around purchase likelihood for a new product are relatively consistent (Faulkner and Corkindale, 2009).

Krueger and Casey (2000) endorses the use of mini focus groups when participants have specialized knowledge and/or experiences to discuss in the group. Purposive sampling was initially used to select participants with predetermined criteria. Specifically, participants had to be practicing innovation experts, actively involved in mobility and autonomous car-related projects. The four experts came from different car industry organizations and included an innovation strategy manager from a global car manufacturer, a mobility program manager in a private-public research institute on mobility, an innovation lab director from a global car supplier and a director of an automobile department from a major market research firm.

Two focus group sessions were conducted, the first one with a duration of one hour fifty minutes and the second one with a duration of one hour and ten minutes. The first focus group session gathered insights about the benefits and risks of autonomous cars. Then, a working session between the authors was used to analyze the data from the first focus group using thematic analysis. Data gathered during the first session was coded to generate categories of perceived benefits and risks linked to autonomous cars. A definition for each category was then established. The second focus group session, with the same executives, enabled validation of the categories. Potential relationships among these categories were also discussed. The focus group was moderated by one of the authors who had extensive professional experience of moderating focus groups. Participants did not want the meeting recorded so the moderator ensured that the discussions were highly structured as a way to improve data quality (Richards and Morse, 2013). Questions were presented to participants in a structured way based around the objectives of each session and the assistant moderators took notes and helped to verify the interpretation of the data (Krueger and Casey, 2000). Analysis in the initial focus group was conducted based around the notes taken, the debriefing session and any summary comments from the moderator or assistant moderators (Onwuegbuzie et al., 2009), which were then subsequently validated in the second focus group.

Based on the analysis conducted, the findings of the focus groups revealed three key consumer benefits (categorized as Outperforming Human Capacities, Overcoming Human Weaknesses, Freeing Time) and four key consumer risks (categorized as Performance Risk, Physical Risk, Security and Privacy Risk, Risk of Loss of Competencies). We also identified that autonomous cars may improve consumer wellbeing as a consequence of these benefits and risks. The focus groups further helped to identify the antecedents of these benefits and risks. These are outlined and summarized in Table 1 and Table 2.

Table 1. Benefits and Risks Attributed to Autonomous Cars (Study 1a & Study 1b)

	Themes	Definition of the construct	Illustrative examples from Study 1a	Illustrative examples from Study 1b	# excerpts/ % of Σ excerpts
Perceived Benefits	Freeing Time	The capacity attributed to autonomous products to free time for other activities	Time reallocation to other activities; Better use of the time; Driving time as a constrained time; Take some rest	Time in the car efficient use to work or quality time with the family; time saving; being multitasking capable	45/6.7%
	Outperforming Human Capacities	The capacity attributed to the autonomous product to optimize consumer performance due to the delegation of tasks	Optimizing fuel consumption; Optimizing traveling time; Reducing pollution emissions; Less accidents	Fewer traffic jams; Easier parking; Environmentally friendly driving; Reduction of accident rate on roads	39/5.8%
	Overcoming Human Weaknesses	The capacity attributed to autonomous products to overcome various self-perceived consumers' physical, psychological or ethical deficit	Inattention, Somnolence; Insufficient driving skills; Imprudence, temptation of driving too fast or overtaking at a bad moment; Incivility (running red lights)	Independence in disability and age, Faster reaction in dangerous moments, Fewer accidents due to human error; Support with responsible driving	115/17.1%
Perceived Risks	Loss of Competencies	The risk that by using an autonomous product, consumers will lose useful skills and competencies	Drivers progressively lose their competencies and ability to concentrate; Dependence on technology; Inability to react in complex dangerous situation	One forgets the classic driving; Incapacitation of the driver; Dependent on the car	25/3.7%
	Performance Risk	The risk the autonomous product will not perform correctly and the driver won't have the control to correct malfunctions (adapted from Jacoby and Kaplan, 1972)	The use of sophisticated and sensitive sensors and electronic systems which can potentially fail; Driver may fear of not being able to intervene	Technical failure; Uncertainty, technical errors, malfunctions, failure electronics; To be at the mercy of technology	149/22.2%
	Physical Risk	The risk that the failure of autonomous products can be a threat to human health and safety (adapted from Jacoby and Kaplan, 1972)	Potentially life-threatening accident if the system fails; If the system is complicated to understand and to communicate with, higher risk of accident	Risk of accident; Maybe safety is not as high as told; Accidents due to the autopilot and the driver's lack of involvement	43/6.4%
	Security and Privacy Risk	The risk that autonomous products may be manipulated by a distrusted third-party or that generated private data can be misused (adapted from Miyazaki and Fernandez, 2001)	Threat of hacking - can be infected by a computer virus; Carmakers can monitor users very closely; Threat of the unauthorized use of information about the driver and car's route; Generation of data about the passenger's' life	Hacker attacks on the system; Security against viruses; Driver monitoring, Privacy issues	17/2.5%
Anticipated Improvement in Well-Being		The perceived ability of autonomous products to enhance positive emotions and life satisfaction (adapted from Diener et al., 1999)	Drivers and passengers feel more secure and less stressed; Less negative interaction with other drivers; More peacefulness; More fun/enjoyment; Fewer repetitive and burdensome tasks.	More relaxed driving thanks to the support of the systems; Pleasant driving; More driving comfort	96/14.3%
Attitude toward Delegation		Position assumed of users to the task that they are invited to delegate to an autonomous product	Loss of driving pleasure, less stimulation, monotony	Lack of driving pleasure; Loss of driving fun	33/4.7%
Other comments			Radical Innovation, Technological progress.	Brings progress in mobility, Innovation	112/16.7%

Within the identified benefits, Outperforming Human Capacities refers to the ability of autonomous products to exceed human capabilities. For example, it was felt that autonomous cars were able to make more accurate calculations to improve vehicle performance. This included, but was not limited to, optimized fuel consumption, travel times and distances, better navigation of traffic conditions and improved parking ability. Overcoming Human Weaknesses refers to autonomous products being able to avoid some of the judgment errors that humans might be prone to. For example, human reactions are more subjective and might vary based on a range of factors. Autonomous cars make objective decisions based on the data available to them. Human reactions on the other hand were felt to be less reliable and consistent. As such it was felt that negative emotions such as anger are likely to be a weakness of human drivers, which affect their response. Similarly, humans may be prone to judgment errors and violation of rules to speed up their journey. Likewise, humans may feel fatigue, which affects their driving ability. Other physiological issues were raised too including the ageing process. Autonomous cars on the other hand are not subject to such emotions or physiological differences. By delegating tasks to autonomous cars consumers free themselves of the physiological weaknesses they may be prone to. Freeing Time refers to the ability of autonomous products to allow consumers extra time for other activities. Through delegating tasks to a machine, consumers can dedicate their time to achieving other tasks, entertaining themselves or simply having a rest. Overall, perceived individual benefits of autonomous cars are strongly related to opportunities for consumers to relieve themselves of various constraints.

For the identified perceived risks, Performance Risk refers to fears arising from the malfunctioning of the technology. These fears seemed to be exacerbated by the complexity of autonomous systems and the system's reliance on complex high-tech sensor systems, which have to respond in real-time to hazards. Participants felt that the machine takes over functions, dulls their senses and leaves them at the mercy of the product. Physical Risk has been shown to be closely associated to Performance Risk (Jacoby and Kaplan, 1972). This may be especially true in the context of autonomous cars where breakdowns can lead to road traffic accidents. In the context of autonomous cars, it refers to the potential injuries that result from the malfunctioning of the machine. Security and Privacy Risk was also at the forefront of participant's minds. This included fears that such robotic systems could be hacked and taken over by unscrupulous individuals or that information could be mishandled or obtained without permission. Risk of Loss of Competencies refers to the user losing valuable skills and the ability to control a car as well. For example, if a user no longer had to park a car then they would lose the skills needed to park cars in the future. Therefore, users feared the loss of useful skills developed over the course of their lifetime. Beyond loss of useful skills users also feared they may lose the capacity to concentrate as fully if given the spare time. This was felt to lead to a strong dependence on the product itself.

The focus groups also explored antecedents and consequences of these perceived benefits and risks. One such identified consequence was the impact upon consumer Anticipated Improvement in Well-Being. It was strongly felt by participants that such autonomous products had the ability to enhance consumers' well-being. In particular, due to the ability of such systems to take on repetitive and burdensome tasks this may generate a feeling of relief, pleasure and happiness. Three further antecedents to the benefits and risks were also identified from the focus groups. Specifically, according to the experts, consumers with a high level of Perceived Expertise in the Delegated Task may perceive less value to Overcoming Human Weaknesses and Outperforming Human Capacities. Participants also indicated that consumers with Perceived Expertise may associate a higher level of risk related to Loss of Competencies. Second, the results suggested that consumers' Attitudes towards the Delegated Task may affect the value they associate with delegating this task. For example, consumers who like driving may be reluctant to delegate as they anticipate more monotony, less fun and lack of stimulation.

Therefore, they may appreciate less the time freed up due to delegation. Third, the results suggested that Previous Engagement in Delegation, even partially, seemed to impact perceptions of benefits and risks. For example, consumers who previously used adaptive cruise control systems - which automatically adjust the speed of the vehicle to maintain a safe distance from vehicles ahead - associate higher benefits and lower risk levels to autonomous cars.

Table 2. Antecedents to the Benefits and Risks

Identified Themes	Definition of the Construct	Examples from Study 1a
Perceived Expertise in the Delegated Task	Refers to the knowledge users in the task that they are invited to delegate to an autonomous product	Bad drivers will be more willing to use autonomous car; Self-confident drivers won't like autonomous cars
Attitude Toward the Delegated Task	Refers position assumed of users to the task that they are invited to delegate to an autonomous product	People who hate driving will more emphasize the benefits; People who really enjoy driving will be more reluctant to delegate
Previous Engagement in Delegation	Refers to users familiarity with delegating a task to an autonomous product acquired over actual practice	Those who use cruise control will more easily accept autonomous cars, drivers who had bad experience with cruise control won't accept autonomous cars

4. Study 1b: Validating the Benefits and Risks of Autonomous Driving

To further validate the findings obtained from the focus groups, a subsequent qualitative confirmatory study on consumers was conducted. This was done using a direct questioning approach among consumers who were about to take part in a trial of a car with autonomous driving functions on and around a university campus. Given these participants registered voluntarily to the trial, they demonstrated a specific interest in and understanding of this technology and could be taken to represent "innovators" who might reflect the characteristics of initial adopters. This study, therefore, aimed to complement and provide a degree of multi-method convergence for the findings from Study 1a, by taking a more direct consumer perspective. Specifically, the purpose of the study was to verify whether the categories found in Study 1a corresponded with consumer perceptions.

Participants were invited to a trial through an advertisement in the press. Prior to the trial, consumers were asked to answer two open ended questions, including: "What benefits do you associate with autonomous cars" and "What risks do you associate with autonomous cars?" A large number of respondents answered the questions and they represented a wide demographic cohort. Respondents' (n=204) average age was 41 (min. 19; max. 81) and 25% of the sample were female. Respondents' answers were taken verbatim from the survey and led to 695 distinct responses, including 354 positive associations and 341 negative associations. Associations where the meaning was not intelligible were discarded.

Elaborative coding was used to analyze the data. Elaborative coding "is the process of analyzing textual data in order to develop theory further" (Auerbach and Silverstein, 2003, p. 104). It is a "top down" process as it involves cross-referencing and coding the new results against those results from the prior qualitative study. As such it starts with some theory in mind and uses the subsequent study to corroborate this. A list of codes was defined beforehand from the benefits and risks established in Study 1a. Answers provided by respondents from Study 1b were then assigned to one of these categories by one of the co-authors. Only answers which could be assigned to the categories with no ambiguity were coded at this stage. Then another co-author independently validated the categorizations made. Any remaining answers which were not initially assigned during the first round were assigned based on discussion between the two co-authors using a process known as "member checking" (Saldaña, 2009 p 28). Answers which were not associated with risks (e.g., neutral expressions, simple description of autonomous cars) were coded as "Other comments". Overall, the results from Study 1b were highly consistent with those of the first qualitative study providing convergence about the perceived benefits and risks identified.

5. Conceptual Model

The findings of Study 1a and 1b as well as a complementary literature review served as the basis on which to establish the conceptual model and subsequent hypotheses for further empirical testing. From Studies 1a and 1b, three major benefits were linked to autonomous cars, including: Freeing time, Outperforming Human Capacities and Overcoming Human Weaknesses. These benefits have some overlap with existing academic literature on other autonomous technologies. Public opinion surveys have shown, for example, that users expect to delegate burdensome tasks to autonomous products, which relieve the user and allow them to overcome several constraints. For example, research on public expectations of robotic technology by Ray, Mondada, and Siegwart (2008) shows that customers anticipate help for people with disabilities and the elderly, time saving, simplification of tasks and improved quality of life, all of which provide relief to humans for day-to-day tasks. Studies 1a and 1b also identified four main perceived risks, including: Loss of Competencies, Security and Privacy Risk, Performance Risk, and Physical Risk. However, consistent with the literature, Physical Risk is a consequence of a performance failure, meaning that these two dimensions cannot easily be separated empirically. In fact, the lack of trust in technology leads users to anticipate negative physical consequences. The identified risks are partially echoed in academic literature on robots. Ray, Mondada, and Siegwart (2008) show that negative aspects were less frequently mentioned by users participating in their survey, but included job loss, danger, lack of trust, and inhumanity. Among the fears expressed by the public are dependence, loss of autonomy and laziness. Studies 1a and 1b identified the impact of autonomous cars on consumer Anticipated Improvement in Well-Being. The impact of Anticipated Improvement in Well-Being on consumer evaluation of autonomous products is consistent with previous literature. An emerging literature outlines the role of consumer well-being on the adoption of technological innovations (e.g., Partala and Saari, 2015), yet no research has formalized and empirically tested this mechanism. Subjective well-being is a broad construct that encompasses a consumer's emotional responses, domain satisfaction, and global judgements about life satisfaction (Diener et al., 1999) and comprises affective and cognitive components (e.g. Busseri and Sadava, 2011). Affective well-being refers to the frequency and intensity of positive and negative emotions and mood; cognitive well-being refers to domain-specific and global evaluations of life such as marital satisfaction or global life satisfaction (Luhmanna et al., 2012). Bagozzi and Lee (1999) propose that consumer decision processes about innovations can be considered as an instance of purposive behavior, where a consumer makes decisions about goals related to his or her subjective well-being. Research by Lehning (2012) finds that innovations in transportation and housing can improve seniors' health and well-being. Partala and Saari (2015) state that experienced well-being becomes especially important for technologies that are used frequently, as would be the case for autonomous cars.

Including well-being within technology adoption studies is a typical consideration within the development literature about poverty reduction (e.g., Mendola, 2007). However, it has been less widely used to explain technology adoption in the mainstream adoption literature (e.g., Davis, 1989; Rogers, 2003). Perhaps this is because it may be subsumed under the broader heading of "relative advantage" or "perceived usefulness". Yet, it seems the impact of technology adoption on user well-being is attracting increased research attention given the increased pervasiveness of technology in our daily lives and its associated negative effects (e.g., stress, anxiety etc.) Such technology paradoxes are not new (e.g., Mick and Fournier, 1998), yet they appear to be manifesting in different ways as the characteristics and nature of technology change. For example, Peters, Calvo, and Ryan (2018) develop the "METUX" model (Motivation, Engagement and Thriving in User-Experience), which outlines the steps by which user engagement with technology affects user well-being. Based on this, we propose that a key reason why autonomous products are adopted by more and more consumers is their motivation to improve their subjective well-being. In societies in which individuals are increasingly called upon to perform several tasks at the same time, consumers are particularly interested in technologies which allow them to enhance their well-being. Therefore, autonomous products which perform undesired tasks instead of users, are expected to have a positive impact on well-being for users. On the other hand, such technologies have also been shown to negatively impact well-being through their increased interconnectedness, privacy concerns and safety risks. Based on this the following hypotheses are proposed.

> **H_1:** Perceived benefits, including Freeing Time **(H_{1a})**, Overcoming Human Weaknesses **(H_{1b})** and Outperforming Human Capacities **(H_{1c})**, positively influence perceived value through the mediation of Anticipated Improvement in Well-Being.
>
> **H_2:** Perceived Risks, including Loss of Competencies **(H_{2a})**, Performance Risk **(H_{2b})** and Security and Privacy Risk **(H_{2c})**, negatively influence perceived value through the mediation of Anticipated Improvement in Well-Being.

Study 1a allowed identifying the potential impact of Perceived Expertise in the Delegated Task on some of the perceived benefits (Overcoming Human Weaknesses and Outperforming Human Capacities) and risks (Risk of Loss of Competencies). These links are supported by the "theory of delegation for agent based systems, robotics and autonomous systems" established by Castelfranchi and Falcone (1998, p.145). This theory proposes that "it is rational to delegate the task to the contractor if the value of the goal (achievable by that task delegated) for the client is greater than the cost of delegation for the client itself". It also suggests that the benefit/risk ratio related to delegating a task depends both on the user's ability to perform the task and on his/her attitude to the task, both of which influence their evaluation of the cost either to perform the task by himself or to delegate it. Perceived or subjective expertise refers to the users' beliefs about their ability to achieve a task successfully (Alba and Hutchinson, 1987, p. 411). Subjective expertise is expected to be negatively associated with value perception because experts perform tasks more quickly, with less cognitive effort and more automaticity (Alba and Hutchinson, 1987). As such, some direct benefits from delegation sound less relevant or valuable for experts and some perceived risks may be overestimated.

> **H_3:** Perceived Expertise in the Delegated Task is negatively associated with Overcoming Human Weaknesses (**H_{3a}**) and Outperforming Human Capacities (**H_{3b}**), and positively associated with the perceived risk of Loss of Competencies (**H_{3c}**)

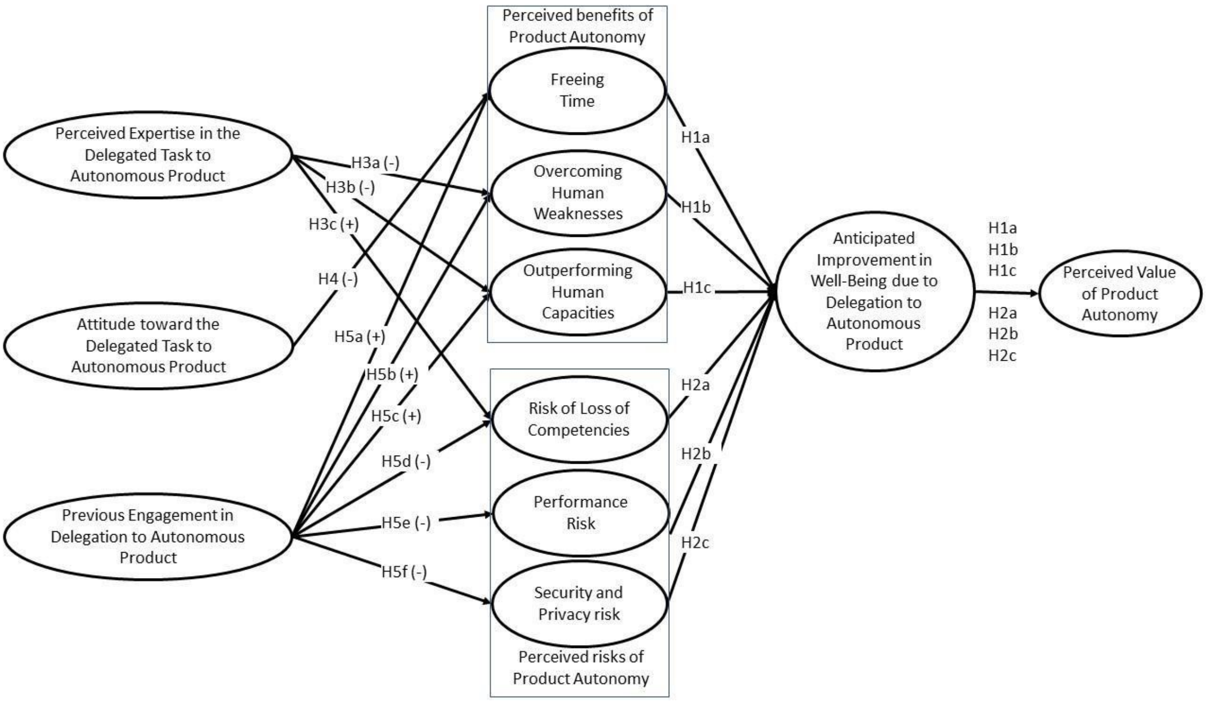
Results of Study 1a and 1b also suggest that consumers' Attitude toward the Delegated Task can impact the perceived value consumers associate with the delegation of this task to an autonomous car. This link has theoretical support in research about passionate drivers (Philippe et al., 2009). Individuals who are passionate about driving value this activity highly and invest time and energy in it even if they do not have a specific place to go. The hedonic value that some drivers associate with this activity may help to explain this phenomenon. As such it might be expected that individuals who like performing a task, associate hedonic value with this activity, and they lose this value when they delegate this activity to an autonomous product. Therefore, automation may in fact be a negative for people who take pleasure in the act of driving. Such hedonic motivations are an important aspect of consumer behavior because consumers also have motivations driven by fun, arousal, enjoyment and sensory stimulation.

> **H_4:** Attitude Toward the Delegated Task is negatively associated with the benefits of Freeing Time.

Study 1a also identifies that Previous Engagement in Delegation can impact perceived benefits and risks of delegation. This proposal finds a theoretical basis in commitment theory developed in the field of social psychology (Kiesler and Sakumura, 1966). According to Kiesler (1971 p.81) commitment is "what binds the individual to his or her behavioural acts". Commitment theory suggests that individuals are not committed through their feelings and ideas but rather through their actions or behaviors. According to Beauvois and Joule (1981) the more a person acts within a particular situation the more they commit themselves to it. Thus, people may rationalize their behavior by endorsing ideas adapted to justify them even if this is retrospective. Based on these elements, we propose that consumers who have already experienced delegation to autonomous technologies, to some degree, will associate higher benefits and lower risk levels to delegating to autonomous vehicles:

> **H_5:** Previous Engagement in Delegation is positively associated with the perceived benefits of delegating the task, including, Freeing Time **(H_{5a})**, Overcoming Human Weaknesses **(H_{5b})** and Outperforming Human Capacities **(H_{5c})**, and negatively associated with the perceived risks of delegating the task to autonomous products, including Perceived Risk of Loss of Competencies **(H_{5d})**, Performance Risk **(H_{5e})** and Security and Privacy Risk **(H_{5f})**

Figure 1. Conceptual model



6. Study 2: Testing the Conceptual Model

6.1. Research design

To test the hypotheses a quantitative online questionnaire was developed and administered to a national sample of French car drivers who were also car owners (n=403). Data was collected with a quota sampling method by a market research organization specialized in the automotive industry and represented the target population in terms of gender and age characteristics, with a broad range of occupations represented and respondents from every key region in France. From the original sample, 28 questionnaires (7.7%) were removed due to incorrect answers to an attention check question and completion of the questionnaire too quickly (less than 10 minutes, which was 2 standard deviations under the average time taken to complete – 19 minutes). Respondents were asked to watch a real news clip from a TV documentary about autonomous technology integrated into a car. The film was carefully selected to comply with two requirements, including realism (both of the car and the use context) and the focus on the autonomous technology. The clip focused on the presentation of the self-driving technology within an existing car model that was not too futuristic, and which respondents could relate to. It was also set in a familiar context. The self-driving technology was installed on a recent but well-known vehicle and the demo was performed on a motorway, which represents a very familiar context for most of the drivers. These factors ensured respondents were able to project themselves into the situation as it was something they could relate to easily. In the chosen clip, the aesthetic of the car and the other technological options were not emphasized; the focus was on the autonomous nature of the drive. This ensured respondents were focused on the attribute of autonomous driving rather than other characteristics of the car. Conversation inside the car was also about the autonomous nature of the car. After exposure to the film clip respondents were then presented with the questions from the questionnaire. To reduce the potential for halo effects and Common Method Variance (CMV), some of the procedural controls by Podsakoff, MacKenzie, Lee and Podsakoff (2003) were used, including an introductory statement that emphasized there were no right or wrong answers and which assured respondents of anonymity and confidentiality. The order of items was also randomized, and varied scale formats were used. A marker variable was also used, which was theoretically unrelated to the other constructs in the questionnaire. The marker variable chosen was the “worry” dimension from Rose and Orr’s (2007) symbolic money meanings.

6.2. Scale development

Perceived benefits and risks. We did not find existing measures in the still limited academic literature on autonomous cars for perceived benefits and risks. Consequently, content validity was key when defining measures for the benefits and risks and item wording was based around the expert interviews in Study 1a. Once an initial scale was defined, five items in total were removed after a classical purification process through exploratory and confirmatory analyses. Performance Risk was captured by measuring the two dimensions of uncertainty and perceived severity of negative consequences (Oglethorpe and Monroe, 1987). These dimensions are conceptually and statistically distinct as they share less variance together than with their own indicators but remain highly correlated (r=.75) leading us to model Performance Risk as a second-order latent factor.

Anticipated Improvement in Well-Being. The definition of subjective well-being (SWB) by Diener et al. (1999) encompasses emotional responses, domain satisfaction and life satisfaction. Thus, well-being is either measured using emotions inventories such as the Positive and Negative Affect Schedule (PANAS) scales (Watson, Clark, and Tellegen 1988), or using the Satisfaction with Life Scale (SWLS; Diener et al., 1985). In alternative approaches, SWB is captured through multidimensional measures. For example, SWB manifests itself through perceptions of self-esteem, emotional, professional equilibrium or temperance, social involvement, sociability, self-control / control on events and happiness / life satisfaction (Massé et al., 1998). However, we do not aim to measure subjective well-being *per se*, but the anticipation that delegation of tasks to an autonomous product will increase well-being. Even if the scale we created reflects these different ideas, they are formulated to capture this anticipated improvement. This is probably the reason why they appeared as closely associated in users' minds (α=.95)

Perceived Value. To measure perceived value, self-driving technology was presented as an option on the vehicle that users can decide to add or not to add. However, we did not provide any price information. We captured perceived value with an adapted version of the scale of Cronin, Brady, and Hult (2000) to which we included an item that measures the intention to add the self-driving option in spite of its probable cost (α=.82). In order to verify the predictive validity of perceived value, a measure of willingness to pay was included in the questionnaire [How much would you be ready to pay to have this technology on your car (between 0 and 10000 euros); M=1969 € SD= 1349 €; 134 drivers out of 343 responded with 0]. A left-censored Tobit regression was performed, because willingness to pay combines in fact two variables, one qualitative (wanting or not this technology) the other quantitative (for those who want the technology, how much they are ready to pay). Perceived value has a significant and positive effect on willingness to pay (t=7.47; p<.001) and explains 15% of variance.

Other variables. Attitude toward the Delegated Task [driving] was measured by five items. Wordings were selected and adapted from different scales measuring attitude to ensure relevance with the driving activity (α=.92). Previous Engagement in Delegation was measured through the declared use of the speed regulator [0: no use of speed regulator, n=182; 1: at least occasional use of the speed regulator, n=161). Perceived Expertise in the Delegated Task was measured via a single item on a bipolar scale [With regard to driving you see yourself as 1. A beginner; 5. An expert, M=3.88; SD=.957]. Based on these scales, the questionnaire was validated by the same car industry experts who participated in Study1a.

7. Data Analysis and Results

7.1. Confirmatory factor analysis

Hypotheses were tested with SEM, using AMOS 24. We first estimated a measurement model with all latent variables correlated in order to verify the goodness of fit of the measurement model as well as convergent and discriminant validity (Anderson and Gerbing, 1988). For variables captured by a single item or for binary variables, we followed the recommendations of Anderson and Gerbing (1988) to fix parameter values. On the whole, the model fits the data well confirming measurement model adequacy (Model fit: Chi²/df=1.57; GFI/AGFI[1]=.87/.852; RMSEA= .04 [.03;.05] P-close=.98; SRMR=.05; TLI=.97). Only very small discrepancies, from .001 to .011 in absolute value were observed between estimated parameters and average estimations based on 5000 samples generated by a bootstrap simulation; this suggests that the multinormality violation is not a serious issue. All the constructs have satisfactory internal (see Table 3) and convergent reliability (see Table 4). For the 11 constructs, average variance extracted is above .5 and all latent factors share less variance with other constructs than with their own indicators, providing evidence of discriminant validity.

As well as taking account of CMV with procedural controls we also followed the recommendations of Richardson, Simmering, and Sturman (2009) and used a marker variable (worry money meaning – Rose and Orr, 2007) to control CMV ex-post. This was done by introducing the latent marker construct into the model. Shared variance between this marker and the other variables is represented by modeling the latent marker construct with paths to each of its own unique manifest indicators as well as with paths to the manifest indicators of all the other constructs believed likely to be contaminated by CMV. Only the indicator measuring the existing propensity to delegate was put aside as it is based on a discrete behavior (that is, use or not of the speed regulator). The variance shared between the marker and the indicators was between .01% and 2.8% suggesting a negligible incidence of CMV within the data. To

[1] GFI and AGFI values are impacted by the introduction of single item variables (Perceived Expertise in the Delegated Task and Previous Engagement in Delegation). When these two variables are withdrawn from the model, the values for these indicators are over .9.

confirm this finding, the model with the latent marker construct was compared with an identical model where all the regression weights of the paths between the marker and the other constructs' indicators were constrained to 0. No significant difference was found ($\Delta\chi^2$ = 62. 67 (34 df), p=.20), providing further evidence of satisfactory model fit.

Table 3. Construct Measures and Descriptive Statistics for Study 2

	Mean	SD	St. β
Ability to Overcome Human Weaknesses[1] (Joreskög rhô =.85)			
– This self-driving technology can overcome some of my weaknesses as driver inattention.	3.86	1.09	.81
– With this self-driving technology I would have a more civic driving behavior	3.54	1.27	.74
– This self-driving technology would help me avoiding acting recklessly on the road as driving too fast	4.05	1.07	.84
– I am less likely to cause an accident by using this self-driving technology than by trusting my driver qualities.	3.24	1.15	.71
Ability to Outperform Human Capacities (Joreskög rhô =.77)			
– By optimizing paths, accelerations and trajectories, this self-driving technology should help to save money	3.91	.99	.88
– By optimizing paths, accelerations and trajectories, this self-driving technology should enable to reduce polluting emissions	3.87	1.04	.88
Ability to Free Time (Joreskög rhô =.92)			
– This technology would free up the time usually spent to driving)	3.08	1.30	.88
– This self-driving technology would allow a better use of my time	3.06	1.27	.88
– With this self-driving technology I will have the possibility to devote my time to other activities (writing messages, surfing the Internet, reading, etc.)	3.07	1.30	.79
– Thanks to this self-driving technology it is possible to take some rest during my car travels.	3.19	1.26	.90
Performance Risk			
Technological uncertainty (Joreskög rhô =.93)			**.97**
– Although this technology undergoes extensive testing before launch, I fear an electronic flaw	4.06	1.06	.93
– Even if this technology undergoes numerous tests before its launch, I will still be afraid that it is not perfectly reliable	4.13	1.07	.93
Anticipated negative consequences (Joreskög rhô =.95)			**.79**
– I have a feeling that an electronic flaw of this technology would seriously endanger the driver and passengers	4.32	.95	.97
– I have a feeling that an electronic flaw in this technology would endanger other pedestrians and two-wheelers	4.31	.95	.92
– A dysfunction of this self-driving technology would have very serious consequences	4.36	.93	.96
Risk of Loss of Competencies (Joreskög rhô =.89)			
– With this technology, I think that I will lose the habit to take the many decisions required when driving	3.85	1.15	.82
– In the long run, I fear to lose my driving skills with thus technology.	3.56	1.26	.86
– If I use this technology I will become dependent on the vehicle	3.46	1.29	.87
– Ultimately, this technology may diminish my vigilance when I have to drive myself.	3.92	1.17	.73

[1] Items measured using Likert scales from Strongly Disagree (1) to Strongly Agree (5), except where noted

Table 3. Construct Measures and Descriptive Statistics for Study 2 (continuing)

	Mean	SD	St. β
Security and Privacy Risk[1] (Joreskög rhô =.88)			
– If I use this technology, I would be afraid that companies (eg the car manufacturer, the insurance company, etc.) misuse the information collected on my trips 1	3.47	1.30	.92
– If I use this technology, I would be afraid to disclose too much private information.	3.20	1.38	.87
– I would be afraid that, hackers take control of my vehicle, even if the carmaker ensure me that the technology is secure	3.71	1.23	.63
Perceived Value (Joreskög rhô =.88)			
– Overall, the value of this self-driving option to me is [1. Very low; 7. Very high]	3.87	1.96	.84
– Compared to what I had to give up (in time, money, effort), the overall ability of this self-driving option to satisfy my wants and needs is [1. Very low; 7. Very high]	3.29	1.78	.78
– Considering its probable costs, this self-driving option [1. Does not interest me at all; 9. Interests me a lot]	4.53	2.69	.80
Anticipated Improvement in Well-Being (Joreskög rhô =.93)			
– This self-driving technology is likely to improve my psychological well-being	3.78	1.78	.89
– I would feel more self-confident with this self-driving technology	3.38	1.76	.80
– This self-driving technology could prevent me from stress	4.06	1.94	.90
– This self-driving technology would allow to travel in a more convivial atmosphere	4.55	1.78	.84
– This self-driving technology is likely to improve my life quality	4.02	1.76	.88
– In a car equipped with this self-driving technology, I would feel more serene	3.66	1.80	.89
–			
Attitude toward the Delegated Task (Joreskög rhô =.92)			
Driving is an activity that :			
– I hate (1) → I love (5)	3.45	1.10	.86
– Is mainly a constraint for me (1) → Is funny (5)	3.24	1.15	.88
– I find unpleasant (1) → I find pleasant (5)	3.54	1.19	.88
– Is just something necessary (1) → Is a pleasure (5)	3.22	1.30	.74
– I would avoid if I could (1) → I would not dispense with (5)	3.18	1.29	.84
Perceived Expertise in the Delegated Task With regard to driving you see yourself as: A beginner (1) → An expert (5)	3.88	.953	.95
Previous Engagement in Delegation Use of cruise control (binary variable – 0=No, 1=Yes)	.46	.49	.95

[1] Items measured using Likert scales from Strongly Disagree (1) to Strongly Agree (5), except where noted

Table 4. Construct Correlation Matrix and Average Variance Extracted Values

		1	2	3	4	5	6	7	8	9	10	11
Attitude Toward the Delegated Task	**1**	**.76**	.01$^{\wedge}$	.33***	-.07	-.09	-.14*	.06	.11$^{\wedge}$	.06	-.01$^{\wedge}$	-.10$^{\wedge}$
Previous Engagement in Delegation	**2**	*.00*	**.89**	.13*	.22***	.19**	-.01	-.20***	-.08	.17**	.13*	.21***
Perceived Expertise in the Delegated Task	**3**	*.11*	*.02*	**.89**	-.09	-.03	-.14*	-.02	-.03	-.05	-.05	-.05
Outperforming Human Capacities	**4**	*.00*	*.05*	*.01*	**.78**	.64***	.46***	-.15*	-.10$^{\wedge}$	-.10	.52***	.52***
Overcoming Human Weaknesses	**5**	*.01*	*.04*	*.00*	*.40*	**.60**	.65***	-.30***	-.28***	-.23***	.74***	.62***
Freeing Time	**6**	*.02*	*.00*	*.02*	*.21*	*.42*	**.75**	-.24***	-.33***	-.19**	.67***	.62***
k of Loss of Competencies	**7**	*.00*	*.04*	*.00*	*.02*	*.09*	*.06*	**.65**	.44***	.55***	-.41***	-.44***
Performance Risk	**8**	*.01*	*.01*	*.00*	*.01*	*.08*	*.11*	*.19*	**.82**	.32***	-.46***	-.41***
Security & Privacy Risk	**9**	*.01*	*.03*	*.00*	*.01*	*.05*	*.04*	*.31*	*.10*	**.67**	-33***	-.32***
Anticipated Impro-vement in Well-Being	**10**	*.01*	*.02*	*.00*	*.27*	*.55*	*.45*	*.17*	*.21*	*.11*	**.79**	.73***
Perceived Value	**11**	*.01*	*.04*	*.00*	*.27*	*.38*	*.39*	*.19*	*.17*	*.10*	*.54*	**.65**

NB: Values in bold and on the diagonal are AVEs. Values above diagonal represent the correlations between constructs. Values in italics and below the diagonal are squared correlations. $^{***}p< .001$ $^{**}p< .01$ $^{*}p< .05$ $^{\wedge}p< 0.1$

7.2. *Test of mediation hypotheses*

The significant correlations observed between the different benefit and risk variables (Table 4) create potential estimation biases due to multicollinearity. To assess the likelihood of multicollinearity, Variance Inflation Factors (VIFs) for the independent variables were estimated through an OLS model in IBM SPSS Statistics 25. All VIFs were under 1.9 suggesting the estimated parameters were not affected by multicollinearity. To test the mediation hypotheses, a first model was estimated that included only benefits, risks, well-being improvement and perceived value. This model allowed us to specify the covariances between antecedents. Model fit was satisfactory based on typical diagnostics and standards (χ^2=639.32 df=405 p<.001, CFI=.96, χ^2/df=1.69, SRMR=.05; RMSEA=.045 [.039; .051], p-close=.926). At this stage, the insignificant links were left in the model to conduct the mediation analysis. The model was estimated again on 5000 bootstrap samples following the approach recommended by Preacher and Hayes (2004, 2008). The mediation mechanism is established when the confidence interval does not include 0, depending on the degree of precision required (i.e., 90% or 95%). Table 5 reports the direct effects from antecedents to mediator (a) and from mediator to the output variable (b), the residual direct effects (c) and the indirect effects with their 90/95% bias-corrected confidence intervals in order to test their significance (Preacher and Hayes, 2008). We also provide the mediation type following the taxonomy by Zhao, Lynch and Chen (2010). Taken together, the different benefits and risks associated with the anticipated improvement in well-being explain 61% of the variance in perceived value. This suggests that the antecedents identified in the exploratory phase are useful in explaining the perceived value of delegating driving.

For perceived benefits, the positive effect of the perceived ability of driving delegation to Overcome Human Weaknesses on perceived value is fully mediated by the anticipation of an improvement in well-being, which results in an insignificant direct residual effect (c=.007 p=.97), supporting H_{1a}. Perceived ability of driving delegation to free up time is significantly associated with an increase in well-being (a=.27,p<.001) with a significant indirect effect on perceived value (a*b=.10 with a 95% confidence interval that does not include 0 [.044; .19]), supporting H_{1b}. However, the remaining direct effect is also significant (c=.20; p=.002), suggesting the value of freed time cannot be fully associated with the improvement in well-being. As stated by Zhao, Lynch and Chen (2010), complementary mediation often suggests that other mediating variables might be relevant. For example, freed time can be used to work more and/or make more money. Similarly, the perceived ability of driving delegation to optimize travel time exerts both a direct (c=.18, p=.004) and an indirect (a*b=.04, [.001; .0104]) influence on perceived value, supporting H_{1c}. For perceived risks associated with delegation, we also observe somewhat contrasting results. As expected, Performance Risk decreases perceived value by attenuating Anticipated Improvement in Well-being (a=-.19, p<.001; a*b=

-.07 with a 95% confidence interval that does not include 0 [-.134; -.032]), supporting H_{2a}. Interestingly, the remaining direct effects are not statistically significant. The Risk of Loss of Competencies exerts a direct and significant negative effect on perceived value (c=-.15, p=.012) leading to rejection of H_{2b}. Finally and surprisingly, Security and Privacy Risks are not significantly associated with an anticipation of an improvement in well-being, nor with perceived value, resulting in rejection of H_{2c}. In the end, the results suggest that the anticipation of an improvement of well-being is a key factor in the process of attributing value to autonomous products, however it is not the only one.

Table 5. Mediation Tests

	Direct effect[a] on…		**Indirect effect[a] on…**	**Bootstrap confidence interval of the indirect effect (95%)**		**Type of effect**
	Anticipated improvement in well-being (a)	**Perceived Value**	**Perceived value (a*b)**	**Lower bound**	**Upper bound**	
Overcoming Human Weaknesses	$.42^{***}$	.01	.16	.08	.28	Indirect only/ H_{1a} supported
Freeing Time	$.27^{***}$	$.20^{**}$	.10	.04	.19	Complementary mediation/ H_{1b} supported
Optimizing Performance	$.11^{*}$	$.18^{**}$	.04	.01	.10	Complementary mediation/ H_{1c} supported
Risk of Performance	$-.19^{***}$	-.07	-.07	-.13	-.03	Indirect only/ H_{2a} supported
Risk of Loss of Competencies	-.07	$-.15^{**}$	-.03	-.08	-.01	Direct only/ H_{2b} rejected
Security and Privacy Risk	-.06	.03	-.02	-.07	.01	No effect/ H_{2b} rejected
Anticipated Improvement in Well-Being	-	$.39^{***}$ (b)	-	-	-	-
R^2	.68	.61				

$^{***}p<.001$ $^{**}p<.01$ $^{*}p<.05$

7.3. *Test of the complete model*

For the second stage of the analysis the three expected antecedents of risks and benefits (i.e., Perceived Expertise in the Delegated Task, Attitude toward the Delegated Task and Previous Engagement in Delegation) are added and the complete model is estimated using the same approach. Since Perceived Expertise is measured with a single item and Previous Engagement in Delegation is captured through a dichotomous variable. Initially, our approach consisted of specifying only the hypothesized links (Model 1 in Table 6). Then, we used a Lagrange Multiplier (LM) test to complete the model with emerging significant links that were not the object of a research hypothesis and the Wald test to remove links that degraded model fit (Model 2). Model fit indicators are reported in Table 6 for both models. The value of SRMRs are particularly high as might be expected. As set out earlier (see Table 4), most of the latent factors measuring perceived benefits and risks are significantly correlated. However, in the complete model configuration, the correlation links cannot be specified. As a result, to improve the LM test first suggests correlating the error terms associated with these latent factors, or to specify regression links between them, which does not make sense.

As expected, Perceived Expertise in the Delegated Task is negatively associated with the perceived ability of delegation to optimize performance (β=-.125, p=.038) but not with the perceived ability to Overcome Human Weaknesses (β=-.064, p=.291), nor with the Risk of Loss of Competencies (β=-.018, p=.786), which is initially surprising. Therefore, H_{3b} is supported and H_{3a} and H_3c are rejected. Attitude toward the Delegated Task is negatively associated with the perceived ability of delegation to Free Time (β=-.146, p=.012), confirming that users who enjoy doing an activity are less likely to consider the prospect of delegating that activity as a way to free up time. This supports H_4. We also observe a positive and significant association (at the 10% level) between attitude and Performance Risk (β=.11, p=.062), suggesting that when they enjoy performing an activity, users have a tendency to attribute the machine to lower

Performance Risk. The results also confirm that an advanced level of delegation to an autonomous machine is more valued when users are already engaged in some kind of delegation behavior. This is probably because existing experience with delegation may be associated with a high perceived benefit and a lower perception of risk. Also, Previous Engagement in Delegation is positively associated with the perceived ability to Overcome Human Weaknesses ($\beta=.231$; $p<.001$) and to optimize performance ($\beta =.255$; $p<.001$), and negatively associated with the Performance Risk ($\beta =.-108$; $p=.049$), the Risk of Loss of Competencies ($\beta =-.243$; $p<.001$) and with Security and Privacy Risk ($\beta=-.243$; $p<.001$). Finally, we find that Previous Engagement in Delegation is not related to the ability to free up time ($\beta =-.038$; $p=.522$). This result may be due to the proxy used to measure Previous Engagement in Delegation.

Table 6. Path Coefficients for the Conceptual Model

				Model 1		Model 2		
				β	*p*	B	*p*	
H3a	Perceived Expertise in Delegated Task	→	Overcoming Human Weaknesses	-.06	.291	-	-	Not supported
H3b	Perceived Expertise in Delegated Task	→	Outperforming Human Capacities	-.13	.038	-.12	.046	Supported
H3c	Perceived Expertise in Delegated Task	→	Risk of Loss of Competencies	.016	.786	-	-	Not supported
H4	Attitude toward the Delegated Task	→	Freeing Time	-.15	.012	-.15	.012	Supported
	Attitude toward the Delegated Task	→	Performance Risk	-	-	.11	.062	-
H5a	Previous Engagement in Delegation	→	Freeing Time	.04	.522	-	-	Not supported
H5b	Previous Engagement in Delegation	→	Overcoming Human Weaknesses	.23	<.001	.22	<.001	Supported
H5c	Previous Engagement in Delegation	→	Outperforming Human Capacities	.26	<.001	.25	<.001	Supported
H5d	Previous Engagement in Delegation	→	Performance Risk	-.11	.071	-.12	.049	Supported
H5e	Previous Engagement in Delegation	→	Risk of Loss of Competencies	-.24	<.001	-.24	<.001	Supported
H5f	Previous Engagement in Delegation	→	Security and Privacy Risk	-.19	.002	-.19	.002	Supported
-	Freeing Time	→	Anticipated Improvement in Well-Being	.39	<.001	.39	<.001	-
-	Overcoming Weaknesses	→	Anticipated Improvement in Well-Being	.46	<.001	.46	<.001	-
-	Outperforming Human Capacities	→	Anticipated Improvement in Well-Being	.18	<.002	.19	<.001	-
-	Performance Risk	→	Anticipated Improvement in Well-Being	-.24	<.001	-.25	<.002	-
-	Risk of Loss of Competencies	→	Anticipated Improvement in Well-Being	-.12	.011	-.12	.01	-
-	Security and Privacy Risk	→	Anticipated Improvement in Well-Being	-.09	.05	-.09	.05	-
-	Freeing Time	→	Perceived Value	.24	<.001	.26	<.001	-
-	Outperforming Human Capacities	→	Perceived Value	.19	.002	.16	.003	-
-	Risk of Loss of Competencies	→	Perceived Value	-.21	<.001	-.19	<.001	-
-	Well-Being	→	Perceived Value	.43	<.001	.42	<.001	-
-	Attitude toward the Delegated Task	↔	Perceived Expertise in the Delegated Task	.33	<.001	.32	<.002	-
-	Previous Engagement in Delegation	↔	Perceived Expertise in the Delegated Task	.13	.034	.10	.081	-
-	Previous Engagement in Delegation	↔	Attitude toward the Delegated Task	.09	.128	-	-	-

Model 1: Chi^{2}=1434.15 p<.001, Chi^{2}/df=2.23, SRMR=.169, TLI=.92, CFI=.92, RMSEA=.06 [.056; .064]
Model 2: Chi^{2}=1431.2 p<.001, Chi^{2}/df=2.21, SRMR=.169, TLI=.92, CFI=.92, RMSEA=.06 [.056; .064]

8. Discussion and conclusions

8.1. Contributions

Autonomous technologies differ from other technologies as they allow the consumer to delegate decision-making to a machine. Such technologies place consumers in a paradoxical situation where they need to surrender control over a decision in exchange for some kind of benefit and this comes with various risks attached to it. Therefore, the aim of this research was to develop and test a conceptual model of perceived value in relation to user perceptions of autonomous cars as an archetypal autonomous technology. To do this, qualitative data helped to identify (Study 1a) and validate (Study 1b) the perceived benefits and risks attributed to autonomous cars as an archetypal autonomous technology, and their antecedents. This was followed up by a quantitative study (Study 2) which tested the conceptual model of perceived value developed from the literature and the qualitative research. Specifically, it was found that i) the benefits and risks identified were able to explain a substantial amount of the variation in perceived value, ii) anticipation of an improvement in well-being mediates the link between the benefits/risks and perceived value, and iii) that the identified antecedents to the benefits/risks help to explain variation in the model to some degree. Given this, our research contributes to the rapidly developing literature in the field of autonomous technologies (cars in particular) which seeks to understand the drivers and barriers to its future development (Bridgelall and Stubbing, 2021; Gurumurthy and Kockelman, 2020; Merfeld, Wilhelms, Henkel and Kreutzer, 2019; Penmetsa et al. 2019; Skeete, 2018).

Thus, our first theoretical contribution is to examine this situation through the angle of delegation. From a general point of view, delegation comes with the expectation of increased efficiency and performance. However, when the anticipated "costs" are higher than these anticipated benefits, individuals will be reluctant to delegate (Venton, 1997). This means that the delegation of decision-making to an autonomous product must be justified by the anticipation that the benefits of doing so will exceed the costs.

Our second contribution centers around further conceptualization of the main categories of individual benefits and risks involved in a consumer's decision to delegate to autonomous products. Prior research in the area outlines three key benefits to consumers, which influence willingness to use, including economic, time and safety benefits (e.g. Hohenberger, Spörrle, and Welpe, 2017). The benefits we identify are broadly consistent with this set but also offer a further point of difference by specifying the key focus of those benefits for autonomous cars. For example, we found that perceived value of product autonomy relates to three key perceived benefits and three key perceived risks. The first benefit refers to the ability of autonomous products to overcome human weaknesses. This broad category encapsulates benefits such as compensating for fatigue, overconfidence or avoiding temptations to violate road rules and is broadly consistent with what Hohenberger, Spörrle, and Welpe (2017) define as safety benefits. The second benefit is linked to the ability of the product to outperform human capabilities thanks to an autonomous technology's superior computing capacity. This seems to overlap with what Hohenberger, Spörrle, and Welpe (2017) define as economic benefits. The third one, which is less surprising, is to free up time that can be allocated to other activities when delegating to a machine. While these benefits overlap with those defined in Hohenberger, Spörrle, and Welpe (2017), the new conceptualization provides subtle differences which are focal to the notion of delegating to a machine. We also build on their research by identifying key dimensions of perceived risk, which further illuminate the nature of the anxieties that Hohenberger, Spörrle, and Welpe (2017) delineate. The first dimension of perceived risk relates to the consequences of a lack of performance. This is somewhat expected as previous research highlights the importance of Performance Risk in predicting technological innovation adoption (e.g. Luo, Zhang, and Shim, 2010). However, in the context of delegation of decision-making, this dimension takes a particular meaning. In fact, for autonomous products, control is delegated to the user who is concerned about losing control (Howard and Dai, 2014) and the feeling of control is closely related to risk perception (Renn, 1998). Thus, giving control to a machine may foster anxieties about the anticipated adverse negative consequences of potential technological flaws, which may have rather serious consequences, and which may vary across product categories and the nature of the delegated task.

The second category of perceived risk relates to the fear of losing competencies by letting a machine act and decide on its own on a regular basis. Some industries (e.g., the airline industry) are no stranger to such risks, given existing levels of automation and the high risk nature of flying (Ebbatson, 2009). The risks are very relevant for autonomous cars too as behaviors begin to change and responsibility for control diminishes (Demeulenaere, 2020). It is interesting, however, that final users are concerned with a gradual loss of response capacity associated with decisional delegation. Finally, our studies highlighted a third dimension of risk in this context, consistent with recent literature (e.g., Kaur and Rampersad, 2018), based around the undue exploitation of personal data and system permeability to hackers.

Although some of these benefits and risks have already been identified in prior literature (e.g., Brell, Philipsen, and Ziefle, 2019), our axial categorization within a perceived value framework and conceptualization with other pertinent constructs such as Anticipated Improvement in Well-Being, offers a conceptual framework for autonomous technologies to better grasp the antecedents and consequences of these perceived benefits and risks. These broader motivational categories (e.g., Overcoming Human Weaknesses) can be used by both academics and product designers to get an extensive overview of what can drive or hamper the adoption of new autonomous products. Our findings also point out that consumers consider the potential loss of competencies due to the use of autonomous products as a major risk. This category suggests that some consumers would prefer to preserve their competencies to secure their independence, signifying a potential barrier to adoption. While we look at this for autonomous cars similar fears and anxieties may exist for other autonomous products so the results here may translate into other categories.

Third, this article contributes to adoption literature by deepening the understanding of the mechanisms binding benefits/risks perception and perceived value. While previous research emphasizes the role of trust in the context of autonomous products (e.g., Liu, Yang, and Xu, 2019) we draw attention to consumer subjective well-being. It is widely acknowledged that product innovation can improve quality of life (Dolan and Metcalfe, 2012). However, this dimension is under explored in innovation adoption literature, which puts an emphasis on variables such as usefulness (e.g., Davis, 1989). This research shows that the Anticipated Improvement in Well-Being associated with the use of autonomous products plays a key role in connecting perceived benefits or risks with perceived value. Indeed, the effect of Overcoming Human Weaknesses, at least in the case of autonomous cars, is fully mediated by the Anticipated Improvement in Well-Being. When users associate autonomy with a reduction of human fallibility, it reduces anxiety and stress and generates positive emotions, which leads to higher perceived value. This finding helps to further extend the work by Hohenberger, Spörrle, and Welpe (2017) by showing what factors are associated with technological anxiety in this context. Interestingly, we find a similar result with Performance Risk. If the prospect of a technological flaw is salient in the minds of users, they are less likely to anticipate an improvement in well-being due to the use of autonomous products. This will in turn limit their value perception. However, the anticipation of an improvement in well-being does not always capture all the effect of benefits and risks on perceived value. Complementary mechanisms may exist and may need to be investigated further. For instance, Freeing Time and Outperforming Human Capacities also have a significant direct impact on perceived value. This suggests that additional mediators should be considered to understand how these variables influence perceived value. For example, anticipated monetary gain may be a potential mediator for these two benefits: the time freed up using autonomous products can be reinvested in monetizable activities. Conversely, anticipated well-being does not mediate the effect of the risk of losing competencies on perceived value. One reason for this would be that the loss of skills is gradual and can be only seized over the long term; it does not have a direct effect on well-being. The research also does not find a significant effect of Security and Privacy Risk, neither on well-being, nor on perceived value. This finding was initially surprising but is in line with the extensively studied "privacy paradox", which is described as a "discrepancy between individuals' intentions to protect their own privacy and how they behave in the marketplace" by Norberg, Horne, and Horne (2007). In fact, even though consumers may have concerns over the deterioration of personal privacy due to usage of autonomous products, it does not decrease the perceived value of delegating tasks and decisions.

Fourth, this paper is among the first to highlight the role of antecedent variables that explain why consumers perceive that delegating decision-making to autonomous products is beneficial or risky. We logically find that users who love driving are less likely to consider driving delegation as a time gain. In the same way, the findings suggest that consumers who see themselves as experts in the delegated activity tend to be less likely to perceive benefits related to Outperforming Human Capacities. Being an expert implies a better knowledge about the usefulness of delegating an activity and the ability of autonomous products to Outperform Human Capacities. From a broader point of view, this finding suggests that in an era of autonomy, the comparison between user and machine performance will be an important evaluative criterion for products. Regarding the factors that predict perceived benefits and risks, the most important factor is whether consumers are already engaged in task delegation. In the context of driving, simply being a regular user of a function like adaptive cruise control seems enough to influence a consumer's mindset about autonomous driving. Previous Engagement in

Delegation strengthens the beliefs that delegating tasks to autonomous products is a way to Overcome Human Weaknesses and to Outperform Human Capacities. At the same time, it decreases perceived Performance Risk, Perceived Risk of Loss of Competencies and Security and Privacy Risk. This finding highlights the importance of creating products which allow sequential levels of delegation and which enable the user to first become experienced with base levels of delegation, enhancing trust in delegation.

8.2. Managerial Implications

This study provides several useful insights for managers to enhance adoption of autonomous products. First, it highlights the need for managers to be aware of a paradox related to the adoption and perceived value of autonomous products: to attribute high value and be willing to adopt these products, consumers expect to have the opportunity to choose to delegate or not delegate the decision-making to a product, for example, via an actionable option. However, these autonomous functions need to be widely adopted and used to deliver the promised benefits (e.g., shorter travel time thanks to traffic regulation enabled by wide autonomous car adoption). In the same vein, in a situation of delegation, the perception of risk may be exacerbated due to the limited possibility of user intervention. Therefore, in designing autonomous products, companies should convey that the user ultimately remains in control with the ability for manual override (at least during a transitory period).

Second, the findings highlight that consumers evaluate autonomous products through different categories of benefits and risks and that this evaluation transpires into changes to well-being and ultimately perceived value. This emphasis on well-being as a key consequence for the evaluation of autonomous technologies reveals that consumers need to make sense of product autonomy. Product autonomy is not desirable in itself. Therefore, at the early stage of product conception and development, designers and new product marketers have to think about how they will guide and support individuals to make sense of the technology’s benefits and reduce their risks. It is also important to note that the weight of the different risks and benefits is likely to vary based on product category. The model could be used as a framework to elaborate on concept testing surveys, by highlighting key benefits to build on and risks to be mitigated in order of priority. Third, the benefits we have uncovered suggest valuable axes of discourse to accelerate autonomous product adoption, even if the content of discourse should vary depending on the degree to which one benefit is perceived. For example, our results suggest that people who feel expert in the activity might resist a discourse centered on outperforming human capacities but may be more open to arguments linked to the overcoming of human weaknesses. In the same vein, users who like to practice the activity to be delegated might not accept the argument of freed time but appreciate a discourse focused on the other benefits.

Fourth, to anticipate particular conditions or technological breakdowns, the autonomous system could even schedule training sessions and give feedback to users on their performance, helping them to maintain their competencies. Finally, this research highlights the importance of committing consumers gradually to decision-making delegation as a change that is too sudden may induce anxieties that become too prominent. This suggests that a sequential, progressive approach to launch autonomous products may be more appropriate to reach a wide target. The strategy of carmakers to offer more and more sophisticated and autonomous driving assistance systems seems to be very relevant and could be extended to other product categories for which delegation is associated with high Physical Risk (for instance healthcare robots).

8.3. Limitations and Future Research

The context and focus of this research was on autonomous cars. Autonomous cars were chosen because they are highly associated with the process of decision-making and they are the most commonly discussed autonomous technology in the press. However, the choice of autonomous cars also raises some limitations. First, autonomous cars probably tend to exacerbate the perception of certain benefits and risks: an individual who uses his car every day to go to work and regularly faces traffic jams will potentially gain a lot of time, avoid a lot of stress and even save money by delegating driving. On the other hand, by depriving users from taking action, a technological flaw can have very serious consequences. Moreover, as the model we have developed is expected to be relevant for other consumer-based autonomous technologies, a replication of this research to other products categories and contexts such as autonomous appliances or personal robots is needed. Such replications would be useful to investigate the extent to which the impact of the identified benefits and risks on perceived value varies across product categories. With the general model identified here such replications could easily be achieved. However, though the identified constructs seem appropriate for the majority of consumer-based autonomous products, the list may not be exhaustive and as the technology evolves, this should be revisited. Moreover the model is also not suitable to explain delegation to autonomous machines in an industrial context in which the decision is based on an assessment of long-term economic and organizational benefits.

In wanting to identify a model that could be transposed to different categories of consumer-based autonomous products, we focused on individual risks and benefits, rather than the collective effects of autonomous vehicles (mobility efficiency, sustainable mobility, extended access to mobility…) which in turn may improve individual well-being. Future research could extend the model by studying the extent to which perception of the collective benefits/risks influences perception of the individual benefits/risks and in turn perceived improvement of well-being.

It was also not possible to conduct the study using fully autonomous cars in a realistic way for security reasons. We used a short video that clearly showed a driver deciding to activate the autonomous mode and then doing something else. This was to emphasize the object of our study: the perceived value of delegating decision-making. However, with this scenario based approach respondents may not be easily able to project themselves into such a usage situation. Again, replicating the research by using more immersive methods (e.g., self-driving simulators, prototype testing) would be very useful. Finally, fully autonomous cars are specific because they have not been launched yet and it is impossible to know when that will happen. Beliefs and representations are shaped by a diverse range of actors and thus are likely to evolve. This may have a contextual influence on the strength of the effects we identified.

8.4. Conclusion

This research develops and tests a model of consumer perceived value about autonomous cars which we feel is also applicable to other technologies. In doing so it identifies the key perceived benefits and risks through a series of qualitative and quantitative studies and examines how these antecedents affect perceived value through the mediating role of anticipated improvement in well-being. Though widely used models such as the TAM and IDT are useful in understanding the adoption decision, further theoretical elaboration around this context and the role of well-being is needed. In doing so, the research here provides important insights about how marketers can overcome consumers' anxieties about technologies which enable them to delegate control to a machine.

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