Eco-friendly Smart Home Devices: The Role of Artificial Intelligence Functioning and Environmental Effectiveness on Purchasing Intention.

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Abstract:

This study examines the role of artificial intelligence (AI) in promoting environmental sustainability through AI-powered smart home devices. In two experimental studies, a moderated mediation model is tested, focusing on two key characteristics of smart home devices: AI functioning (responsive vs. intelligent) and environmental effectiveness (high vs. low). The results show that AI functioning indirectly affects purchase intentions through three mediators: positive emotions (amazement and delight), perceived self-efficacy, and the desire to own the product. Moreover, the study reveals that environmental effectiveness moderates the relationship between AI functioning and positive emotions. Specifically, when environmental effectiveness is high, responsive AI generates stronger positive emotions compared to intelligent AI. This suggests that consumers prefer smart products with responsive AI, particularly when the product's environmental effectiveness is high. This preference reflects consumers' desire to maintain control over pro-social behaviors, opting for a moderate degree of technological advancement.

Keywords: *responsive smart products, environmental effectiveness, positive emotions, self-efficacy*

Track: *Innovation Management and New Product Development*

1. Introduction

In recent years, AI technologies have facilitated the development of products that balance individual needs with societal and environmental goals. AI applications promoting sustainability, such as reducing water usage, food waste, and energy consumption, have gained significant attention. However, despite the growth of these eco-friendly smart home products, the landscape remains unstable, and the term "smart object" is often used to describe a wide range of disparate products (Raff et al., 2020). This research investigates the role of AI in enhancing smart home solutions for environmental sustainability, focusing on two key characteristics of smart home devices: their functioning (responsive versus intelligent) and their effectiveness (high versus low environmental impact in reducing CO2 emissions). While AI functioning pertains to the consumer's individualistic perspective regarding personal interaction with the smart device, environmental effectiveness is linked to the consumer's pro-social perspective concerning its environmental impact. Two experimental studies demonstrate that these two perspectives interact to evoke positive emotions (amazement and delight), which, in turn, influence perceived self-efficacy and increase purchase intentions. This study makes three key contributions: first, it is the first to explore the differential impact of responsive versus intelligent smart home devices on purchase intentions, thereby deepening prior research on consumers' acceptance of smart products. Second, it highlights the dual perspectives of consumers: individual interaction with the device and collective benefits. Third, it employs a moderated mediation model to illustrate the psychological processes induced by the varying AI characteristics.

2. Theoretical Background and Hypotheses

AI-powered environmental applications provide solutions that enhance sustainability efforts. For example, AI is increasingly applied in smart home devices for emissions reduction, energy conservation, and optimization to reduce pollution. These applications represent a shift from traditional sustainability approaches to those that leverage AI's dynamic learning and adaptability. Nishan et al. (2020) identify three core benefits of AI technologies: task automation, data analysis, and contextual problem-solving through machine learning and deep learning. These signals—representing unobservable product characteristics—can influence purchase intentions (Herbas et al., 2018). While Frank (2021) addresses AI's environmental impact, the study does not investigate how AI's learning and decision-making processes can serve as distinct signals to consumers. The influence of AI varies depending on

the level of human-machine interaction, categorized as agency, autonomy, and authority (Puntoni, 2021; Novak et al., 2018). Agency refers to AI systems that are influenced by external entities (e.g., humans); autonomy pertains to AI systems that independently find solutions; and authority involves AI systems exerting control over other entities. AI-powered smart home devices can vary along the dimensions of agency and autonomy. In their meta-analysis of the smart products literature, Raff et al. (2020) identified 16 capabilities that shape various smart products and subsequently categorized them into four archetypes: digital, connected, responsive, and intelligent. The latter two archetypes are particularly relevant to Novak et al.'s (2018) cues, as they differ in terms of agency, autonomy, and authority. Specifically, responsive smart objects are capable of learning and becoming aware, reacting to input signals given or by humans, whereas intelligent smart products can learn, anticipate, and act independently. In essence, intelligent smart products do not require human intervention in reasoning or decision-making, as they are characterized by autonomy and self-management (Rijsdijk & Hultink, 2003). This distinction has significant psychological implications, as it changes the role of the consumer, who shifts from being an active agent in pro-environmental actions to potentially a passive observer. However, this aspect has not been sufficiently explored in the existing literature (Vaid et al. 2023).

2.1 Emotional Reactions to AI Solutions

Shank et al. (2019) identify various emotional responses to AI, including surprise, happiness, amazement, and delight. Specifically, amazement and delight tend to arise when responsive AI systems tailor experiences to meet individual needs, surpassing human capabilities and enabling rapid decision-making (Schill et al., 2019; Morewedge, 2009; Waytz et al., 2010). Based on these emotional responses, we hypothesize that responsive AI-powered smart home devices will elicit stronger amazement and delight compared to intelligent AI-powered smart home devices. This is due to the direct involvement of the consumer in the interaction with the former, as well as the empowerment fostered by responsive AI capabilities preserving the key role of the human agent. Moreover, we propose that the acceptance of AI-powered solutions in the green technology sector is significantly influenced by consumers' perceived effectiveness in reducing environmental impact. Consumers assess new technologies based on their functionality and perceived usefulness (Davis, 1989). For environmentally focused products, the perceived effectiveness in mitigating environmental harm plays a critical role in their adoption. Schill et al. (2019) found that the perceived effectiveness of AI solutions is a key determinant of consumer acceptance, regardless of the

consumer's level of environmental concern. We hypothesize that when environmental effectiveness is high, consumers will experience stronger emotional reactions and greater purchase intentions when interacting with responsive AI solutions compared to intelligent ones. This is because responsive smart products allow consumers to achieve significant collective outcomes while preserving their active role in the process.

H1: The functioning of the smart home objects interacts with environmental effectiveness to influence consumers' emotions. Specifically, in the case of responsive functioning (vs. intelligent), the higher (vs. lower) the expected environmental effectiveness, the more positive the consumer emotions will be.

Emotions are strongly linked to desire. According to the cognitive-motivational theory of emotion, desire depends not only on beliefs but also on anticipated emotions (Reisenzein, 2009). The affective component of the desire consists of a feeling of "wanting" of varying intensity, which is induced by an anticipated emotional experience (Barthomeuf et al., 2012). Therefore, we propose that the positive emotions associated with the responsive functioning of smart home objects product will induce the motivational state of desire to own or possess that product.

H2: The stronger consumers experience positive emotions induced by the smart home device, the greater the desire to own one of these products.

The motivational component of desire drives behavior (Hofmann & Kotabe, 2013). Desiring something entails wanting to possess, consume, or engage with it in anticipation of pleasure or the reduction of discomfort. The Model of Goal-Directed Behavior (Perugini & Bagozzi, 2001) introduces desire as a critical motivational process that directs consumers toward goal-oriented behaviors, such as the intention to purchase (Choi & Ng, 2011; Herbas Torrico et al., 2018; Koller et al., 2011; Nyilasy et al., 2014). Consistent with this framework, we hypothesize:

H3: The greater the desire to own a smart home device, the higher the purchase intention for the same smart home device.

3. Study 1

To test H1, H2, and H3 we conducted a 2 (smart home object functionality: intelligent vs. responsive) × 2 (environmental effectiveness: low vs. high) between-subjects experiment. We recruited 310 Italian participants (50% male; mean age 38) on Prolific (we retained 295 valid responses after excluding those failing manipulation checks). Participants were presented with the image and the description of a smart home thermostat and they were asked to imagine interacting with and using the thermostat. In the intelligent AI functionality scenario the smart thermostat automatically implemented energy-saving solutions, learning by itself, developing an intuition about its users, and then autonomously switching to eco-temperature when nobody is at home, while in the responsive AI functionality scenario the smart thermostat required user interaction to activate eco-friendly recommendations. Environmental effectiveness was manipulated by presenting data on energy savings and CO2 reduction, with one set indicating a low level and the other a high level of positive environmental impact. Participants rated anticipated emotions (amazement and delight), desire to own, and purchase intention. We also control participants' environmental commitment, attitude toward technology, and familiarity with AI products.

3.1 Results

We conducted a moderated mediation analysis (Process Model 83, Hayes, 2018), to test how smart home device functionality affects purchase intention through the serial mediation of positive emotions (amazement and delight) and desire to own a smart home with environmental effectiveness as a moderator of the indirect effect (H1, H2, H3). The results supported the moderated serial mediation and showed a significant indirect effect of smart home device functioning on purchase intention through positive emotions **(**amazement and delight) and desire to own the product in the high environmental effectiveness condition (indirect effect = 0.01; 95% Confidence Interval (CI) = [0.002, 0.03]). In contrast, no significant indirect effect was found in the low environmental effectiveness condition. See detailed results in Table 1.

Table 1. Serial moderated mediation results (Study 1)

MEDIATOR VARIABLE MODELS				
M1 – Positive emotions				
			b	t
X – Smart home device functioning (intelligent vs. responsive)			.03	.39
W – environmental effectiveness (low vs. high)			-.05	-.67
X * W			**.20**	**2.85****
Control – environmental commitment			.26	2.99**
Control – attitude toward using technology			.52	5.47***
Control – familiarity with AI			-.07	-.74
Control – gender			.34	2.42*
Control – age			-.09	-1.21
				R-square = .21
Bootstrap 95% Confidence Intervals for Conditional Indirect Effect - Bias Corrected and Accelerated (BCa)				
			Effect	Lower Upper
M1 – Positive emotions	Low environmental effectiveness		-.17	-.37 .03
	High environmental effectiveness		.22	.04 .41
M2 - Desire to have				
			b	t
X – Smart home device functioning (intelligent vs. responsive)			-.06	-.89
M1 – Positive emotions (amazement and delight)			**.26**	**4.67*****
Control – environmental commitment			-.09	-1.08
Control – attitude toward using technology			.69	7.12***
Control – familiarity with ESHO			.25	2.92**
Control – gender			-.26	-1.92
Control – age			.08	1.10
				R-square = .36
OUTCOME VARIABLE MODEL				
Y - intention to buy				
			b	*t*
X – ESHO functioning (intelligent vs. responsive)			-.03	-.51
M1 – positive emotions (amazement and delight)			**.31**	**6.03*****
M2 – desire to own			**.19**	**3.65*****
Control – environmental commitment			.23	3.08**
Control – attitude toward using technology			.33	3.67***
Control – familiarity with AI			.27	3.58***
Control – gender			.25	2.12*
Control – age			-.05	-.87
				R-square = .47
Indirect effect: X – Smart home device functioning →M1 –Positive emotions →M2 –Desire to own →W - Intention to buy				
W - environmental effectiveness	Effect	Lower	Upper	
Low environmental effectiveness	-.01	-.02	.002	
High environmental effectiveness	.01	.002	.03	

† if $p < .10$; * if $p < .05$; ** if $p < .01$; *** if $p < .001$. X = independent variable, W = moderator, M = mediator. Continuous variables are mean-centered for the analysis. Bolded parameter estimates correspond to the significant focal interactions and key direct effects highlighted in the text.

These findings support all of the study's hypotheses. Specifically, they confirm that responsive AI functionality significantly influences purchase intention, through the serial enhancement of consumers' amusement and delight and the desire to own the smart home

device. Furthermore, results support the moderation of environmental effectiveness, suggesting that the positive serial mediation is significant only when environmental effectiveness is high. Specifically, higher emotional activation was observed when the AI functionality was responsive and the environmental effectiveness was high.

5. The role of perceived self-efficacy

Building on the idea that AI's agentic potential—such as its ability to plan, reason, and take action—elicits specific emotional reactions, Study 2 focuses on how these emotions influence consumers' perceptions of their own control and efficacy in contributing to environmental goals. In Study 1, emotional responses such as amazement and delight were linked to AI's advanced capabilities, such as learning and adaptation. However, these emotions were analyzed from a passive "receiver" perspective, where consumers are primarily recipients of AI-driven solutions. In contrast, Study 2 shifts the focus to the active role consumers play in environmental action. By viewing consumers not only as recipients of AI interventions but also as active agents in promoting sustainability, this study aims to understand how emotions influence their perceptions of their own environmental impact. In Study 2 we hypothesize that emotions such as amazement and delight foster a sense of self-efficacy—the belief in one's ability to control and influence external outcomes. Self-efficacy (Bandura, 1997; Cleveland, 2005; Rizkalla & Erhan, 2020; Hanss & Bohm, 2010) is especially important in the context of sustainable consumption, as consumers' beliefs in their ability to contribute to environmental goals can significantly affect their behaviors. We propose that positive emotions, particularly in the presence of responsive AI functionality and high environmental impact, will enhance consumers' self-efficacy in contributing to environmental change. Thus, we hypothesize that perceived self-efficacy will mediate the relationship between emotional activation and the desire to own an eco-friendly smart home device. Consumers with higher self-efficacy will be more motivated to engage with the product and its environmental benefits, ultimately leading to stronger purchase intentions. Study 2 revisits the moderated mediation model from Study 1 by introducing self-efficacy as an additional mediator.

H4: The stronger the positive emotions induced by the smart home device, the higher the perceived self-efficacy experienced by consumers and, subsequently, the desire to own and the purchase intention of the smart home device.

6. Study 2

To confirm H1, H2, H3, and then H4 we conducted a 2 (smart home object functionality: intelligent vs. responsive) × 2 (environmental effectiveness: low vs. high) between-subjects experiment. We recruited 403 US participants (51% male; mean age 49) on Prolific. We retained the same procedures, materials (stimuli) and measures adopted in Study 1. To test H4 we also measure perceived self-efficacy (adapted from Demirci and Teksoz, 2017).

6.1 Results

We conducted a moderated mediation analysis using Process Model 83 (Hayes, 2018) to examine the serial multiple mediator model, which explains the role of smart home device functioning (intelligent vs. responsive) in affecting purchase intention through positive emotions (amazement and delight), perceived self-efficacy, and desire to own the product. Environmental effectiveness (low vs. high) was tested as a moderator in the relationship between smart home device functioning and positive emotions. The analysis revealed a significant indirect effect of smart home device functionality on purchase intention through the sequence of positive emotions (amazement and delight), self-efficacy, and desire to own the product in the high environmental effectiveness condition (indirect effect = 0.04; 95% Confidence Interval (CI) = [0.002, 0.08]). However, the indirect effect was not significant in the low environmental effectiveness condition (indirect effect = 0.001; 95% CI = [–0.02, 0.02]). This result supports the moderated serial mediation proposed. Detailed results are summarized in Table 2.

Table 2. Serial moderated mediation results (Study 2)

MEDIATOR VARIABLE MODELS				
M1 – Positive emotions (amazement and delight)				
			b	t
X – smart home device functioning (intelligent vs. responsive)			.10	.39
W – environmental effectiveness (low vs. high)			.19	-1.91†
X * W			**.07**	**4.73*** **
Control – environmental commitment			.25	1.68†
Control – attitude toward using technology			.36	5.60***
Control – familiarity with AI			.14	3.94***
Control – gender			.00	.00
Control – age			-.01	-1.32
			R-square = .22	
Bootstrap Confidence Intervals for Conditional Indirect Effect - Bias Corrected and Accelerated (BCa)				
			Effect	Lower Upper
M1 – Positive emotions	Low environmental effectiveness		.01	-.11 .12
	High environmental effectiveness		.27	.07 .48

M2 – Self efficacy		
	b	t
X – ESHO functioning (intelligent vs. responsive)	-.03	-.56
M1 – Positive emotions *(amazement and delight)*	**.50**	**11.41*** **
Control – environmental commitment	.22	5.37***
Control – attitude toward using technology	.25	3.02**
Control – familiarity with AI	.002	.03
Control – gender	-.03	-3.47***
Control – age	-.01	-2.30*
	R-square = .42	
M3 - *Desire to own*		
	b	t
X – Smart home device functioning (intelligent vs. responsive)	-.03	-.54
M1 – Positive emotions	.33	5.31***
M2 – Self efficacy	**.66**	**10.50*** **
Control – environmental commitment	.09	1.67†
Control – attitude toward using technology	.25	2.44*
Control – familiarity with ESHO	.22	3.33**
Control – gender	.03	2.72**
Control – age	-.002	-.45
	R-square = .55	

OUTCOME VARIABLE MODEL		
Y - intention to buy ESHO		
	b	*t*
X – Smart home device functioning (intelligent vs. responsive)	-.01	-.12
M1 – positive emotions	.31	5.82***
M2 – Self efficacy	.24	4.08***
M3 – desire to own	**.49**	**11.68*** **
Control – environmental commitment	.15	3.43***

6. Conclusion and Implications

The results align with existing research on artificial intelligence, emphasizing the need to further explore AI's various characteristics, especially in the context of sustainable household consumption. The study reveals that the highest level of technology is not always the most preferred. Intelligent smart devices, which typically result from an upgrade of responsive smart devices through OTA integration, are not necessarily favored. Responsive smart products which maintain an active role for the consumer (Clegg et al., 2024) were preferred over intelligent smart products, especially when the consumption choices involved significant environmental impact. Consumers appeared to be overwhelmed by more advanced innovations, opting instead for a moderate degree of technological advancement that allowed them to retain control over pro-social actions. These findings highlight the importance of responsive AI combined with high environmental effectiveness in eliciting positive emotions, fostering self-efficacy, and increasing purchase intentions. This study contributes to the literature by integrating the technology acceptance framework with AI characteristics (responsive vs. intelligent) to advance the understanding of pro-environmental products. It also deepens insights into the emotional responses triggered by AI, such as amazement and

delight, which influence consumer behavior in pro-environmental contexts. Additionally, it shows that AI-powered products signal consumer commitment to sustainability, particularly when engagement is active and environmental effectiveness is high. From a managerial perspective, the study suggests that balancing individual empowerment with collective sustainability goals offers a "win-win" model for product design and marketing. Future research could explore different AI functionalities, environmental contexts, and product categories to assess whether these findings hold across various settings and examine the long-term effects of AI-powered environmental products.

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