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Consumers' adoption of autonomous cars as a personal values-directed behavior

B. Crisafulli [a,*], R. Guesalaga [b], R. Dimitriu [c]

[a] Birkbeck, University of London, Malet Street, Bloomsbury, London WC1E 7HX, United Kingdom
[b] Universidad Alberto Hurtado, School of Economics and Business, Almirante Barroso 10, Santiago, Chile
[c] Trinity Business School, Trinity College Dublin, 182 Pearse St, Dublin 2, D02 F6N2, Ireland

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ABSTRACT

Autonomous cars are the future of transportation. Manufacturers' success is, nonetheless, dependent on consumers' adoption of such innovation. Past studies distinguish between factors contributing to autonomous cars' adoption and those prompting resistance. Extant evidence does not explain, however, when and why certain factors both facilitate and inhibit adoption. Addressing this gap, we propose a personal values-directed perspective on consumers' adoption of autonomous cars. Through a means-end chain analysis of 54 laddering interviews and an online survey, we show that personal values function as a sense-making mechanism in innovation adoption decisions. We propose a comprehensive set of consumer-perceived consequences arising from autonomous cars' attributes, which explain adoption and non-adoption based on personal values. Notably, we show an innovative application of means-end chain analysis based on bipolar hierarchical value maps to investigate the adoption of highly novel innovations. Findings have implications for managers seeking to encourage the adoption of yet-to-be-commercially-launched innovations.

1. Introduction

Increasingly, businesses introduce technological innovations in the form of autonomous products (De Bellis & Johar, 2020; Leung et al., 2018; Rijsdijk & Hultink, 2003; Sohn, 2024; Song & Kim, 2022). In particular, autonomous cars are considered a quintessential type of autonomous products, with 45% of the world's automakers investing in such innovations or planning to do so in 2024–25 (KPMG, 2023, 2024). In addition to General Motors, Volvo and Tesla (Solomon, 2022), Volkswagen has been working on self-driving taxis and Toyota has been investing in autonomous driving operating systems (Smith, 2022). While yet not widely circulating on public roads, autonomous cars are deemed to have the potential to transform transportation and society at large, as evidenced by government investment toward piloting such cars (HM Government, 2022; U.S. Department of Transportation, 2022). The autonomous cars' market is currently worth ca. $122bn (Precedence Research, 2022), and autonomous driving is predicted to generate up to $400bn in revenue by 2035 (Deichmann et al., 2023). Such estimates imply that autonomous cars will create value for users and their experience of mobility, thus encouraging adoption. However, developing and marketing such innovations does not necessarily translate into adoption, as consumers have different needs and values (Ruosch et al., 2024). Understanding what drives or hinders consumers to adopt autonomous cars is therefore a timely issue for manufacturers.

Extant research classifies factors as drivers or inhibitors of autonomous cars' adoption. Freeing up time (Bertrandias et al., 2021; Hohenberg et al., 2017), ease of use and usefulness (Dong et al., 2023; Man et al., 2024; Nastjuk et al., 2020; Park et al., 2021), image and enhanced performance (Foroughi et al., 2023; Meyer-Waarden & Cloarec, 2022) are desired consequences of autonomous cars, all seemingly conducive to adoption. Undesired consequences such as anxiety (Hohenberg et al., 2017; Huang & Qian, 2021), competency loss (Bertrandias et al., 2021) and risk (Jing et al., 2023) are deemed to foster resistance to such innovations. Notwithstanding the proliferation of research in the domain, extant knowledge does not yet provide a comprehensive set of consumer-envisaged, desired and undesired consequences of autonomous cars that facilitate or hinder adoption. Crucially, there is lack of theoretical understanding of when and why certain attributes of autonomous cars are linked to both desired and undesired consequences conducive to adoption and non-adoption. In this regard, scholars have called for a fine-grained approach to examining factors that drive adoption as well as non-adoption (Antioco & Kleijnen, 2010; Claudy

* Corresponding author.
E-mail addresses: B.Crisafulli@bbk.ac.uk (B. Crisafulli), rguesalaga@uahurtado.cl (R. Guesalaga), radu.dimitriu@tcd.ie (R. Dimitriu).

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et al., 2015).

We draw on the theory of personal values (Schwartz, 1992; 1994; Schwartz et al., 2012) postulating that societies and individuals rely on basic human values as guiding principles in life. Personal values drive perceptions and motivate actions (Bagozzi & Dholakia, 1999; Gutman, 1991; Sagiv & Schwartz, 2022). Crucially, values serve as sense-making systems, acting as standards against which to evaluate, judge and justify personal choices (Rohan, 2000; Schwartz, 1992). In this sense, intentions and behavior are manifestations of one's efforts to attain personal values. We theorize that personal values represent a hitherto neglected aspect explaining the psychological process behind consumers' decisions concerning technological innovation adoption. Scholars have highlighted the need to understand psychological processes underlying human thought in technology adoption (Rejali et al., 2023). As stated by van Oorschot et al. (2018), "… we expected that cognitive processes underlying human thought would hold a more prominent position in innovation adoption research" (p. 16).

Considering the high degree of novelty of autonomous cars, we expect personal values to play a pivotal role as a sense-making mechanism guiding adoption and non-adoption, and this analysis is at the core of our research. Studies building on established models of technology adoption (e.g., Technology Acceptance Model, Unified Theory of Acceptance and Use of Technology) conceptualize a limited set of factors as drivers of adoption, and establish their relative effect (e.g., Davis, 1989; Venkatesh et al., 2003; Venkatesh et al., 2012). In practice, such factors are consequences associated with a variety of innovation attributes and can act both as drivers and inhibitors of adoption, given certain personal values. Innovation attributes can, in fact, be associated with both desired and undesired consequences, which acquire meaning based on personal values (Olson & Reynolds, 1983; Paul et al., 2009). Complementing existing evidence, we explain how personal values modulate the way in which the attributes of autonomous cars are evaluated, desired or undesired consequences arise, and adoption is facilitated or hindered. We employ a means-end chain analysis of laddering interviews (Reynolds & Gutman, 1988) to identify ladders (or "chains") depicting how autonomous cars' attributes are linked to desired and undesired consequences of adoption (or non-adoption), and in turn personal values. Using a follow-up online survey, we quantitatively assess the relative importance of the ladders and the strength of linkages within the ladders, thereby enhancing the validity and generalizability of means-end chain findings.

Our paper offers a twofold contribution to the literature on consumers' adoption of technological innovations in the form of autonomous cars. It is the first to demonstrate that innovation adoption is a personal values-directed behavior. Empirically, we assess how personal values act as a sense-making mechanism in evaluating highly novel technologies such as autonomous cars, ultimately guiding adoption and non-adoption. Our findings demonstrate that the attributes of autonomous cars are linked to desired and undesired consequences, which in turn facilitate or hinder adoption based on personal values. From a methodological perspective, we propose a novel approach combining means-end chain analysis with a survey to investigate consumers' adoption of yet-to-be-commercially-launched innovations like autonomous cars. We introduce bipolar hierarchical value maps offering a comprehensive picture of the multitude of attributes, desired and undesired consequences, and personal values linked with autonomous cars' adoption and non-adoption.

2. Theoretical background

In this section, we present a focused review of extant research on consumers' adoption of autonomous cars and psychological research on personal values.

2.1. Consumers' adoption of autonomous cars

Autonomous products represent a type of radical innovation (Casidy et al., 2021). These entail Internet of Things-enabled products which are "able to operate in an independent and goal-directed way without interference of the user" (Rijsdijk & Hultink, 2009, p. 26). Autonomous products are infused with Artificial Intelligence and are capable of self-adjusting, taking actions based on environmental conditions, overriding consumer commands (Verhoef et al., 2017). Extant literature examines various types of autonomous products, such as vacuum cleaners, refrigerators, television sets (Rijsdijk & Hultink, 2003), shopping systems and retail technologies (De Bellis & Johar, 2020; Sohn, 2024; Song & Kim, 2022).

Recently, scholarly attention has been directed toward autonomous cars. The evidence on consumers' adoption of autonomous cars presents a mixed picture (see Appendix A for a summary of key studies). This body of work includes two main perspectives – one focusing on consumers' *adoption* of autonomous cars and the other uncovering *resistance* to such innovations. The former presents factors that drive autonomous cars' adoption (Dong et al., 2023; Foroughi et al., 2023; Man et al., 2024; Nastjuk et al., 2020; Park & Han, 2023; Park et al., 2021; Staab & Liebherr, 2024). The identified factors are mainly grounded on the Technology Acceptance Model or extensions of such model and include constructs of perceived ease of use and usefulness, compatibility, trust, image, social influence, self-autonomous cars bias, and subjective knowledge (e.g., Dong et al., 2023; Foroughi et al., 2023; Man et al., 2024; Nastjuk et al., 2020; Park & Han, 2023; Park et al., 2021; Staab & Liebherr, 2024). The literature on consumers' resistance to autonomous cars highlights factors such usage and risk barriers (Casidy et al., 2021). A third stream of work focuses on the interplay between factors driving adoption and those encouraging resistance (Bertrandias et al., 2021), and moderators such as personality traits (Huang & Qian, 2021; McLeay et al., 2022), anticipatory experiences (Lindgren et al., 2021), user innovativeness (Meyer-Waarden & Cloarec, 2022), or else, past experience of accidents (Jing et al., 2023).

Two main observations emerge from reviewing this body of work. First, prior studies have widely used technology adoption models (e.g., Technology Acceptance Model, Unified Theory of Acceptance and Use of Technology), which primarily conceptualize a limited set of variables as either drivers or inhibitors of adoption. For instance, ease of use, usefulness and efficiency are classified as drivers of adoption (e.g., Dong et al., 2023; Man et al., 2024; Nastjuk et al., 2020; Park & Han, 2023; Park et al., 2021), while anxiety, privacy and risk are classified as inhibitors (e.g., Bertrandias et al., 2021; Casidy et al., 2021; Huang & Qian, 2021; Meyer-Waarden & Cloarec, 2022). In practice, the above factors are consequences of various innovation attributes and may act as drivers and/or inhibitors of adoption based on consumers' personal values. In fact, through one attribute, consumers might anticipate both desired and undesired consequences depending on personal values. In this sense, personal values modulate the extent to which certain consequences act as drivers and/or inhibitors of adoption. Adoption research accounting for the role of personal values is thus far scant. One exception is the study by Hohenberg et al. (2017) examining one personal value, namely self-enhancement. The same study shows that self-enhancement dampens the negative effect of anxiety on autonomous cars' adoption. Research inspecting a multitude of personal values might explain why prior work captures certain factors, such as security, both as drivers (Meyer-Waarden & Cloarec, 2022) and as inhibitors of adoption (Bertrandias et al., 2021).

Second, much of extant research examines the relative effect of drivers and inhibitors on autonomous cars' adoption. Given the nature of studies testing technology adoption models, only a limited number of attributes and desired/undesired consequences are tested (e.g., Lu et al., 2018; Marikyan et al., 2019; van Oorschot et al., 2018). Such approach pre-empts the disentangling of self- and society-relevant consequences, consistent with a fine-grained approach to studying innovation adoption

(Antioco & Kleijnen, 2010; Claudy et al., 2015). In practice, recent research by Lindgren et al. (2021) proposes, through ethnographic insights, that anticipatory experiences are a key factor in accepting autonomous driving. Altogether, there is thus far no comprehensive picture of the sense-making process by which consumers ponder the adoption and non-adoption of autonomous cars. Decisions to adopt and not adopt an innovation are qualitatively different and driven by diverse reasons (Casidy et al., 2021; Claudy et al., 2015; Garcia et al., 2007). Consumers may unravel reasons for non-adopting autonomous cars while thinking about adoption, and the reverse can also be true. It follows that adoption and non-adoption need to be examined in tandem for knowledge advancement.

2.2. Personal values in consumers' decision-making

Personal values are broad, desirable goals that motivate people's actions (Schwartz, 1992). Values affect perceptions, cognitions, and behavior over time and across situations, and their hierarchy reflects the perceived importance of values in individuals' priorities (Sagiv & Schwartz, 2022). Priorities typically affect attitudes and guide behaviors with little or no conscious awareness (Rohan, 2000).

Schwartz's framework (Schwartz, 1992) identifies ten personal values affecting individuals' decisions: self-direction, stimulation, hedonism, achievement, power, security, conformity, tradition, benevolence, and universalism. Interestingly, some of such values are compatible, while others are not. For example, power and achievement are highly compatible, just as hedonism and stimulation, thus easy to pursue together. By contrast, the simultaneous pursuit of less compatible values such as universalism or benevolence and power or achievement can produce psychological or social conflict. Schwartz (1994) conceptualizes value compatibilities and conflicts in a circular model with orthogonal dimensions: self-enhancement (e.g., power and achievement) versus self-transcendence (e.g., universalism and benevolence), and openness to change (e.g., stimulation and hedonism) versus conservatism (e.g., tradition and security). Thus, even if several values seem desirable to pursue, individuals still prioritize values based on their relative importance.

Marketing scholars have long acknowledged the crucial role played by personal values in explaining consumer behavior. In a seminal study, Vinson et al. (1977) suggest that an individual's belief system includes global values (enduring beliefs), which interact with consumption-related values and social issues to influence decision-making. From an ethical consumption angle, Doran (2009) investigates the influence of personal values on fair trade consumption, discovering that loyal users of fair trade vary on their pursued values relative to non-users and infrequent users. Durvasula et al. (2011) show that personal values influence perceptions of overall value, satisfaction and intentions to recommend educational services. Recently, Bhardwaj et al. (2023) note that personal values of altruism and biosphere influence consumers' attitudes toward green purchases, along with product-specific values of quality and uniqueness. Relatedly, Becerra et al. (2023) show that social and environmental values are meaningful antecedents to green buying and referral intentions.

Schwartz's framework has been widely used to study the influence of personal values on consumers' attitudes, behavior and decision making. In tourism research, Ballantyne et al. (2017) show that universalism toward nature (i.e., preservation of the environment) and universalism toward animals (i.e., concern for animal welfare) enhance reflective engagement and environmentally-friendly behavior. Likewise, Ahmad et al. (2020) find that Schwartz's (1992) values of self-transcendence and conservation influence tourists' intentions to visit eco-friendly destinations. Ganglmair-Wooliscroft and Wooliscroft (2022) demonstrate that self-transcendence values, especially universalism, are positively associated with sustainable grocery shopping.

Drawing on the theory of personal values (Bagozzi & Dholakia, 1999; Gutman, 1982), we advance the view that autonomous cars' adoption is a personal values-driven decision. Such a view both complements earlier accounts on consumers' adoption of autonomous cars and advances nuanced understanding on the psychological process underlying technological innovation adoption and non-adoption.

3. Study 1

We employed means-end chain analysis (Gutman, 1982) and the laddering interviewing technique (Reynolds & Gutman, 1988). The means-end chain model is grounded on the principle that individuals act based on envisaged (desired and undesired) consequences, with the latter denoting whether personal values or end-states will be satisfied or not (Reynolds, 2006). Individuals associate attributes of goods/services with desired and/or undesired consequences on the basis of guiding personal values (Gutman, 1982; 1997). Associations follow a hierarchy, known as means-end chain or ladder (Claeys et al., 1995; Reynolds & Gutman, 1988), where values are at the top of the hierarchy, consumers' preferences for certain product attributes at the base, and envisaged consequences occupy the middle level (Bagozzi & Dabholkar, 1994; Ramirez et al., 2015).

Means-end chain analysis has been employed to study a wide range of marketing phenomena, including advertising persuasiveness (Reynolds et al., 1995), standardization strategy (Botschen & Hemetsberger, 1998), market segmentation (Botschen et al., 1999), retail shoppers' motives (Mitchell & Harris, 2005), service satisfaction (Orsingher et al., 2011), and perceived value of business solutions (Macdonald et al., 2016). In our study, means-end chain analysis is most apposite to uncover the role of personal values in directing consumers' decisions to adopt or not autonomous cars.

3.1. Data collection and sampling

We conducted one-to-one, in-depth interviews based on the laddering technique, which is frequently used in means-end chain analysis to elicit constructs in means-end chains (Reynolds & Gutman, 1988). Compared with self-administered laddering questionnaires, in-depth laddering interviews have the advantage of producing rich insights on the elicited constructs (Botschen & Hemetsberger, 1998; Voss et al., 2007). A purposive sample (Creswell & Creswell, 2022; Miles et al., 2014) of 54 young professionals was recruited from the alumni list of a university in South-East England, United Kingdom (59% females, mean age of 28.03). This sample size is in line with recommended standards and prior studies using laddering interviews (Davies & Gutsche, 2016; Reynolds, 2006; Valette-Florence, 1998). Young consumers are prone to adopting new products, thus represent a relevant target market for autonomous cars' manufacturers (Im et al., 2003). Participants were aware of autonomous cars, thus able to answer interview questions, as further confirmed by our pilot interviews. Participants were approached via LinkedIn, briefed on the purpose of the research, the duration of the interviews and the incentive. We ended data gathering when no further insights emerged from new interviews, consistent with prior research (Voss et al., 2007).

3.2. Procedure

One-to-one interviews were conducted by a trained interviewer over a period of four months, using the Skype video conferencing tool to offer convenience and to minimize dropout. Participants were informed about research ethics at the start of the interview and were asked to provide verbal informed consent. Pre-determined, open-ended questions tapping into participants' reasons and views were employed (Edwards & Holland, 2013). We pre-tested the interview guide by asking for peer feedback and by conducting two pilot interviews later excluded from analysis (see Appendix B for the interview guide).

During the interviews, participants first watched a two-minute video showcasing how autonomous cars function. The video showed a

passenger being driven around while the controls and metrics of the autonomous car were in action. By providing a visual demonstration of autonomous cars' functioning and technology, participants could imagine themselves in the car and articulate thoughts more easily. Visual elicitation through photos or videos is known to stimulate critical parts of the brain, and to evoke deep elements of human consciousness, thus allowing for richer, honest input from participants (Harper, 2002).

Next, participants stated whether they would adopt or not an autonomous car, and the reasons behind their answer. When participants reported their propensity to adopt autonomous cars, the interviewer exhausted all the attributes, consequences and associated personal values justifying adoption. Subsequently, the interviewer inquired about reasons for non-adoption, probing into attributes, consequences and personal values. The same approach was followed with participants who initially stated that they would *not* adopt autonomous cars. Consistent with past research (Reynolds & Gutman, 1988), participants were repeatedly asked 'why is this attribute/consequence/value important to you?'. This question is pivotal to start the laddering process. Based on the given answers, the interviewer laddered down by asking questions probing into the attributes of autonomous cars or laddered up to tap into the consequences and personal values associated with the elicited attributes (Nasr et al., 2018).

The interview procedure used soft laddering, wherein participants followed their natural flow of speech in answering the questions and the interviewer captured the meaning of answers, linking them to the means-end chains (Voss et al., 2007). Concurrently, the interviewer sought to identify ladders in a more structured fashion, following a methodical process similar to hard laddering (Botschen & Hemetsberger, 1998). Consistent with laddering in marketing research, "the idea is to stimulate the respondents up a ladder of abstraction until the moment they reach the level of values. For this purpose, repetitive and interactive questions are made firstly considering the product attributes (A), secondly the consequences (C) and finally the values (V)" (Modesto Veludo-de-Oliveira et al., 2006, p. 299). The interviewer collected data reflecting attributes, consequences, and personal values (Bagozzi & Dabholkar, 2000; Mitchell & Harris, 2005), yet also retained the richness of insights from in-depth interviewing. After the interview, participants received a web link to claim a £20 Amazon e-voucher provided as thank you token for their participation. Each interview lasted between 35 and 60 minutes, was recorded and professionally transcribed.

3.3. Data analysis and findings

The analysis of interview transcripts followed the three-stage process of means-end chain analysis advocated by Reynolds and Gutman (1988). First, we developed the coding scheme based on the categorization of attributes, consequences, and personal values proposed by Reynolds et al. (1995), who argue that the three elements of the means-end chain differ based on abstractness, motive and purpose (see Appendix C). We used the conceptualization of personal values by Rokeach (1973) and Schwartz (1994), in line with prior means-end chain studies (Nasr et al., 2018; Paul et al., 2009).

The data coding followed best practices (Bazeley, 2020; Maher et al., 2018; Miles et al., 2014; Saldaña, 2021). Two members of the research team, acting as independent coders, adopted a systematic, two-cycle iterative process of manual content analysis of the transcripts using the coding scheme. Microsoft Excel was used to facilitate the identification of patterns (Bazeley, 2020). The coding scheme was refined as additional interviews were conducted and new categories emerged (Saldaña, 2021), at which point the coding of all transcripts was reviewed. Categories overlapping conceptually were merged upon agreement between the coders. The inter-rater agreement on the coding of means-end chain constructs (attributes, consequences, personal values) was 82.8%, confirming satisfactory reliability (Perreault & Leigh, 1989). Any remaining discrepancies were resolved by discussion. The results of the first stage of analysis are illustrated in Tables 1 and 2.

Table 1
Attributes, consequences, personal values underpinning the adoption of autonomous cars (Study 1).

Concept	Classification type	Counts
Autonomy	Attribute-concrete	46
New technology	Attribute-concrete	13
Reliable	Attribute-concrete	7
Cool	Attribute-abstract	10
Extra time	Consequence-functional	37
Convenience	Consequence-functional	23
Flexibility	Consequence-functional	15
Few requirements	Consequence-functional	11
Few accidents	Consequence-functional	9
Rest	Consequence-functional	11
Work	Consequence-functional	10
Learn	Consequence-functional	6
Socialize	Consequence-functional	5
Do other things	Consequence-functional	27
Less stress & anxiety	Consequence-psychological	17
Productive & competent	Consequence-psychological	11
Enjoyment	Consequence-psychological	12
Inclusiveness	Consequence-psychological	6
Contemporary	Consequence-psychological	7
Confident	Consequence-psychological	8
Feel safe	Consequence-psychological	11
A healthy life	Value-instrumental	15
Self-development	Value-instrumental	10
Being in control	Value-instrumental	5
Being innovative	Value-instrumental	7
A comfortable life	Value-terminal	15
Accomplishment	Value-terminal	17
An exciting life	Value-terminal	5
Freedom	Value-terminal	12
Equality	Value-terminal	7
Social recognition	Value-terminal	11
Security	Value-terminal	9
Happiness	Value-terminal	28

Table 2
Attributes, consequences, personal values underpinning the non-adoption of autonomous cars (Study 1).

Concept	Classification type	Counts
Autonomy	Attribute-concrete	25
New technology	Attribute-concrete	23
High price	Attribute-concrete	14
Controlled system	Attribute-concrete	6
Not driving	Consequence-functional	6
Not controlling the car	Consequence-functional	7
Risk of accidents	Consequence-functional	14
Legal complexity	Consequence-functional	9
Reduced budget for living	Consequence-functional	12
Access to personal data	Consequence-functional	5
Less enjoyment	Consequence-psychological	9
Threaten to fairness	Consequence-psychological	12
Stress	Consequence-psychological	15
Threaten to privacy	Consequence-psychological	5
Being in control	Value-instrumental	16
Focus on things that matter	Value-instrumental	7
Financial stability	Value-instrumental	7
An exciting life	Value-terminal	7
Justice	Value-terminal	8
Freedom	Value-terminal	12
Security	Value-terminal	20
A comfortable life	Value-terminal	10
Happiness	Value-terminal	15

Second, causal chains (also known as "ladders", Reynolds & Gutman, 1988) were generated. We analyzed a total of 112 ladders for adoption and 76 for non-adoption of autonomous cars (on average 3.5 ladders per participant). Next, we aggregated the ladders to derive implication matrices summarizing the number of linkages (or "implications") between attributes, consequences, and personal values (Davies & Gutsche, 2016; Nasr et al., 2018). The implication matrices depict the amount of

direct and indirect linkages between concepts, such as direct linkages between attributes and consequences or indirect linkages between attributes and consequences via other attributes or consequences (Reynolds & Gutman, 1988). The detailed implication matrices are presented in Appendix D and Appendix E.

Third, based on the implication matrices, we created hierarchical value maps for autonomous cars' adoption and non-adoption, namely bipolar value maps (see Fig. 1 and 2). The hierarchical value maps illustrate the key constructs and their linkages (Claeys et al., 1995) following a visual representation used in prior studies (Nasr et al., 2018; Voss et al., 2007). The numbers within parentheses denote frequencies (i.e., the number of participants mentioning a concept), while the thickness of the lines connecting the boxes indicates the strength of associations between concepts (i.e., the total number of linkages between concepts). We report hierarchical value maps generated at a cut-off level of 4, which is recommended with a sample of 50 respondents (Reynolds & Gutman, 1988), enabling us to gain a good balance between detail and interpretability (Nasr et al., 2018). The hierarchical value map for autonomous cars' adoption included 83% of total linkages, while the hierarchical value map for non-adoption included 85.5% of total linkages.

3.3.1. The trade-off between self-accomplishment and loss of control

The findings from Study 1 suggest that autonomy, a noteworthy attribute of autonomous cars, and autonomous products more generally, acts as a double-edged sword, thus warrants particular attention when seeking to encourage adoption. As illustrated in Fig. 1, autonomy is the most frequently discussed attribute among consumers pondering autonomous cars' adoption. Autonomy is associated with desired functional consequences of "convenience", "flexibility" and "gaining extra time for socializing, learning, or doing other things", as well as psychological consequences of "reduced stress and anxiety" and "greater enjoyment". The prospect of fulfilling instrumental values of "self-development" and "having a healthy life", both conducive to terminal values of "accomplishment", "freedom", "comfortable life" and "happiness", guides positive associations between the attribute of autonomy and the above-discussed desired consequences, as illustrated by participants' comments:

> *"Imagine you can make use of this time to do all your work. If you are driving your autonomous car alone, this means that you would have your own private area, it would be like a mobile workplace where you can really focus on your work."* (female respondent; age: 32).
>
> *"I mean, if you could use your time well you could complete something while you're going to work, you could read a book, or listen to a podcast, or learn a language. So, if you want to use that time to learn new skills, it's extremely important for personal development."* (male respondent; age: 31)

Notably, as shown in Fig. 2, autonomy is also associated with undesired functional consequences of "not being in control of the car", "accidents", "legal complexity", as well as undesired psychological consequences of "stress", "lack of safety", "unfairness", and "lowered sense of enjoyment" linked to car driving. Such undesired consequences emerge from perceptions that personal values of "being in control", "security", "justice", or "exciting life" are unattainable by adopting autonomous cars. For instance, legal complexity in the event of accidents is anticipated from autonomous cars' adoption, as exemplified below:

> *"Because the decision is not made by the driver, it's made by the computer. Which depends on the designer of the system. So if there is a responsibility, I didn't make any decision, why is it my responsibility to take it?"* (female respondent; age: 33)

3.3.2. A social recognition leverage and an impingement to freedom

The modern driverless technology is an attribute frequently mentioned when pondering adoption (13 participants). In particular, driverless technology is associated with desired consequences of "feeling cool", "contemporary" and "confident". Such consequences are guided by the prospect that, by adopting autonomous cars, the personal values

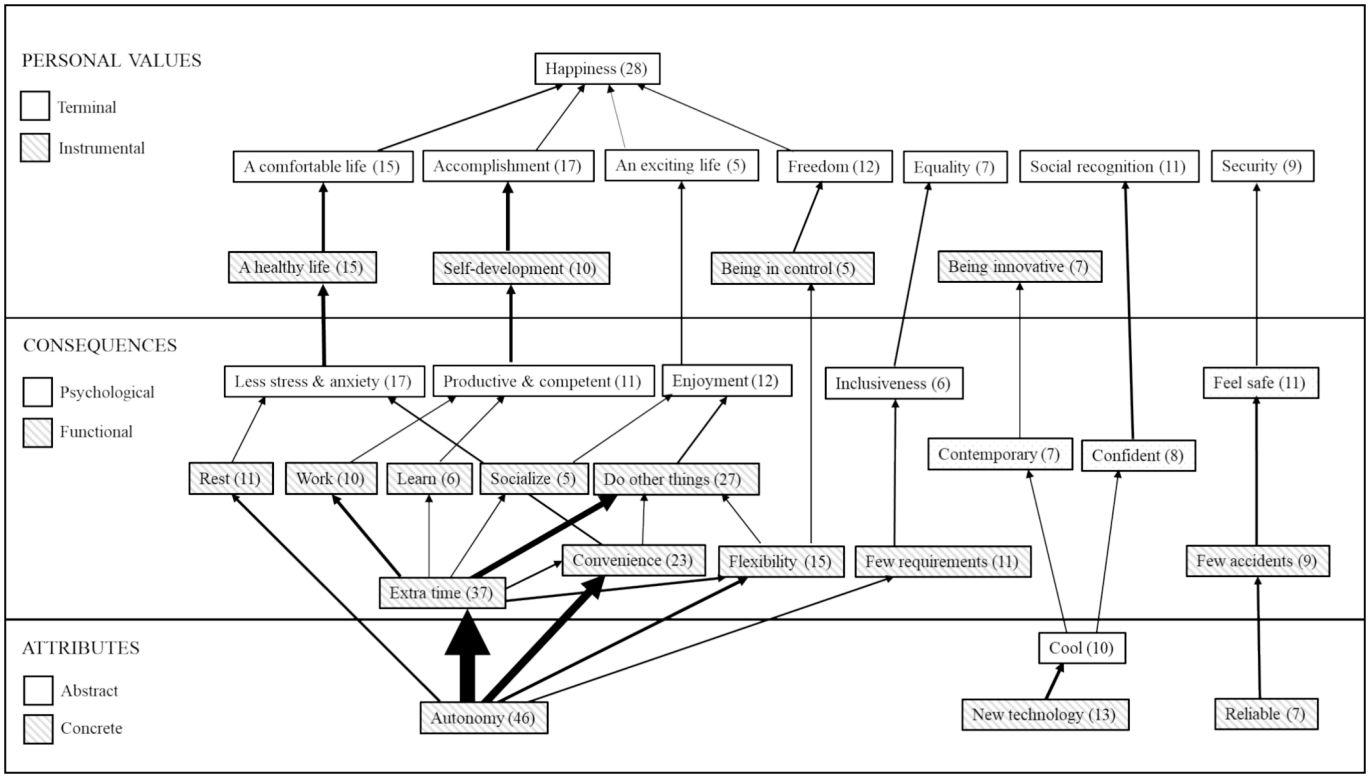

Fig. 1. Hierarchical value map for autonomous cars' adoption (Study 1).

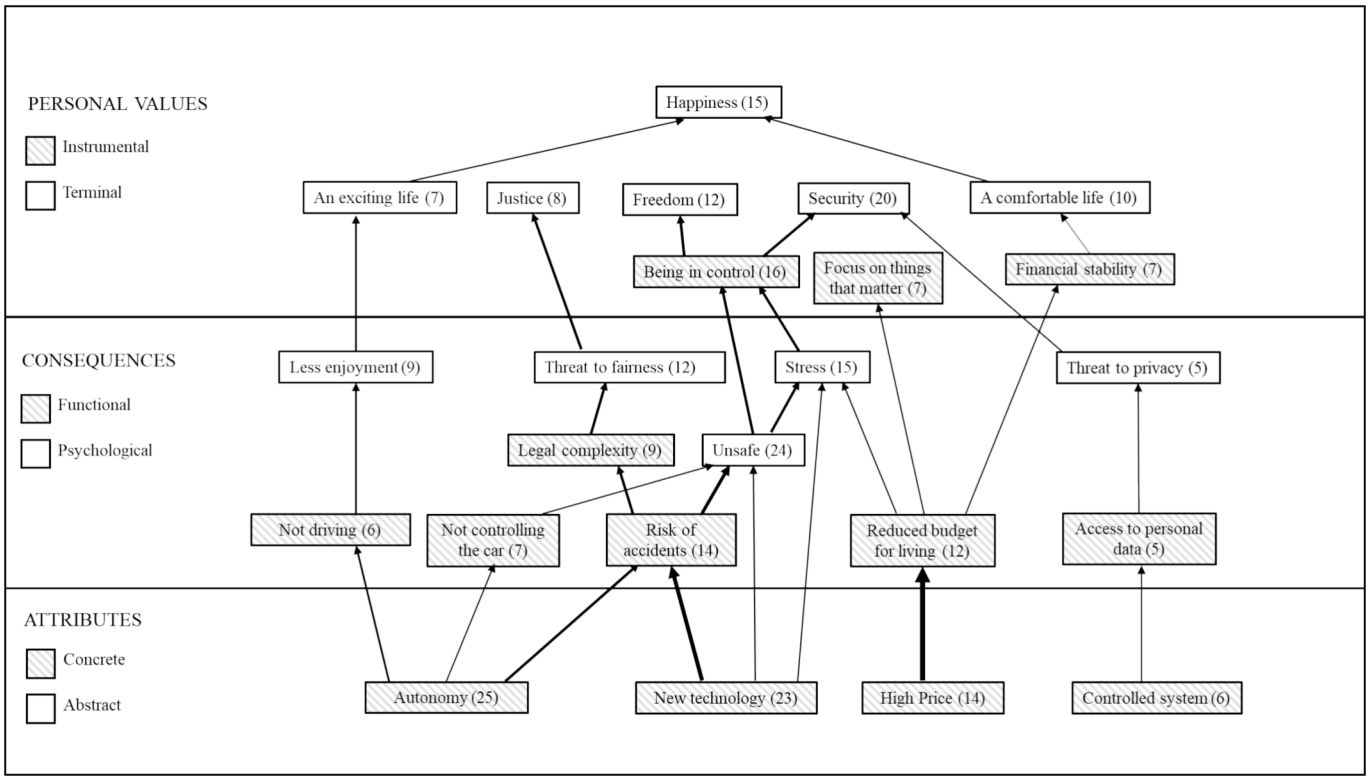

Fig. 2. Hierarchical value map for autonomous cars' non-adoption (Study 1).

of "feeling innovative" and "social recognition" would be attained, as noted in the remarks below:

> *"I think about technology, it would be really cool and really nice to drive an autonomous car, you are really up with the technology you are leading the trend. So you are a part of that."* (female respondent; age: 27)
>
> *"…a reason that is a bit less rational, more like vain or mundane. But it will be like it's new and it will probably be seen as cool. Because everybody will still be driving their own car and you are not so it's a luxury. This is cool, you know, new technology, very futuristic. Maybe feeling like you're ahead of other people."* (male respondent; age: 29)

However, a sizeable number of respondents (23 respondents) also associate the novelty of driverless technology with undesired consequences of "accidents", "stress" and "reduced safety". Such consequences are regarded as important given the prospect that driverless technology might impinge on "sense of control" and "security", as illustrated below:

> *"I can't see myself, as of yet, adopting or getting into a car that drives itself on its own. I know you'd ask why and possibly I would say that the lack of trust and confidence. I don't believe that technology is 100% there yet. And as a human being, I do tend to trust my abilities slightly more than I should and that goes to comparison with a car that drives itself on its own."* (male respondent; age: 36).

Intriguingly, stress is associated with the financial risk inherent to the purchase of an autonomous car. High price of autonomous cars raises concerns about "living standards", thus it is associated with "stress" and "financial instability". Financial instability, in turn, is perceived to inhibit the attainment of the personal value of "living a comfortable life". High price, stress and financial instability thus explain non-adoption.

3.3.3. A means toward equality promotion

Personal values benefiting the individual are not the only values guiding consumers' decisions to adopt autonomous cars. Consumers are also concerned about realizing societal values. As autonomous cars drive by themselves, society-relevant desired consequences include "having fewer driving requirements" and yet "greater inclusiveness" of individuals with disabilities. The importance of such consequences is explained by consumers' concerns about satisfying the value of "equality", as exemplified below:

> *"I don't know, I think that's the next level of driving because now you need to take a test, you need to have the experience, you need to have some knowledge about driving. But if it's an autonomous car, it means everyone can drive. Anyone can have their own car and even if you're disabled, even if you're blind. We can all drive, I mean, it's really good."* (female respondent; age: 30)

In this sense, autonomous cars are seen to act as a catalyst for the creation of an inclusive society based on equal opportunities.

3.3.4. Both a guarded and a threatened sense of security

A widely mentioned attribute serving adoption is autonomous cars' reliability. This attribute is associated with the desired functional consequence of "having fewer accidents" and the psychological consequence of "feeling safe". Both consequences are perceived to be conducive toward guarding the terminal value of "sense of security". Yet, the very same technology behind autonomous cars is associated with the undesired functional consequence of "access to personal data" and the psychological consequence of "threat to privacy", as the controlled systems installed in autonomous cars enable automakers to access drivers' personal data. Such undesired consequences are perceived to threaten one's "sense of security in life", as further illustrated below:

> *"I also feel because all of this is very… the car is taking all of the data that is being stored. So I don't know about it from the privacy angle, a lot of the data to know where you going, your every move, your routes are being stored, so how to let data be misused is also what I feel might be an issue."* (female respondent; age: 27)

One's sense of "threat to security" is heightened when individuals anticipate autonomous cars to be lacking safety, given a general distrust in the reliability of this new technology. Thus, "sense of control" is also questioned, as further exemplified below:

> *"My feeling is I just don't know how reliable the technology is. If there is something that happens and also there is no driver in the car, how can you control it? That's very risky from my perspective and that's the reason… although car manufacturers can claim that the reliability of the car is like 99% or even above that. But still, how can you just make me trust that? How can you make me feel that okay, if I just sit in the autonomous car, nothing dangerous will happen?"* (male respondent; age: 29).

4. Study 2

A follow-up, online survey was conducted to; (a) quantitatively assess the relative importance of ladders identified in Study 1 along with the strength of linkages within the ladders, and (b) enhance the generalizability of findings from Study 1 by establishing the convergence of two sources of data (Natow, 2020). Such assessment is important for theory advancement and for the allocation of resources by car manufacturers. While refraining from offering formal hypotheses, we expected the ladders identified in Study 1 to be supported, with autonomous cars' attributes being linked to desired and/or undesired, psychological and functional consequences for both the self (e.g., enjoyment) and for society (e.g., fairness), and personal values modulating their importance, in line with our theorizing.

4.1. Sampling and measures

The sample consisted of 601 UK participants recruited from the online panel Prolific (prolific.co). The suitability of Prolific for social science research has been confirmed (Peer et al., 2017). We selected younger consumers prone to adopting autonomous products, in line with Study 1, as well as older consumers to validate results with a larger sample. The sample was consistent in size across the two age groups – 21–35 years (N = 299) and 36 years and above (N = 302) – and included 63% females. The survey lasted approximately 10 minutes, and participants received £1 for their participation. We used 54 single-item measures from prior research and six self-developed items (see Appendix F), consistent with past research (Hohenberg et al., 2017; Paul et al., 2009). The self-developed items were constructed using the definitions of the attributes and consequences emerging from Study 1, in line with the approach followed by prior studies (Paul et al., 2009; Ter Hofstede et al., 1998). Results from a pilot study (n = 10) confirmed that the object of the constructs we measured could be easily and uniformly imagined by participants, thus providing support for the use of single-item measures (Bergkvist & Rossiter, 2007; Rossiter, 2002).

4.2. Procedure

Participants read about the purpose of the study and then watched the two-minute video from Study 1. When prompted, participants confirmed whether they would (or not) consider using/buying/renting an autonomous car. They were then assigned questions based on the stated intent to adopt or not autonomous cars. Results from the pilot study suggested that presenting all attributes, consequences and values in our hierarchical value maps did cause fatigue and distraction among participants. Hence, consistent with past research (Paul et al., 2009), participants first rated the importance of product attributes identified in our ladders, and for the attributes receiving the highest importance rating, they answered questions about associated consequences and values (see Fig. 1 and Fig. 2). All ratings were on a seven-point, Likert-type scale (1 = strongly disagree, 7 = strongly agree). For instance, participants were asked "With an autonomous car, I would value that such a car … (a) drives by itself, … (b) incorporates very novel technology, … (c) is reliable, … (d) is seen as cool". If an attribute was rated as important (i.e., received a score of 5 or above), participants answered questions about the psychological and functional consequences identified in our ladders. Accordingly, if participants rated "autonomy" highly, a representative follow up question asked "The fact that autonomous cars drive by themselves is important to me because … (a) I could rest while in the car … (b) I would have extra time while in the car … (c) I would have more flexibility … (d) I would have greater convenience … (e) there would be fewer legal and formal requirements to ride such cars". If participants rated a consequence as important (e.g., "convenience") which was connected in the ladder to other consequences, they were probed to rate the importance of all linked consequences. Lastly, focusing on the consequences rated with a score of 5 or above, we asked to confirm the importance of associated personal values. For instance, if "flexibility" was rated as important, participants answered follow up questions such as: "Having greater flexibility with an autonomous car is important to me because … (a) I could do other things instead of driving, (b) I would feel being in control of my life". If a participant did not rate an attribute or a consequence as important (i.e., a score of 4 or below), the actual score was recorded, and questions about direct or indirect linkages within the ladders were not presented.

4.3. Data analysis and findings

We analyzed the relative importance of ladders identified in Study 1 following the approach used in past research (Paul et al., 2009). Because ladders include interlevel linkages between attributes, consequences and values, the strength of linkages (direct and indirect) within the ladders was captured. Given our focus on adoption/non-adoption of autonomous cars as a personal values-directed behavior, we assume that the proportion of participants associating a specific attribute of autonomous cars to certain consequences, and in turn personal values, explains why an attribute is salient toward attaining certain personal values. Tables 3 and 4 summarize the frequency with which the attribute-consequences-values ladders, including direct and/or indirect linkages, were identified as important (i.e., scores of 5 or above), when pondering adoption and non-adoption of autonomous cars. To further enhance generalizability, we tested the strength of linkages within the ladders across age groups by conducting χ^2 tests.

The survey results confirm the bipolar hierarchical value maps developed in Study 1. When considering autonomous cars' adoption (see Table 3), we find that ladders derived from qualitative interviews are consistently supported, though to varying degrees. Specifically, 72.26% of participants are willing to adopt autonomous cars on the basis that the reliability of such innovation would minimize accidents (functional consequence) and make them feel safe (psychological consequence), thus attaining security in life. By comparison, a smaller number of participants consider adopting autonomous cars based on the prospect that the novel, cool technology embedded in such cars will make them feel contemporary and confident, in line with personal values of innovativeness and social recognition (26.64% and 21.90% respectively). A sizeable share of participants agree on the importance of autonomy in: (i) gaining convenience (53.28%) and (ii) the chance to rest (51.46%), and lowering stress and anxiety, all aspects which are conducive to having a comfortable, happy life. Autonomy is associated with increased flexibility to do other things and greater enjoyment, which contribute toward living an exciting happy life (43.07%) and toward enhanced sense of control and freedom in life (46.35%). Autonomy is also linked to freeing up extra time to do work (26.64%), learn (29.56%), socialize (36.13%), do other things (39.78%), all deemed central to one's self-accomplishment, exciting life, and in turn, happiness. The strength of linkages in the adoption ladders is only marginally affected by age, with significant age differences detected for just six of the 17 ladders. Compared with older consumers, younger ones are more motivated by values of self-accomplishment, exciting life and social recognition when pondering autonomous cars' adoption.

Table 3
Relative importance of Attributes-Consequences-Values ladders for autonomous cars' adoption.

Attributes-Consequences-Values linkages	Overall sample (n = 274)	Age 21–35 (n = 151)	Age 36 or above (n = 123)	$\chi 2$
Autonomy → Extra time → Work → Productive & competent → Self-development → Accomplishment → Happiness	26.64%	31.79%	20.33%	4.56*
Autonomy → Extra time → Learn → Productive & competent → Self-development → Accomplishment → Happiness	29.56%	37.75%	19.51%	10.83*
Autonomy → Extra time → Socialize → Enjoyment → An exciting life → Happiness	36.13%	37.75%	34.15%	0.38
Autonomy → Extra time → Do other things → Enjoyment → An exciting life → Happiness	39.78%	44.37%	34.15%	2.96
Autonomy → Extra time → Convenience → Do other things → Enjoyment → An exciting life → Happiness	40.15%	44.37%	34.96%	2.50
Autonomy → Extra time → Convenience → Less stress & anxiety → A healthy life → A comfortable life → Happiness	40.51%	41.06%	39.84%	0.04
Autonomy → Extra time → Flexibility → Being in control → Freedom → Happiness	39.42%	44.37%	33.33%	3.46
Autonomy → Extra time → Flexibility → Do other things → Enjoyment → An exciting life → Happiness	42.34%	47.68%	35.77%	3.94*
Autonomy → Convenience → Do other things → Enjoyment → An exciting life → Happiness	45.62%	50.99%	39.02%	3.91*
Autonomy → Flexibility → Do other things → Enjoyment → An exciting life → Happiness	43.07%	48.34%	36.59%	3.82
Autonomy → Flexibility → Being in control → Freedom → Happiness	46.35%	49.01%	43.09%	0.95
Autonomy → Convenience → Less stress & anxiety → A healthy life → A comfortable life → Happiness	53.28%	53.64%	52.85%	0.02
Autonomy → Rest → Less stress & anxiety → A healthy life → A comfortable life → Happiness	51.46%	51.66%	51.22%	0.01
Autonomy → Few requirements > Inclusiveness → Equality	24.09%	27.15%	20.33%	1.73
Novel tech → Cool → Contemporary → Being innovative	26.64%	33.11%	18.70%	7.21*
Novel tech → Cool → Confident → Social recognition	21.90%	29.14%	13.01%	10.31*
Reliable → Few accidents → Feel safe → Security	72.26%	74.83%	69.11%	1.11

Note: *$p < 0.05$.

In relation to non-adoption (see Table 4), we find that 63.61% of participants report non-adoption on the grounds of the high price of autonomous cars and the undesired consequence of having a reduced budget for living, which shifts the focus away from priorities in life. Relatedly, 61.47% of participants are concerned that a reduced budget creates financial instability, thus hinders the ability to live a comfortable, happy life. A sizeable number of participants are unwilling to adopt autonomous cars because autonomy could threaten security in life, due to either the risk of accidents and feelings of being unsafe and stressed (48.01%), not in control of life (48.62%), or the envisaged lack of control over the car, which is also linked to stress (46.48%) and hindrance to attaining control in life (48.01%). By comparison, the lowered sense of enjoyment derived from enhanced autonomy and the impact on living an exciting, happy life is less concerning (11.31%).

Further looking into non-adoption, the value of security in life is a conspicuous concern given the novel technology embedded in autonomous cars. Participants anticipate undesired consequences arising from such novel technology, including the risk of accidents causing stress (41.90%), lack of control (42.81%) and legal complexity (37.31%). The latter consequence is expected to cause unfairness, which is important for those caring about justice. Participants also ponder the prospect of privacy being under threat due to the controlled system embedded in

Table 4
Relative importance of Attributes-Consequences-Values ladders for autonomous cars' non-adoption.

Attributes-Consequences-Values linkages	Overall sample (n = 327)	Age 21–35 (n = 148)	Age 36 or above (n = 179)	$\chi 2$
Autonomy → not driving → less enjoyment → exciting life → happiness	11.31%	11.49%	11.17%	0.01
Autonomy → not controlling the car → unsafe → stress → being in control → freedom	34.86%	35.14%	34.64%	0.01
Autonomy → not controlling the car → unsafe → stress → being in control → security	46.48%	47.97%	45.25%	0.24
Autonomy → not controlling the car → unsafe → being in control → freedom	37.61%	38.51%	36.87%	0.09
Autonomy → not controlling the car → unsafe → being in control → security	48.01%	48.65%	47.49%	0.04
Autonomy → risk of accidents → legal complexity → threat to fairness → justice	36.39%	40.54%	32.96%	2.01
Autonomy → risk of accidents → unsafe → stress → being in control → freedom	39.45%	40.54%	38.55%	0.14
Autonomy → risk of accidents → unsafe → stress → being in control → security	48.01%	50.00%	46.37%	0.43
Autonomy → risk of accidents → unsafe → being in control → freedom	42.20%	45.27%	45.27%	1.04
Autonomy → risk of accidents → unsafe → being in control → security	48.62%	52.03%	45.81%	1.25
Novel technology → unsafe → stress → being in control → freedom	38.84%	39.86%	37.99%	0.12
Novel technology → unsafe → stress → being in control → security	42.20%	41.89%	42.46%	0.01
Novel technology → unsafe → being in control → freedom	40.67%	40.54%	40.78%	0.01
Novel technology → unsafe → being in control → security	44.34%	43.92%	44.69%	0.02
Novel technology → stress → being in control → freedom	39.45%	40.54%	38.55%	0.14
Novel technology → stress → being in control → security	43.73%	43.92%	43.58%	0.01
Novel technology → risk of accidents → unsafe → stress → being in control → freedom	39.14%	37.84%	40.22%	0.19
Novel technology → risk of accidents → unsafe → stress → being in control → security	41.90%	39.86%	43.58%	0.46
Novel technology → risk of accidents → unsafe → being in control → freedom	39.45%	39.86%	39.11%	0.02
Novel technology → risk of accidents → unsafe → being in control → security	42.81%	42.57%	43.02%	0.01
Novel technology → risk of accidents → legal complexity → threat to fairness → justice	37.31%	37.84%	36.87%	0.03
High price → reduced budget for living → stress → being in control → freedom	39.45%	41.89%	37.43%	0.68
High price → reduced budget for living → stress → being in control → security	39.45%	42.57%	36.87%	1.10
High price → reduced budget for living → focus on things that matter	63.61%	69.59%	58.66%	4.19*
High price → reduced budget for living → financial stability → comfortable life → happiness	61.47%	66.22%	57.54%	2.57
Controlled system → access to personal data → threat to privacy → security	41.59%	44.59%	39.11%	1.01

Note: *$p < 0.05$.

autonomous cars, which is expected to expose personal data (41.59%). Attaining freedom in life features equally prominently as a concern due to; (i) autonomy being envisaged to lower control over the car (34.86%) while increasing the risk of accidents (42.20%), (ii) the novel technology being perceived as unsafe (44.34%), and (iii) the high price of this innovation reducing budget for living while increasing stress and a sense of loss of control in life (39.45%). The strength of linkages in the non-adoption ladders is largely unaffected by age; there is age difference for only one of 26 ladders. When compared with older consumers, younger ones appear more concerned about the high price of autonomous cars, reduced budget for living and the accomplishment of things that matter in life.

5. Discussion

5.1. Theoretical implications

Our research makes notable contributions to theory. First, we propose a personal values-directed perspective on consumers' adoption of highly novel innovations such as autonomous cars. Prior studies argue for facilitators of autonomous cars' adoption, including freeing up time (Bertrandias et al., 2021; Hohenberg et al., 2017), ease of use and usefulness (Nastjuk et al., 2020; Park et al., 2021), and enhanced performance (Foroughi et al., 2023; Meyer-Waarden & Cloarec, 2022). The same studies identify inhibitors of adoption such as anxiety (Hohenberg et al., 2017; Huang & Qian, 2021) and perceived risk (Bertrandias et al., 2021; Jing et al., 2023). We advance knowledge by explaining when and why facilitators and inhibitors of autonomous cars' adoption at times overlap. Specifically, we demonstrate that personal values function as a sense-making mechanism dictating when certain attributes of autonomous cars are envisaged to lead to desired and/or undesired consequences of adopting such innovations. In practice, both desired and undesired consequences can be associated with one attribute of autonomous cars, given the prospect of personal values being (or not) attained. This means that a discussion of facilitators and inhibitors of autonomous cars' adoption is only meaningful to the extent that consumers' sense-making process is accounted for. Complementing earlier accounts (see Appendix A), we identify a comprehensive set of desired and undesired, psychological and functional consequences associated with autonomous cars' attributes and personal values, for decisions concerning adoption and non-adoption. Further, we quantitatively assess the relative importance of attributes, consequences and values across different groups of consumers. While our findings are specific to autonomous cars, the importance of personal values extends to evaluations of other highly novel innovations.

More broadly, our evidence contributes to prior technological innovation research by demonstrating the importance of personal values in explaining adoption decisions. Prior studies have often used models of technology adoption such as the Technology Acceptance Model and the Unified Theory of Acceptance and Use of Technology, which conceptualize a limited set of factors as drivers of adoption or resistance (Foroughi et al., 2023; Park et al., 2021). We explain how individual variables, namely human values, guide adoption decisions. Particularly, we show paths through which specific attributes of innovations like autonomous cars can lead to both desired and undesired consequences of adoption, depending on the likely accomplishment of fundamental values in life.

Second, we demonstrate the application of means-end chain analysis combined with survey design to investigate consumers' adoption of innovations. Prior innovation adoption models tend to be prescriptive regarding the variables that promote adoption or resistance (see the reviews by Arts et al., 2011; van Oorschot et al., 2018). Such an approach can limit the ability to identify a comprehensive set of consumer-perceived, desired and undesired consequences of novel innovations like autonomous cars, and it overlooks the role of personal values in explaining when and why innovation attributes drive and/or hinder adoption. The proposed approach overcomes such limitations by systematically capturing innovation attributes deemed salient by consumers, along with envisaged desired and undesired consequences, and it explains how personal values give meaning to consequences. Further, we show how means-end chain analysis can be complemented by a survey to assess the relative strength of attributes-consequences-values chains of adoption and non-adoption.

In a novel advancement to means-end chain analysis, we introduce *bipolar* hierarchical value maps elucidating consumers' sense-making process in autonomous cars' adoption or non-adoption decisions. Using bipolar hierarchical value maps, adoption and non-adoption decisions are explained organically through probing into a multitude of attributes and explaining associations with consequences and values. The bipolar hierarchical value maps align with growing evidence that reasons for adoption and non-adoption are qualitatively different, thus need to be examined in tandem (Casidy et al., 2021; Claudy et al., 2015; Garcia et al., 2007). While our findings are specific to autonomous cars, the approach can be applied to autonomous products and any yet-to-be-commercially-launched innovations.

5.2. Managerial implications

Our findings offer, for the first time, an evidence-based account on how autonomous cars can be best designed and promoted. Our bipolar hierarchical value maps support innovation processes by enabling managers to understand which attributes of autonomous cars are meaningful to consumers given their personal values. Furthermore, our survey enables managers to verify the attributes-consequences-values linkages and to quantitatively assess their relative strength across different consumer segments.

At a general level, we advise managers against using a one-size-fits-all approach to promoting autonomous cars. Our findings suggest that personal values matter in innovation adoption decisions. Different segments of consumers might therefore respond to highly novel innovations based on the personal values they seek to attain in life. Likewise, the same attribute of autonomous cars can drive adoption and non-adoption depending on personal values. For instance, when aiming to attain self-accomplishment, consumers are appreciative of the enhanced autonomy of such cars. The values of self-accomplishment, exciting life and social recognition are particularly conspicuous among younger consumers, as evidenced by Study 2. By contrast, older consumers value innovations that provide a sense of control in life. For the latter group, autonomy increases risk, stress and legal complexity in the event of accidents. Our findings raise managerial awareness about the significance of personal values in consumers' decisions to adopt or not highly novel innovations like autonomous cars.

Accordingly, we recommend managers to tailor promotional campaigns to their target audience. For instance, the attribute of autonomy could be accentuated when targeting consumers who care about self-development. One intuitive way to do so would be to showcase how autonomous cars enable career progression. Advertisements might include the image of a young professional who feels productive after having completed work-related tasks while riding in a driverless car. Further, the interiors of autonomous cars could be designed with added comforts such as a height-adjustable table, a Wi-Fi hotspot, a fast USB charging point, or a multizone climate system; all features that facilitate working while being transported. By contrast, for consumers concerned about retaining control in life, messaging shall offer reassurance about legal complexity in using autonomous cars. One approach could be to show how to navigate legal procedures in the event of road accidents. When dealing with younger consumers (21–35 years of age), messaging that stresses the benefits of autonomous cars given its premium price could be beneficial. Alternatively, a systematic approach toward segmenting prospective users and targeting high income consumers is advised. Our results may be used as input for the clustering of consumers.

Relatedly, the novelty of driverless technology should not be overstated. We find that, while contributing to social recognition for some consumers, the novelty of autonomous cars comes with the dilemma of restricted sense of freedom and security in life; both values are perceived to be undermined when the risk of accidents is envisaged. Accordingly, we advise communicating the safety features of autonomous cars vigorously. Sales representatives could also be trained to educate consumers about safety features during test drives. Likewise, car manufacturers may present autonomous cars as a modern technology promoting equality in society. The latter aspect is important for consumers who care about equality in society.

Lastly, our bipolar hierarchical value maps combined with the survey approach offer a practical market research tool for capturing consumer-perceived, desired and undesired consequences associated with yet-to-be-commercially-launched innovations, alongside the relative strength of attributes-consequences and consequences-values linkages. By employing the proposed approach , potential adopters of certain innovations can be probed before market launch. While pertinent to autonomous cars, our approach has wide applicability beyond this category and extends to other autonomous products. For instance, with kitchen robots, the need for touch or taste in cooking might be at conflict with desire for self-development, thereby determining adoption and non-adoption decisions (Leung et al., 2018). Our approach can prove useful toward revealing the circumstances that explain the adoption of such autonomous products.

5.3. Limitations and areas for further research

Our paper's limitations present avenues for future research. First, our findings summarized in the hierarchical value maps illustrate the most prominent ladders for adoption and non-adoption. We combined such findings with a quantitative assessment of the relative strength of the identified ladders, using a larger sample of consumers belonging to different age groups, thus enhancing the generalizability of Study 1. Based on the ladders unveiled in our paper, future research could run a multidimensional clustering of autonomous cars' adopters (and non-adopters) accounting for the prominent attributes, consequences and personal values in the ladders and other profiling characteristics. Insights could inform companies' decisions about marketing mix.

Second, our approach allowed us to unearth an array of desired and undesired consequences that consumers associate with autonomous cars' attributes. The identified consequences offer a rich view of the sense-making mechanism underlying autonomous cars' adoption and non-adoption. Further, we establish the relative prevalence of identified consequences in relation to attributes and personal values, further comparing consumers of different age groups. Future studies could use experiments to isolate the effects of specific attributes on consequences, and in turn values, thus enhancing the internal validity of our findings. Given the novelty of autonomous cars, our findings capture the opinions of UK consumers at the current stage of innovation development, anticipating the consequences of adoption and non-adoption decisions. Once autonomous cars are formally commercialized in the UK and regularly circulate on public roads, research might consider examining attributes and consequences accruing from the experience of driving, renting or sharing such cars.

Lastly, some of the ladders in our findings appear to speak to consequences and personal values that might logically extend the relevance of autonomous cars to society. Future research could examine the adoption of autonomous cars from a societal value systems perspective (Rohan, 2000), thereby accounting for people's societal value systems and priorities.

CRediT authorship contribution statement

B. Crisafulli: Writing – original draft, Project administration, Methodology, Data curation, Conceptualization. **R. Guesalaga:** Writing – original draft, Methodology, Formal analysis, Conceptualization. **R. Dimitriu:** Writing – original draft, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Summary of key studies on consumers' adoption of autonomous cars

Study	Research purpose	Theory	Method	Personal values	Drivers (D)/Inhibitors(I)	Key findings
Hohenberg et al. (2017)	Examine how benefits, anxiety-related affect and their interplay influence willingness to use autonomous cars	No grand theory	Survey	YES – self-enhancement; openness-to-change, conservation, self-transcendence as covariates	D: Economic, time, safetyI: Anxiety	Perceived benefits increase and anxiety decreases the willingness to use autonomous cars; the positive effect of benefits decreases with anxiety. Self-enhancement dampens the negative effect of anxiety.
Nastjuk et al. (2020)	Analyze the drivers of autonomous driving acceptance	Extended Technology Acceptance Model	Survey	NO	D: ease of use, usefulness	Perceived ease of use (anticipated enjoyment, innovativeness), and usefulness (compatibility, relative advantage and innovativeness) influence intent to use autonomous driving.
Huang & Qian (2021)	Examine how consumers' reasons for adoption influence attitudes and adoption intent, as moderated by psychological traits	Behavioral reasoning theory	Survey	NO – face consciousness (cultural value)	D: Improved efficiency, mobility needs fulfilment, road safety I: Anxiety, safety concerns, cyber security	Reasons for (against) adopting positively (negatively) influence attitudes toward autonomous cars and intentions to adopt. Need for uniqueness (risk aversion) strengthens the effect of reasons for (against) adoption. Face consciousness positively influences both reasons for, and against adoption.

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Study	Research purpose	Theory	Method	Personal values	Drivers (D)/Inhibitors(I)	Key findings
Bertrandias et al. (2021)	Develop and test a model of the antecedents of value attributed to autonomous cars	No grand theory	Survey	NO	D: ability to overcome human weakness, outperform human capacities, free up timeI: Performance risk, risk of competency loss, security and privacy risk	Ability to overcome human weakness, free up time, outperform human capacities have a positive effect. Performance risk has a negative effect on perceived value via anticipated improvement in well-being. Risk of lost competencies has a direct effect on perceived value, while security and privacy risk do not.
Park et al. (2021)	Test usefulness, ease-of-use, social influence and facilitating conditions on intentions to use autonomous cars	Modified Technology Acceptance Model	Survey	NO	D: usefulness, ease-of-use	Perceived usefulness, social influence and facilitating conditions predict intentions to use autonomous cars. Age, marital status, family size, educational level moderate the effects of usefulness and social influence intent to use.
Casidy et al. (2021)	Examine the role of brands in overcoming resistance to autonomous cars	No grand theory	Survey & experiment	NO	I: Usage and risk barriers	Self-brand connection is positively associated with intentions to adopt autonomous cars, mediated by reduced risk barriers, especially for brands high in openness (vs conservation).
Lindgren et al. (2021)	Assess how anticipatory experiences impact autonomous cars' driving	No grand theory	Ethnography	NO	None	Methodological contribution. The anticipatory experiences of consumer confidence, hope and being-in-the-moment through imagining the use of autonomous cars are captured.
Eggers & Eggers (2022)	Examine consumer preferences when buying or renting autonomous cars	Brand extension theory	Choice experiment	NO	None	Technology brands are most successful when launching autonomous cars' brand extensions. Consumers prefer established automaker brands when purchasing, not when renting.
McLeay et al. (2022)	Investigate how personality traits motivate consumers to adopt autonomous cars	Mowen's 3 M model	Survey	NO	None	Personality traits (consciousness, openness to experience, agreeableness, need for material resources, need for arousal) influence autonomous cars' adoption intention either directly, or indirectly via self-identification expressiveness and innovativeness.
Meyer-Waarden & Cloarec (2022)	Examine how benefits and sacrifices influence performance expectancy, user well-being and technology trust	Extended Unified Theory of Acceptance and Use of Technology	Survey	NO	D: Hedonism, social recognition, technology security and trust, less effort, performanceI: privacy	Hedonism has a positive effect via performance expectancy, privacy has a negative effect via technology trust, and technology security has a positive effect via technology trust, on intentions to use autonomous cars. User innovativeness enhances the performance expectancy-use intentions link.
Dong et al. (2023)	Examine how self-car satisfaction bias affects acceptance of autonomous cars	Technology Acceptance Model	Driver simulator experiment & survey	NO	D: Perceived usefulness, ease of use, self-autonomous cars bias	Perceived usefulness and ease of use have a positive effect on attitude, which in turn affect intent to use autonomous cars. Self-autonomous car bias is a predictor of perceived usefulness.
Foroughi et al. (2023)	Determine the rank determinants of the intention to adopt autonomous cars	Modified Unified Theory of Acceptance and Use of Technology	Survey	NO	D: performance, less effort, hedonism, image	Important factors driving intentions to use autonomous cars are: trust, hedonic motivation, social influence, compatibility, effort expectancy. Performance expectancy predicts intentions to use autonomous cars when compatibility is high.

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Study	Research purpose	Theory	Method	Personal values	Drivers (D)/Inhibitors(I)	Key findings
Park & Han (2023)	Explore the external and internal factors affecting baby boomers' acceptance of autonomous cars	Automation Acceptance Model	Survey	NO	D: usefulness, ease-of-use	Usefulness, trust and compatibility drive autonomous cars' acceptance. Ease-of use, trust, compatibility drive usefulness. Prior knowledge and social influence positively impact usefulness, trust, compatibility and ease-of-use.
Jing et al. (2023)	Explore public perception of autonomous cars following an accident	Various adoption models	Social media data & survey	NO	D: TrustI: Perceived risk	Trust, attitude, knowledge, perceived risk, media exposure, and severity affect public acceptance of autonomous cars. Differences exist between fully automated autonomous cars and those with driver assistance.
Man et al. (2024)	Explored factors affecting the acceptance of level 4 automated cars amongst the public	Technology Acceptance Model	Survey	NO	D: perceived usefulness and ease of use, social influence, facilitating conditions (e.g. guidance), trust I: technology anxiety	Usefulness and ease of use explain autonomous cars' acceptance. Facilitating conditions positively influence usefulness and ease of use. Anxiety negatively influences usefulness. Usefulness builds trust.
Staab & Liebherr (2024)	Determine the role of subjective knowledge in acceptance of autonomous cars	Unified Theory of Acceptance and Use of Technology	Survey	NO	D: perceived ease of use, usefulness, trust, self-perceived knowledge, personal innovativeness I: perceived risk	Self-perceived knowledge results in high perceived ease of use, lower risk perception.
Our study	**Examine the role of personal values in explaining adoption and non-adoption of autonomous cars**	**Means-end chain theory**	**Laddering interviews**	**YES — Happiness, comfortable life, exciting life, freedom, equality, social recognition, security, justice, accomplishment**	**Desired & undesired psychological and functional consequences**	**Personal values function as a sense-making mechanism dictating when certain attributes of autonomous cars are envisaged to lead to desired and/or undesired consequences of adopting autonomous cars.**

Appendix B. Interview guide (Study 1)

Interview stage	Questions
Introduction	Presentation of the video stimulus Q1: The video should have given you an idea of what autonomous cars are about. Based on what you watched and your knowledge of autonomous cars, would you see yourself adopting autonomous cars at some point in the future? (*Participant answers Yes or No)* Q2: Why is that? What is the reason for your answer? Can you elaborate more?
Laddering	As needed, laddering down or laddering up: Q2.1 – laddering down: Can you please tell me more? What aspect about an autonomous car makes it [consequence ABC]? Q2.2- laddering up: Why is [attribute XYZ / consequence ABC] important to you? What does it mean to you? Q3. Are there more reasons for why you would adopt (would not adopt) an autonomous car?Repeat question together with procedure above until participant exhausts all the reasons for adopting (not adopting) an AC. Q4. *(Probing for reasons for the opposite)* You said you would (would not) adopt an autonomous car, and we discussed several reasons for it. Still, would you see any reasons for the contrary, i.e., why you would not (would) adopt an autonomous car? Reiterating laddering procedure above for reasons for the opposite
Thank you and dismiss	Thank you for your participation and link to Amazon e-voucher

To be filled in by interviewer:
Interviewee ID:_____
Interview date:_____
Interview time:_____
Gender of the participant:_____

Appendix C. Components of means-end chains based on Reynolds, Gengler, and Howard (1995)

Attributes	Consequences	Personal values
Concrete – tangible	*Functional* – factual outcomes of product use	*Instrumental* – short-term-related end states
Abstract – intangible	*Psychological* – personal and emotional outcomes of product use	*Terminal* – long-term-related end states

Appendix D. Implication matrix for adoption of autonomous cars (Study 1)

	Elements / Content codes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1	Autonomy					48.0	7.0	16.9	2.10	9.1	0.11	0.6	2.21	1.7		0.15	0.21	0.15		0.7	0.2	0.7	0.13	0.5	0.18		0.17	0.6	0.9	0.12	0.7	0.4	0.7	0.40
2	New technology			1.0	11.0												0.1	0.1						0.1		0.6	0.2	0.8	0.2	0.1	0.2			0.3
3	Reliable						1.0								10.0		2.1				1.9	0.1		0.2	0.1				0.2	0.2		0.7	0.1	0.3
4	Cool							1.0			0.1						0.1	1.0	6.0	4.1						0.5	0.3	0.7	0.1		0.2			0.3
5	Extra time							8.0	8.1	1.0	11.0	5.0	9.10	4.1		0.12	2.5	0.9		1.5			0.11	0.4	0.5		0.15	0.4	0.5	0.5	0.6			0.23
6	Few requirements																					8.0											0.8	
7	Convenience								2.0		1.0	1.0	6.0	2.0		0.2	10.2	1.3		0.1			0.3	0.1	1.8		0.2	0.2	0.3	0.8				0.15
8	Flexibility												6.0			1.0		1.2						4.1	0.1				1.5	0.1	0.1			0.8
9	Rest															1.0	5.0				2.0				1.3				0.1	0.2		0.3		0.2
10	Work															6.0	1.0			3.1			0.5				1.6	0.3						0.3
11	Learn															5.0							2.5				0.6	0.1						0.3
12	Do other things													1.0		2.0	3.0	8.0		0.1			0.2	1.1	2.1		1.2		2.2	1.2	0.4			2.9
13	Socialize																	5.0		1.0											0.3			2.6
14	Few accidents																1.0				9.0			0.1				0.1				0.6		0.2
15	Productive & competent																			1.0			10.1		1.0		2.10	0.1						0.4
16	Less stress & anxiety																			1.0			1.0	1.1	14.0		0.1		1.1	2.8		1.0		2.10
17	Enjoyment																												2.0		7.0			6.6
18	Contemporary																			1.0						6.0	0.1	0.4	0.1	0.1	0.1			0.2
19	Confident																						1.0	1.0			1.1	9.1						0.2
20	Feel safe																							1.0					0.1	1.0		8.0		0.2
21	Inclusiveness																																	8.0
22	Self-development																										13.0	1.0						0.5
23	Being in control																												6.0					1.3
24	A healthy life																													11.0	1.0	2.0		5.7
25	Being innovative																										1.0	2.1	1.0	1.0	1.0			0.2
26	Accomplishment																											2.0						6.0
27	Social recognition																																	3.0
28	Freedom																																	6.0
29	A comfortable life																																	7.0
30	An exciting life																																	4.0
31	Security																																	2.0
32	Equality																																	
33	Happiness																																	

In populated cells, numbers before "." represent the number of times that direct links between concepts occur, whereas numbers after "." represent the number of times that indirect links between concepts occur.

Appendix E. Implication matrix for non-adoption of autonomous cars (Study 1)

	Elements / Content codes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Being autonomous					8.0	7.0	10.0	1.10			0.8	0.3	2.3	0.10		0.8			0.7	0.5		0.9	0.6	0.6
2	Technology is too new						1.0	13.0					5.12	5.12			0.8				0.2	0.2		0.13	0.2
3	High price									18.0				0.5			0.2	0.5	0.6	0.1	0.3	0.8		0.3	0.6
4	Controlled system							2.0			6.0		0.1	0.1		0.5	0.1				0.2	0.2		0.5	0.1
5	Miss the driving experience											8.0								0.7					0.6
6	Not controlling the car												4.0	2.0			2.5				0.3			0.5	
7	Risk of accidents								10.0				12.0	2.7	0.9		1.8				0.4	0.1	0.8	0.9	0.1
8	Legal complexity													1.0	10.0		0.1						0.9		
9	Reduced budget for living													5.0			1.0	4.1	5.1	0.1	0.3	2.7		0.3	0.6
10	Access to personal data													1.0		5.0					0.1	0.2		0.4	0.1
11	Less enjoyment																			7.0					0.6
12	Unsafe													9.0			7.3				0.3	0.1		3.10	
13	Stress																9.0				2.3	3.2		9.5	
14	Threaten to fairness																						9.0		
15	Threaten to privacy																				1.0	0.1		4.0	0.1
16	Be in control																				8.1	1.0		9.1	
17	Focus on things that matter																			1.0	2.0	2.0			0.1
18	Financial stability																					4.0		1.0	1.1
19	An exciting life																								6.0
20	Freedom																								1.0
21	A comfortable life																								5.0
22	Justice																								
23	Security																								2.0
24	Happiness																								

* In populated cells, numbers before "." represent the number of times that direct links between concepts occur, whereas numbers after "." represent the number of times that indirect links between concepts occur.

Appendix F. Measures table (Study 2)

Constructs	Type	Measurement items	References
Autonomy	A	Autonomous cars drive by themselves	Rijsdijk & Hultink (2003)
New technology	A	Autonomous cars incorporate very novel technology	Schweitzer & Van den Hende (2016)
Coolness	A	Autonomous cars are seen as cool	Schweitzer & Van den Hende (2016)
Reliable	A	Autonomous cars are reliable	Nastjuk et al. (2020)
High price	A	Autonomous cars are highly priced	Nastjuk et al. (2020)
Controlled system	A	Autonomous cars have a controlled system able to access my personal data	Self-developed item
Rest	C	I could rest while in the car	Self-developed item
Extra time	C	Extra time while in the car	Hohenberg et al. (2017)
Work	C	Extra time to work	Hohenberg et al. (2017)
Learn	C	Extra time to learn new things	Hohenberg et al. (2017)
Socialize	C	Extra time to socialize with others	Hohenberg et al. (2017)
Do other things	C	Extra time to do other things instead of driving	Hohenberg et al. (2017)
Convenience	C	I would have greater convenience	Hohenberg et al. (2017)
Flexibility	C	I would have more flexibility	Hohenberg et al. (2017)
Legal requirements	C	There would be fewer legal and formal requirements to ride such cars	Rijsdijk & Hultink (2003)
Risk of accidents	C	There would be fewer accidents on the road	Hohenberg et al. (2017)
		… concerning due to the risk of accidents [R]	
Stress	C	I would feel less stressed and anxious	Paul et al. (2009)
		… that would make me feel stressed [R]	
Productive and competent	C	I would feel more productive and competent	Hohenberg et al. (2017)
Enjoyment	C	I would enjoy myself more	Qian et al. (2023)
		I would not be enjoying myself without the experience of driving [R]	
Inclusiveness	C	… would promote inclusiveness	Self-developed item
Contemporary	C	… would make me feel contemporary	Nastjuk et al. (2020)
Confident	C	… would make me feel confident	Self-developed item
Feel (un)safe	C	… would make me feel safe	Nastjuk et al. (2020)
		… that would make me feel unsafe [R]	
Driving	C	… I would not be the one driving	Casidy et al. (2021)
Control of the car	C	… I would not be in control of the car	Casidy et al. (2021)
Budget for living	C	… that would reduce my budget for day-to-day living	Self-developed item
Access to personal data	C	… that would allow access to my personal data by third parties	Nastjuk et al. (2020)
Fairness	C	… that would be a threat to fairness	Self-developed item
Privacy	C	… that would be a threat to my privacy	Nastjuk et al. (2020)

(*continued on next page*)

(*continued*)

Constructs	Type	Measurement items	References
Legal complexity	C	… that could bring legal complexity in determining who is responsible in the event of a road accident	Qian et al. (2023)
Healthy life	V	… helps me to have a healthy life	Rokeach (1973)
Comfortable life	V	… helps me to have a comfortable life	Rokeach (1973)
Self-development	V	… helps my self-development	Paul et al. (2009)
Accomplishment	V	… helps me to be accomplished in life	Paul et al. (2009)
Exciting life	V	… helps me to have an exciting life	Paul et al. (2009)
		… prevent me from having an exciting life [R]	
Be in control	V	I would feel being in control of my life	Rijsdijk & Hultink (2003)
		… that would prevent me from being in control of my life [R]	
Freedom in life	V	… gives me freedom in life	Paul et al. (2009)
		… that would limit my freedom [R]	
Equality	V	… that would promote equality in society	Hohenberg et al. (2017)
Being innovative	V	… would make me feel that I am innovative	Nastjuk et al. (2020)
Social recognition	V	… would make me socially recognized by others	Paul et al. (2009)
Security	V	… would give me a sense of security	Hohenberg et al. (2007)
		… that would prevent me from having security in life [R]	
Happiness	V	… would make me happy	Rokeach (1973)
		… that would prevent me from being happy [R]	
Justice	V	… that would go against social justice	Hohenberg et al. (2017)
Focus on things that matter	V	… that would prevent me from focusing on the things that matter in life	Rokeach (1973)
Financial stability	V	… that would prevent me from having financial stability	Hohenberg et al. (2017)
Adoption intent	–-	I would consider …	Nastjuk et al. (2020)
		… using an autonomous car as a mean of transport	
		… using an autonomous car as driver or co-driver	
		… buying an autonomous car if I could afford one	
		… renting an autonomous car if such an option becomes available	
Non-adoption	–-	I would not consider …	Nastjuk et al. (2020)
		… using an autonomous car as a mean of transport	
		… using an autonomous car as driver or co-driver	
		… buying an autonomous car if I could afford one	
		… renting an autonomous car if such an option becomes available	

Note: A = Attribute, C = Consequence, V = Value.

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Benedetta Crisafulli is Reader in Marketing at Birkbeck, University of London (UK). Her research focuses on areas in consumer behaviour, specifically consumer emotions in advertising and innovation adoption, crisis management, and digital communications. She has published extensively in top-tier international journals such as *Journal of Business Research, Journal of Service Research, Journal of Business Ethics*, *Industrial Marketing Management, Psychology & Marketing, Journal of Advertising Research* and *Technological Forecasting & Social Change*.

Rodrigo Guesalaga is Professor of Marketing at Universidad Alberto Hurtado (Chile). His research focuses on strategic sales, key account management, and digitization, the adoption of artificial intelligence, and responsible consumption. He has published extensively in highly prestigious international journals such as *Journal of Marketing, Journal of the Academy of Marketing Science, Industrial Marketing Management, International Marketing Review* and *Psychology & Marketing.*

Radu Dimitriu is Associate Professor in Marketing at Trinity College Dublin (Ireland). His research focuses on branding, consumer behaviour and psychology, social media marketing, CSR and prosocial behaviour, consumer responses to sensory-enabling technologies, and consumers' adoption of AI-enabled technologies such as autonomous products and *chatbots*. He has published extensively in top-tier international journals including *International Journal of Research in Marketing, Industrial Marketing Management, Psychology & Marketing, European Journal of Marketing* and *Technological Forecasting & Social Change.*