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A DECISION SUPPORT SYSTEM DESIGN TO OVERCOME RESISTANCE TOWARDS SUSTAINABLE INNOVATIONS

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Abstract

The concept of sustainability has been acknowledged as one of the central and most important issues of our time. However, technological innovations which provide a more sustainable way of living, for instance electric cars, are not always welcomed with open arms by consumers but often resisted at the beginning. As such, human resistance behavior can be explained as an interplay of different personality traits that favour the status quo. In this study, a decision support system design is introduced which bases on the concept of digital nudging that addresses innovation resistance on an individual's cognitive level by de-biasing innovation trial decision-making. An experimental pre-study is conducted to test the influence of different DSS modifications on the selection of electric cars in an online rental car booking scenario. First results show that DSS which set sustainable innovations as default option have a significantly positive effect on their trial probability while priming consumers towards electric car trial has no significant effect.

Keywords: choice architecture, electric car, experimental study, nudging, product trial

1 Introduction

The concept of sustainability has been acknowledged as one of the central issues of our time (Daniel and Talaei-Khoei, 2016). However, technological innovations which provide a more sustainable way of living, also called "sustainable innovations", are not always welcomed with open arms by consumers, often they are resisted at the beginning (Pichert and Katsikopolous, 2008). This resistance is caused by several reasons which only partly are related to the innovation itself. While consumers can indeed be open to environmental topics it is not ensured that they also test and adopt sustainable innovations (Ozaki, 2011). Pro-environmental behavior is shaped by external factors like infrastructure, political and social factors but also internal factors which comprise the value system and personality traits of the consumer (Kollmuss and Agyeman, 2002). One of the major barriers are the change of old behavioral patterns towards pro-environmental behavior. That is where the potential of information systems as facilitators of behavioral change lies. To gain more knowledge about appropriate and effective design of information systems to influence human actions about the natural environment will be necessary to establish sustainable behavior in society (Melville, 2010). The question of how an information system should be designed in order to draw the behavior of its user into a certain direction has been addressed by various approaches such as (e.g. Torning and Oinas-Kukkonen, 2009; Oinas-Kukkonen, 2010). Weinmann, Schneider and von Brocke (2015, p.3) in particular coined the term "digital nudging" which means the "*use of user interface design elements to guide people's choices or influence users' inputs in online decision environments"*. Digital nudging builds upon research from behavioral economics that prove that our environment has an influence on our decisions, whether intended by its designer or not (Thaler, Sunstein and Balz, 2013). However, research on the design of information systems as a medium of digital nudging, especially in case of sustainable decision-making, is still scarce (Benartzi and Lehrer, 2015).

In this study, we aim to address this lack of knowledge by building on theory from organizational change and behavioral economics to explain why consumers refrain from testing sustainable innovations. The goal of this paper is thus to propose and test a web-based decision support system (DSS) design for debiasing the trial decisions of consumers regarding sustainable innovations (Ariely, 2008). We aim to design a DSS that supports consumers to overcome their innate tendency to resist change (Stryja, Dorner and Riefle, 2017). This personality trait affects consumer decision-making in an innovation-averse manner such that conventional alternatives are preferred even if they are objectively seen the inferior choice (Oreg, 2003, 2006; Talke and Heidenreich, 2013). The research goal is to alleviate the impact of negative decision-making biases caused by personality traits by applying digital nudging in an online innovation trial decision. This paper complements the work of Stryja *et al.* (2017) by enhancing the application of research to the case of sustainable innovations, presenting the exact experimental design and by including initial results from a pilot study with a student sample. As sustainable innovation, we choose electric cars as from an environmental and social perspective, large-scale introduction of electric cars would help to reduce environmental pollution and therefore contribute to environmental sustainability (Jochem, Babrowski and Fichtner, 2015). Due to the climate goals of the European Union, countries have to reduce greenhouse gas emissions of passenger cars by up to 60% between 1990 and 2050 which urges them to promote alternative and more sustainable propulsion technologies (Abdelkafi, Makhotin and Posselt, 2013). But despite many federal promotion programs electric cars still fail to gain market acceptance (Dudenhöffer, 2013). One of the problems of electric cars is their perception as inferior choices even in settings where costs and utility are nearly identical compared to conventional cars, e.g. carsharing in cities where car range is sufficient for consumers needs (Holzer, 2015). There seems to be an innate consumer skepticism towards the capability of alternative propulsion technologies resulting in resistance behavior. This corresponds with a study that showed that consumers perceptions of electric cars change towards a much more positive opinion once they have tested the cars (Bühler *et al.*, 2014). Thus, the goal of this study is in designing a digital decision environment such that consumers are supported to be more open to test electric cars to reduce innate skepticism and thus alleviate resistance behavior.

The remainder of the paper proceeds as follows: Section 2 summarizes theoretical foundations relevant for our study. Section 3 introduces the research model and hypotheses of our research. Section 4 describes the empirical investigation to test the hypotheses and discusses first results from a pretest. Section 5 closes the paper with a discussion of the topic and its contribution to existing theory.

2 Theoretical Foundations

2.1 Electric Cars as Sustainable Innovations

Besides a few nations, in which the necessary share of electric cars has already been achieved (like e.g. in Norway), many European nations have difficulties to put the share of green cars on the necessary level because high consumer resistance can be observed (Bühler *et al.*, 2011; Steinhilber, Wells and Thankappan, 2013). Much research has been undertaken to identify acceptance factors for electric cars but only a few studies have focused on actual barriers for electric car adoption so far. As such, Franke *et al.* (2012) examine driving range as major psychological barrier and empirically test a comfortable driving range and relevant antecedents (e.g. personality traits and coping skills). Emotions and their role for electric car adoption is focus of Moons and De Pelsmacker (2012) who propose the relevancy of emotions and attitude as main predictors of usage intention. A stronger focus on barriers has the study of Wiedmann *et al.* (2011) who examine the relevancy of several risk factors on resistance towards alternative fuel technologies. The change in routines that comes along with the use of an electric car, e.g. remembering to charge the battery or adapting the long driving route to the driving range usually deters consumers from chosing electric cars (Bühler *et al.*, 2014). In summary, electric cars are highly relevant for environmental, social and economic sustainability. However, in most European countries, consumers hesitate to use and buy them despite their sustainability benefits (Egbue and Long, 2012).

Studies which focus on cognitive and behavioral factors as influencers on electric car adoption decisions are scarce. This study aims to contribute in filling this gap.

2.2 Resistance Towards Sustainable Innovations

Despite its negative connotation, resistance towards innovations and change in general is a common human reaction and a natural part of the innovation adoption process (Rogers, 1976; Ram and Sheth, 1989; Szmigin and Foxall, 1998). Adoption research largely focuses on how to achieve positive adoption outcomes like innovation acceptance while assuming that consumers are actually willing to evaluate new products, i.e. are open to change ("pro-innovation bias")(Talke and Heidenreich, 2013). However, product failure rates around 50 % show that the majority of consumers do not behave according to this paradigm (Ram, 1987; Ram and Sheth, 1989; Andrew and Sirkin, 2003). Theory on innovation resistance aims to understand why consumers refuse to consider (and thus evaluate) innovations they would possibly profit from. A particular causer of innate resistance behavior is the intrinsic human desire to maintain a "psychological equilibrium" which gives humans the feeling of safety and control and which might be disturbed by any change in behavior (Osgood and Tannenbaum, 1955). Since innovations are commonly aligned with some form of novelty and need for adaptation, they are likely to cause initial resistance behavior in consumers (Sheth, 1981; Talke and Heidenreich, 2013). Resistance can be understood as resistance to the behavioral change aligned with the innovation (McCrae and Costa, 1987; Talke and Heidenreich, 2013) and is typically expressed by three behavior forms: adoption postponement, rejection and active opposition (Szmigin and Foxall, 1998; Kleijnen, Lee and Wetzels, 2009). Innovation resistance is caused by several factors. (Talke and Heidenreich (2013) propose the distinction into active and passive resistance. Active resistance occurs when consumers consciously evaluate an innovation and refuse to adopt it due to functional barriers or because it does not match their belief system in terms of tradition and image (Ram and Sheth, 1989; Heidenreich and Spieth, 2013). In contrast, passive resistance occurs before the consumer evaluates the innovation and is caused by the personality trait defined as "dispositional resistance to change" (Heidenreich and Kraemer, 2015b; Laumer *et al.*, 2016a). It describes a general unwillingness for behavior or attitude change (Heidenreich and Handrich, 2014). Originally introduced by Oreg (2003), four elements have been proven as determinants of dispositional resistance to change: *routine seeking, cognitive rigidity*, *emotional reaction to imposed change* and *short-term focus* (e.g. Laumer, 2011; Heidenreich and Kraemer, 2015a; Laumer *et al.*, 2016b). The trait *routine seeking* is caused by a fear of losing emotional control in changing life situations. Routines therefore connote a feeling of stability in change situations (Oreg, 2003). *Cognitive rigidity* is expressed by a frequent selection of low levels of stimulation and a general unwillingness to giving up habits (Heidenreich and Handrich, 2014). The trait *emotional reaction to change* is described as the ability of humans to cope with psychological stress caused by changing situations (Oreg, 2003). Lastly, *short-term focus* refers to the human tendency to misperceive long-term gains as being less relevant than short-term gains (Tversky and Kahneman, 1975). Changing old behavioral patterns is one of the main barriers for pro-environmental behavior (Kollmuss and Agyeman, 2002). While the majority of consumers welcome the concept of sustainable development and campaigns that promote pro-environmental behavior, only a small share actually try green innovations like electric cars. This intention-behavior gap can be explained by several factors which affect consumer personality and information processing (Ozaki, 2011). Strong social norms are an important influencing factor since humans tend to follow activities that are regarded as norm within their social group. One way to communicate such a "social norm" is to set the socially desired choice alternative as default option since most decision makers consider those defaults as recommendations for best practices, e.g. installation of software packages (Pichert and Katsikopolous, 2008). Convenience of switching to the environmentally desirable behavior and a clear structure of information is important. Humans favor the status quo even when the benefits of changing outweigh the current alternative (Samuelson and Zeckhauser, 1988). This implies the necessity of making a behavioral change as easy as possible and to provide illustrative information such as the benfit about the environmental benefits of switching, e.g. via affective priming of positive associations.

2.3 Impact of Innovation Trial on Consumer Openness towards Innovations

The powerful influence of product trial for the formation of attitude and relationship to brands has been consistently shown in marketing research and psychology (Donnelly Jr. and Etzel, 1973; Kempf and Smith, 1998; Kempf, 1999). Direct experience leads to a stronger and more confident attitude which allows better predictions on behavior than experiences made by indirect advertising campaigns (Fazio and Zanna, 1978; Smith and Swinyard, 1982, 1983). Research on this topic largely evolved from the seminal works of Fazio and Zanna (1978) and Smith and Swinyard (1982) who focused on the comparison of the effect of product trial and indirect advertising in terms of brand cognition, brand attitude and attitude-behavior consistency. Product trial impacts the perception of a new product much more than advertisements since it provides the consumer with a direct sensory contact and allows them to touch and feel the product their own way (Soscia, Arbore and Hofacker, 2011). Due to this more intensive product experience, attention towards the product is higher and the self-generated information is perceived as more trustworthy (Kempf and Smith, 1998).

2.4 Choice Architecture in Decision Support Systems

Human decision makers are often challenged with complex and long-range decision scenarios in which they have to react quickly. Information systems can therefore work as assistive technologies by empowering functional abilities of decision makers or as decision support systems (DSS) by providing decisional guidance and relevant information such that the best option is identified faster and with less cognitive effort (Looney and Hardin, 2009; Vichitvanichphong *et al.*, 2014). This leads to a higher quality of decisions and an increased efficiency of decision processes (Looney and Hardin, 2009; Power, Ramesh Sharda and Burstein, 2015). The general purpose of a DSS is to compensate weaknesses in human decision making and to take advantage on the individual strengths of the decision maker (Hoch and Schkade, 1996). However, the way the DSS is designed, has a strong effect on the decision making process because it determines how choice options are perceived and selected (March and Storey, 2008; Johnson *et al.*, 2012). Human decision makers tend to use automatic and intuitive thinking processes, especially in stressful and uncertain situations which makes their decision-making susceptible for biases (Kahneman and Tversky, 1979). Choice architecture aims to design choice environments such that humans are supported to de-bias their thinking and decision processes. By incorporating nudges in the decision making process better alternatives can be highlighted and decision makers are supported to considerate (socially desired) options while not restricting their freedom of choice (Brown, 2012).

In our study, we refer to the approach of digital nudging which proposes a framework for nudging decision makers digitally by modifying the interface through which the decision is undertaken (Weinmann, Schneider and von Brocke, 2015; Stryja, Dorner and Riefle, 2017). As depicted in Stryja *et al.* (2017), we choose two choice architecture tools – default and priming - that have been proven to encourage decision makers to also take desirable options in account instead of rejecting them right away (Bargh, 2006; Pichert and Katsikopolous, 2008). The default option is the choice that is made when the decision maker refuses to decide (Thaler, Sunstein and Balz, 2013). Sticking to the default option allows the decision maker to reduce cognitive effort and to save time or money to take the decision. Especially in case of pro-environmental behaviour where people often face difficulties in merging conflicting goals (protecting the environment versus saving time or money), the use of defaults emphasizes the socially desired behaviour which potentially nudges them towards the sustainable option (Irwin *et al.*, 1993). Priming in turn, works in a different way. Priming is about triggering (un)conscious memories with external stimulants to alleviate the absorption of new cognitive input (Winkielman, 2005). Already small stimuli like specific words may result in behaviour changes e.g. the word “athletic” triggers fitness behavior (Dijksterhuis and Bargh, 2001; Bargh, 2006). In our study, we use a pro-electric slogan which is displayed to the decision maker while processing the trial decision. To sum up, we propose the use of default and priming as digital nudging tools to alleviate negative biases in consumer trial decision-making. These biases are naturally caused by the personality trait dispositional resistance to change and hamper consumer openness towards testing sustainable innovations. We believe that default and priming

work as a DSS in this case since they support consumers in overcoming their innate tendency to choose the status quo and neglect more sustainable but unfamiliar choices.

3 Research Model

Choice architecture offers various tools to influence decision behaviour and which of the tools one should apply depends on the design strategy for the DSS (Weber and Johnson, 2009). The design strategy for our DSS is to offer guidance in web-based choice scenarios in which decision makers can choose between a sustainable innovation and conventional, less pro-environmental alternatives such that they are more likely to select the sustainable innovation – given that the decision maker actually benefits from trying the sustainable innovation (Silver, 1990; Stryja, Dorner and Riefle, 2017). The dependent variable in our research model is the decision to select or reject the sustainable innovation. Dispositional resistance to change influences the innovation trial decision. Being an internal psychological trait, dispositional resistance to change cannot be manipulated externally (Laumer *et al.*, 2016a). We will therefore test whether default and priming have a moderating effect on the influence of dispositional resistance to change on the decision behaviour. Decision makers often perceive negative consequences of behaviour changes as more painful than similar experiences that result from inaction (Kahneman and Tversky, 1984). This biased perception causes routine seeking behaviour. Providing a choice environment in which the innovative option is preselected may reduce the fear of bad outcomes since the default is perceived as choice recommendation. De-biasing the trait of cognitive rigidity requires the compensation of fear of failure, insecurity and low success expectations (Pally, 1955; Oreg, 2003). Indicating the socially desired behavior, the default option can support insecure people to follow the DSS recommendation (Pichert and Katsikopolous, 2008).

H1: *Pre-selecting the sustainable innovation as default option will reduce the effect of routine seeking in the innovation trial decision-making process.*

H2: *Pre-selecting the sustainable innovation as default option will reduce the effect of cognitive rigidity in innovation trial decision-making process.*

The way an individual responds to change is influenced by his general level of psychological resilience, i.e. how change is emotionally coped with. The application of priming which works in favour of the sustainable innovation may thus positively motivate decision makers and enhance self-efficacy to become more confident in trying out the sustainable innovation. It may also support them in de-biasing their perception of short-term suffering by emphasizing the long-term benefit of switching to the sustainable option. The research model is summarized in Figure 1.

H3: *Priming the decision maker towards selecting the sustainable innovation will reduce the effect of emotional reaction to imposed change in the innovation trial decision-making process.*

H4: *Priming the decision maker towards selecting the sustainable innovation will reduce the effect of short-term focus in the innovation trial decision-making process.*

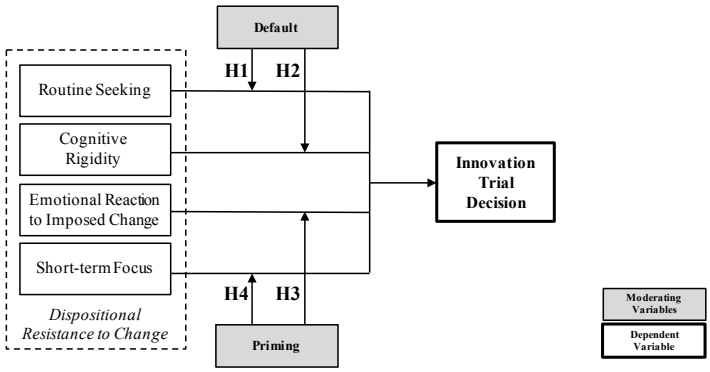

Figure 1. Research Model

In summary, we propose a DSS design based on the choice architecture tools default and priming which aims to alleviate the effect of dispositional resistance to change on sustainable innovation decisions. The research model is tested in an experimental pre-study which will be described in the next section.

4 Empirical Investigation

4.1 Procedure and Treatments

We test the research model in a laboratory pilot study with a 2x2 within-subject design to control for individual differences in information processing (Schuhbeck and Dorner, 2015). As treatment variables default and priming are used. The experimental products are diesel and electric rental cars (= innovation). The experimental setting is a car configurator with which the participants have to configure a rental car for different use case scenarios provided in the task description. After each configuration, a list of six cars are proposed which fit the configuration best. Each car has to be rated on a scale between 0 (lowest benefit) and 10 (highest benefit) and one has to be selected for booking. In total, 33 car models are used as choice set in the configurator, six of them are electric cars and 27 are diesel cars. The cars differ in ten attributes: engine type, amount of luggage, driving range, power, number of seats, number of doors, air conditioning, gears, carbon dioxide emissions and maximum speed. In the treatments with default, "electric" is pre-selected by the configurator as attribute level for "engine type". In the treatment with priming, the participants are shown a slogan in the car selection and rating part which promote the innovativeness and eco-friendliness of the electric car. During the experiment each subject has to pass through four scenarios combined with four treatments. Each scenario is introduced with a short description about the goal of the trip combined with some facts about start location, destination, travel distance and duration. All scenarios have in common that they are feasible with diesel and electric cars. All scenarios are consciously chosen to cover the use of car models commonly used in real applications. To control for scenario-related effects, scenario sequence is randomized for each subject. All subjects start with the same treatment "No Default/No Priming" to control for learning effects. The order of the subsequent treatments are randomized for each subject (see Figure 2).

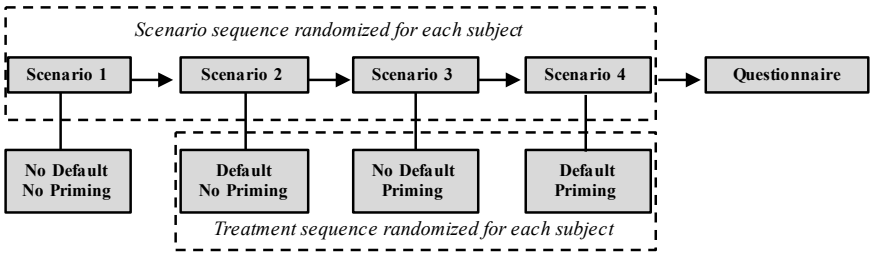

Figure 2. Experimental Procedure

After the configuration and selection task, the participants are guided to a questionnaire which collects data on demographics (e.g. age, gender), attitude towards and experience with electric cars, innovation resistance and personality type (Big Five).

4.2 Measurement of Variables

The dependent variable in this study is the innovation choice (innovation trial decision) which is measured repeatedly in tracking the booking choices made by each subject. We control for attitude towards electric cars and experience with using them by measuring the constructs at the end of the experiment in a survey with seven items based on Mathieson (1991) and Wixom and Todd (2005) on a 5-point likert scale (1-"strongly disagree" to 5-"strongly agree"). Dispositional resistance to change is measured using

the items from Oreg (2003) and Heidenreich and Handrich (2014) at the end of the experiment. We use in total 14 items on a 5-point likert scale (1-"strongly disagree" to 5-"strongly agree").

4.3 Sample

The pretest is conducted at a behavioral laboratory in Germany. 20 students from a large German public university are invited to participate in the pretest. Before the experiment, participants are neither informed about the goal and content of the experiment nor about the payment mechanism. Each participant receives 10 Euros at the end and is paid when all participants have finished their experiment and the questionnaire. In addition to the basic reward a voucher for a car rental subsidy is raffled among the participants to incentivize them to choose more realistically since the voucher is linked to the car models choosen in the experiment. The participants are informed about the lottery in the task description at the beginning of the experiment. 30 % of the participants are female and the average age is 22 years, ranging from 18 to 28. On average, participants have a positive attitude towards the trial of electric cars (4.39, SD = 0.66) while their level of experience are medium (2.60, SD = 0.90). Male participants have a higher experience level (2.83) than female participants (2.06). On average, participants show a medium disposition to resist change: routine seeking (2.23, SD = 0.81), emotional reaction to change (3.30, SD = 0.94), short-term focus (2.59, SD = 0.73) and cognitive rigidity (3.17, SD = 0.81).

4.4 Initial Results

We calculate a generalized linear mixed regression model with fixed effects to considerate potential individual effects. By using the z-statistic (z-Value) we test whether the independent (moderating) variables Default and Priming have a significant effect in the generalized linerar regression model. The z-Value of the variable Default (2.41) is corresponding to a 95% confidence interval which requires a value of at least 1.96. Consequently, the two-tailed test Pr(> |z|) shows a significant effect for the variable Default ($p<0.05$) while the variable Priming does not reach the significance level. Also, combining Default and Priming has no additional effect on the choice behavior (see Table 1). Based on the small data set, Default seems to have a moderating effect and thus hypotheses H1 and H2 can be supported while H3 and H4 cannot be supported.

	Estimate SD	Error	z-Value	Pr(> |z|)
Intercept	-2.9444	0.4588	-6.417	**1.39e-10*** **
Default	1.2862	0.5338	2.410	**0.016 ***
Priming	0.7472	0.5671	1.318	**0.188**
Default x Priming	-0.6746	0.6833	-0.987	**0.323**
***p < 0.05 **p<0.01 ***p<0.001**				

Table 1. Mixed regression results with fixed effects for Default and Priming

4.5 Discussion

Gaining knowledge on how to support consumers best in alleviating the effect of their innate resistance tendencies is an important aspect for both, companies and governments. Our results show that setting the sustainable innovation as default option has a significant effect on its selection while priming seems to have a weaker but not significant effect on choice behavior. We assume this effect to be the result of the small sample size (n=20). Conducting the main experiment will bring clarity to this point. Another possible explanation may be found in the implementation and wording of the priming mechanism (slogan). In the pre-test we use a short and neutral (i.e. non-personal) sentence which seem to be not as effective in triggering the subconscious mind of the participants. The non-effect of the combination of Default and Priming is interesting as it is highly counterintuitive. One explanation of the effect may be

that subjects get the feeling of being persuaded and thus actively choose the exact opposite alternative, i.e. a diesel car. Conducting the main experiment will hopefully provide a response to this question.

5 Conclusion

In this study, we propose a web-based DSS design which supports decision makers with de-biasing their sustainable innovation trial decisions by applying the choice architecture tools default and priming to the case of electric car selection. Initial results indicate that setting the innovation as default is more powerful in alleviating the effect of personality traits than using a priming slogan. The finding corresponds with results from other studies which emphasize the power of defaults to achieve desired behavior change (Pichert and Katsikopolous, 2008). Combining both mechanisms has no improving effect on the decision-making process. One limitation of the study is that participants conduct a hypothetical booking task which is prone to generate biased results due to missing real effort. Also, we use students in our sample which may cause a pro-innovation bias as students are assumed to be more open towards trying out new technologies. Extending the study sample to other user groups may lead to more comprehensive results. Besides these limitations of our study the results contribute to theory by extending the understanding of the working mechanisms of the relatively new concept of digital nudging by applying it to the case of online innovation trial decision-making. Results indicate the power of defaults also in such decision scenarios and thus contribute to innovation resistance theory in particular by complementing the work of Kuester *et al.* (2015) in a digital choice setting and with a sustainable and more complex innovation. By combining the disciplines of innovation resistance theory and choice architecture, further insight on the effect of choice design as alleviating instrument for personality traits like dispositional resistance to change is provided. As managerial implications we suggest to propose designing digital innovation choice environments like booking platforms or online shops such that the sustainable innovation is actively proposed to the consumer by pre-selecting it when s/he enters the website. However, more research is needed to better understand the effect of personality traits on innovation choice behavior and whether and how digital nudging can be used to support consumers to be more open to give innovative, sustainable products a try.

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