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FROM THEORY TO ACTION: WHAT MOTIVATES CONSUMERS TO PURCHASE IOT SUSTABLE PRODUCTS

Luminița-Ștefania BOZDOG [1], Bogdana GLOVAȚCHI [1]✉, Gabriela MIRCEA [1], Grațiela Georgiana NOJA [1], Tomasz DOROŻYŃSKI [2]✉✉, Andrea IMPERIA [3]

[1]*Faculty of Economics and Business Administration, West University of Timisoara, Timisoara, Romania*
[2]*Department of International Economics, Institute of Economics, Faculty of Economics and Sociology, University of Lodz, Lodz, Poland*
[3]*Department of Social Sciences and Economics, Sapienza University of Rome, Rome, Italy*

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Abstract. In an era marked by the importance of sustainability and technological integration, this paper explores the drivers behind sustainable consumption in a rapidly evolving market, focusing on Romanian consumer perspectives towards sustainable products driven by the relationship between the circular economy and the Internet of Things (IoT). Leveraging structural equation modelling, we conduct a thorough survey to investigate the roles of shaping purchase behaviors within the context of the circular economy and IoT integration. The findings reveal that while environmental attitudes significantly influence purchase intentions, price sensitivity and perceived value play a crucial role in shaping consumer choices. From a theoretical perspective, this study highlights the interplay between sustainability concerns and market dynamics, contributing to the broader understanding of sustainable purchase behavior. From a managerial perspective, the results provide actionable insights for businesses to design value-aligned strategies, ensuring that sustainable products are both accessible and appealing to a diverse consumer base. This dual focus on theory and practice offers a roadmap for fostering responsible consumption in a competitive marketplace.

Keywords: technology readiness, attitude, purchase intention, IoT, sustainability, structural equation modelling.

JEL Classification: M21, M30, Q01, L86.

✉Corresponding author. E-mail: ***bogdana.glovatchi@e-uvt.ro***
✉✉Corresponding author. E-mail: ***tomasz.dorozynski@uni.lodz.pl***

1. Introduction

Circular Economy (CE) is becoming increasingly important and a major paradigm in environmental sustainability, as we work to reduce waste generation and use resources more efficiently (Aarikka-Stenroos et al., 2021). The Internet of Things (IoT) plays a crucial role in this economy by helping people and institutions achieve this goal.

One tool we can use in promoting CE is marketing because it can involve and educate consumers about sustainable practices, convince businesses to create better, more eco-friendly products, and promote the idea of living sustainably. Using marketing strategically increases the speed at which CE ideas are implemented in different industries. We believe that this will help protect the environment and increase the resilience of our economy, especially since consumers are increasingly conscious that there is a need for sustainable practices and products (Shevchenko et al., 2023). This demand and awareness encourage innovation and shape the market landscape (Mostaghel & Chirumalla, 2021; Tukker, 2004).

The fact that more consumers want sustainability is the result of several interrelated factors. Social movements advocating for environmental justice have become more visible on a global scale. Often amplified by digital platforms, these movements have persuaded individuals of the need to adopt eco-friendly practices and seek brands that become more accountable for their practices (Peattie & Peattie, 2009). The new eco trend, propagated especially among young people, has reconfigured values and preferences regarding any type of product purchase.

Notably, this trend – especially among younger demographics – appears to be further accelerated by economic incentives. As Gillingham and Palmer (2014) demonstrated, emerging technologies are driving down the cost of sustainable products (think energy-efficient appliances and renewable energy systems) so that consumers begin to reap long-term monetary benefits. On the other hand, public institutions and governmental bodies have introduced a range of fiscal measures – subsidies, tax breaks, and the like – to foster a setting that supports environmentally responsible choices (this trend has been noted, too, in Gillingham & Palmer, 2014).

Meanwhile, demographic shifts, particularly among Millennials and Generation Z, have helped cement sustainability as a core personal value. These groups not only display a marked preference for products that echo their ethical and environmental ideals, but they also integrate sustainability into the very fabric of their identities and lifestyles (Dimock, 2019). Interestingly, there is a growing expectation that companies be held accountable for their social and production practices; as demonstrated by Shevchenko et al. (2023), this accountability further reinforces the overall drive toward sustainable practices.

Turning our attention to Romania, its emerging status within the European Union offers a unique case study for sustainable consumption. Romania's evolving market economy, for instance, exposes it to global environmental challenges while it navigates the transition from traditional consumption to modern sustainability models. By contrast, the rapid adoption of Internet of Things (IoT) technologies – coupled with a strong focus on green initiatives – has spurred significant investment in smart city and renewable energy projects. Therefore, these factors collectively explain why Romania represents a particularly intriguing context for exploring purchasing behavior related to sustainable IoT products.

In this context, through advanced econometric techniques based on structural equation modelling, the present paper seeks to explore the consumer perspective by rigorously examining attitudes, intentions, and behaviors associated with the purchase of sustainable IoT products. Uniquely, the study also interrogates the extent of consumers' technology readiness within the framework of a circular economy, thereby contributing novel insights to the existing body of literature. By examining these dynamics, we can identify the opportunities and barriers associated with integrating CE and IoT for consumers.

It is also pivotal to create a comprehensive empirical model in order to study the variables that influence what sustainable IoT products consumers buy because these are the products that will generate a circular economy. As discussed in previous research (e.g., Oh & Yoon, 2014; Hwang, 2016; Lieder et al., 2018; Mostaghel & Chirumalla, 2021), improving our understanding of consumers' purchasing intentions can help businesses align their marketing strategies with consumer expectations, thus influencing their buying behavior. The reason why this paper focuses on sustainable IoT products is dictated by the importance of sustainability in consumer decisions, particularly IoT that leads to CE (Ćwiklicki & Wojnarowska, 2020).

This research contributes in four significant ways: firstly, it focuses on the role of TR in shaping consumer attitudes, intentions, and behaviors toward sustainable IoT products. Secondly, it integrates the consumer's viewpoint when examining the role of sustainable IoT in CE. This particular perspective has received less attention than the focus on organizational transitions to CE. Thirdly, this research introduces a framework that analyzes the multifaceted nature of purchase behavior, which is crucial to creating CE. Finally, this paper extends the understanding of the foundations of consumer purchase intentions and attitudes towards sustainable IoT products. Furthermore, our paper provides valuable insights of interest to both academia and practitioners as it clarifies the consumer perspective on the circular economy through their purchase intentions and purchasing behavior towards sustainable IoT products.

The paper is organized as follows: Section 2 outlines the literature review on CE, IoT and TR, followed by the theoretical underpinnings of perceived value, attitude, consumer purchase intention and purchase behavior toward sustainable IoT products. Section 3 details the proposed research hypotheses and the theoretical model. Section 4 presents the research data and methodology used in this paper, followed by the empirical results of the study and a discussion of the theoretical and practical implications of the findings. The concluding section offers final thoughts, addresses the study's limitations, and suggests avenues for future research.

2. Literature review

2.1. Connections between the circular economy and the Internet of Things

The Internet of Things has revolutionized how consumers interact with everyday objects, from smart home devices to wearable technology. With the increasing prevalence of IoT in consumer products, it's essential to delve into the impact of IoT on the CE from a consumer's perspective. From the point of view of CE, a sustainable product is designed with the exclusive purpose of minimizing its impact on the environment throughout its life. The goal of such a product is to minimize waste and protect existing resources by circulating inside the economy for as long as possible before returning seamlessly into the production cycle (Chamberlin & Boks, 2018; Geissdoerfer et al., 2018). By implementing better resource management, IoT technologies play an important role in increasing the sustainability of products in CE. They can offer real-time data on the use of resources. They can also facilitate a more effective management and reallocation of said resources which, in turn, reduces waste (Corvellec & Stål, 2017). When consumers understand how IoT and CE are interconnected (Ćwiklicki & Wojnarowska, 2020) they can make informed decisions that lead to sustainability in consumption. In what follows, we will explore the role played by IoT in influencing CE from the consumer's viewpoint. At the same time, we will highlight the opportunities and challenges in promoting a more sustainable and efficient model of consumption.

2.2. Technology readiness

A close assessment of consumers' technological readiness is indispensable in light of the exponential growth of technology-reliant products and services, coupled with companies' increasing dependence on technology to enhance their marketing strategies and consumer services. Notably, Parasuraman and Colby (2015) introduce an influential framework that scrutinizes key attributes – namely, a penchant for innovation and optimism contrasted against discomfort and insecurity – which collectively shape Technology Readiness (TR). One important issue is to identify if individuals and organizations are truly equipped to integrate breakthrough technologies. In an era when innovations such as IoT are rapidly redefining business landscapes, attaining a deep understanding of TR is indispensable for both enterprises and consumers. For instance, Yieh et al. (2012) illustrate that the quartet of TR dimensions yields divergent effects on Consumer Perceived Value (CPV): while optimism and innovativeness tend to elevate CPV, discomfort and insecurity exert a diminishing effect. In another study, Tuyet and Tuan (2019) provided empirical support explaining the link of TR not only with perceived value, but also with customer satisfaction and the likelihood of continued use in self-service technology contexts. On the other hand, Venkatesh et al. (2012) observed that individuals who exhibit high TR are prone to engage in online shopping – although, of course, not all consumers experience technology adoption similarly, as technological anxiety may remain a substantial obstacle.

Furthermore, Parasuraman and Colby (2015) contend that individuals are more apt to adopt technologies that resonate with their core values – a disposition that is further influenced by one's daily surroundings, whether at home or in the workplace. Prior investigations consistently reveal that positive elements of TR (such as optimism) are intimately linked with an enhanced appreciation for the benefits of IoT – enabled solutions (Parasuraman, 2000), whereas negative elements (like insecurity) can erode trust and lower CPV (Yieh et al., 2012). Nevertheless, an open question persists regarding how these dynamics unfold within the realm of the Circular Economy (CE). Many previous studies have focused primarily on organizational readiness, often neglecting the consumer perspective (Geissdoerfer et al., 2018; Pisitsankkhakarn & Vassanadumrongdee, 2020). Clearly, when one wants to fully understand consumer attitudes towards IoT-based CE models, one must take into account both the enabling and inhibiting aspects of TR. Little research has examined how demographic factors, such as age and education, can modulate these interrelationships. We have thus identified a gap that invites further investigation into how these variables affect Romanian consumers' engagement with sustainable IoT products in varied economic and cultural environments.

2.3. Perceived value, attitude, and consumer's purchase intention toward sustainable IoT products

In addition to the financial cost, perceived value in the context of sustainable IoT products includes factors such as the impact on the environment, energy efficiency, and product longevity (Chamberlin & Boks, 2018). The perceived value of sustainable IoT products is influenced differently by businesses and consumers. From a consumer perspective, among the variables that can influence the perceived value of sustainable IoT products, the reduction of carbon emissions and energy savings are at the forefront (Constantinescu & Muntean, 2022). Consumers use their understanding of environmental benefits to evaluate the perceived value of sustainable IoT products by ensuring the latter aligns with their values and beliefs (Shevchenko et al., 2023). Two important theories, the Theory of Planned Behavior and the Theory of Reasoned Action, show the relevance of attitude in obtaining a purchase behavior. The Theory of Planned Behavior (Chatterjee & Bolar, 2018) states that consumers' attitudes towards products, how they view societal norms around them, as well as the control they perceive to have over the purchase and use of these products will influence the products' perceived value (Biswas & Roy, 2015). Several factors may influence attitudes, such as: personal values, values regarding environmental sustainability, personal beliefs, social norms, and the information that individuals receive about the product (Zhang et al., 2021; Shevchenko et al., 2023). A parallel theory, the Theory of Reasoned Action, shows that the fundamental element influencing a customer's inclination to commit to buying is their attitude. Attitude is also used to explain the commitment to circular business models. Another important element that helps is consumers' willingness to pay more for a product. Extracting from the Theory of Reasoned Action this hypothesis, Mostaghel and Chirumalla (2021) state that intentions to engage in particular activities are significantly shaped by attitudes, subjective standards, and perceived behavioral control. Similar research – for instance, studies by Oh and Yoon (2014) and Diddi and Niehm (2016), which draw on the Theory of Reasoned Action – demonstrates that individuals' evaluations of a product are largely determined by their assessments of its features and the weight they assign to these characteristics. Notably, a consumer's attitude toward a product, its perceived value, and its sense of control over its purchase and use collectively shape their buying intentions (Zhang et al., 2021). In fact, both the Theory of Planned Behavior and the Theory of Reasoned Action converge on the idea that attitudes toward sustainable IoT products – as well as the perceived value of these items – directly influence purchase intentions; these frameworks are, therefore, interlinked in their effect on consumer decision-making about sustainable IoT products (as demonstrated by Zhang et al., 2020).

With regard to perceived value, when consumers evaluate sustainable IoT products they consider several dimensions – social, functional and epistemic. For example, a product's social value is defined not only by its perceived usefulness but also by the benefits it offers to a specific social group or community (Pinochet et al., 2018). If a customer believes that purchasing and using sustainable IoT products aligns with their commitment to social responsibility and environmental sustainability, then they are more inclined to view these items favorably. Indeed, this phenomenon has been observed (Biswas & Roy, 2015).

Pisitsankkhakarn and Vassanadumrongdee (2020) conducted a study on how to increase the purchase likelihood in CE, specifically for remanufactured automotive products. The study included the extended theory of planned behavior, incorporating marketing stimuli to analyze purchase behavior. The results show a favorable correlation between buying intentions and attitudes and subjective norms. The report emphasizes how the government and businesses must work together to optimize pricing tactics and product quality in order to increase customer demand for remanufactured goods in emerging nations. According to Mohd Suki (2016), consumers who are more willing to search for new information, as well as new and different products are more likely to make purchases. We can therefore develop a theoretical framework that can help us comprehend purchase behavior toward sustainable IoT goods in the CE setting. The three primary elements included in this model are attitude, purchase intention, and perceived value (Mostaghel & Chirumalla, 2021).

2.4. Purchase behavior

Because technology has been integrated into our lives, it has redefined the shopping journey, it has amplified the influence of social recommendations, and it has provided consumers with unparalleled access to information about products. Businesses that recognize this and are able to adapt to these new influences can carve a position for themselves from which to connect with and cater to the needs of today's tech-minded consumers. Chepurna and Criado (2018) identified the two factors that, in their opinion, will impact consumer purchase behavior in the context of technology: technology anxiety and shared values with a brand.

Technology anxiety plays a significant role in consumer purchase behavior. Because they fear making mistakes or damaging their devices, some consumers may feel uncomfortable or anxious when using certain interfaces (Kulviwat et al., 2007), and may become reluctant to purchase technologically updated products. This anxiety will affect the way consumers participate in online projects and will dictate how willing they are to adopt new technologies (Chepurna & Criado, 2018) and, of course, to adopt purchasing behaviors. Therefore, it is essential to educate consumers if we want to encourage circular consumption (Calvo-Porral & Lévy-Mangín, 2020).

Testa et al. (2020) report that consumer participation in circular consumption increases when the advantages – such as cost reductions or enhanced product quality – are clearly communicated. Contemporary consumers are actively pursuing products that align with their ethical and environmental values, a shift that is reshaping purchasing behaviors and compelling businesses to modify both their strategies and product portfolios (Shevchenko et al., 2023).

Nonetheless, the efficacy of circular consumption and the adoption of circular economy (CE) strategies hinge not solely on corporate initiatives but also on consumer behavior (Shevchenko et al., 2023). Consumers contribute to the CE across three distinct dimensions: product customers, product users, and end-of-life product holders. In their role as product customers, consumers may choose items designed with durability and repairability in mind – often manufactured from recycled materials – to mitigate environmental impacts over the product's lifecycle (Calvo-Porral & Lévy-Mangín, 2020). As product users, routine maintenance and repairs extend a product's service life, thereby embodying responsible consumption practices (Shevchenko et al., 2023). Finally, in their capacity as end-of-life product holders, consumers are pivotal in facilitating recycling or returning products for refurbishment and remanufacturing. Collectively, by electing sustainable products and adopting environmentally conscious behaviors, consumers play a critical role in closing the material loop and advancing the circular economy (Shevchenko et al., 2023).

3. Research methodology

3.1. Research model and hypothesis

Starting from the identified gaps in the literature, our study establishes three primary objectives: first, to examine how optimism and insecurity – two critical dimensions of technology readiness (TR) – interact and subsequently impact perceived value (PV) and consumer attitudes; second, to investigate how demographic characteristics, such as age and education, moderate these relationships; and third, to analyze the extent to which consumers are prepared for Circular Economy (CE) solutions enabled by IoT, thereby addressing the notable absence of consumer-focused research in the CE domain. In essence, by integrating these objectives, our study aims to deepen the understanding of consumer adoption patterns in the context of sustainable innovation.

Interestingly, Yieh et al. (2012) analyzed the effects of TR on PV in digital finance, focusing on consumers using high-speed rail services in Taiwan. Their detailed exploration reveals that various facets of TR distinctly shape consumer perceptions of digital finance services. One might observe that positive attitudes toward technology – especially the dimension of optimism – play a crucial role in augmenting perceived value. In fact, Yieh et al. (2012) found that optimism had the highest impact on PV, while the study also delved into in-use, social, emotional, and security dimensions of PV; notably, TR did not significantly affect emotional value and even negatively impacted security value, but it positively influenced both in-use and social value.

Another investigation by Tuyet and Tuan (2019) examined the relationship between TR and the perceived value of self-service technologies in Vietnam. Their research suggests that higher levels of TR may increase the perceived benefits of such technologies through how consumers develop commitment to their acceptance and use. Complementing these insights, Vy et al. (2022) meticulously explored the connection between TR and the perceived value of online security trading. Their findings provide empirical evidence that TR significantly shapes the valuation of digital financial services, thereby emphasizing the necessity for digital finance platforms to account not only for service quality but also for users' technological inclinations.

H1: Technology readiness has a positive, direct, and significant effect on perceived value of sustainable IoT products.

The concept of perceived value, as demonstrated by dual-processing theories (Chaiken & Maheswaran, 1994), forms the foundation for the attitudes that consumers develop toward sustainable products. One key challenge is that consumers often struggle to access comprehensive information about a product's sustainability (Mostaghel & Chirumalla, 2021). At the same time, Lieder et al. (2018) suggest that the nature of the information shared plays a major role in shaping consumers' attitudes towards sustainability, leading to the conclusion that a positive perceived value is fundamental for promoting favorable attitudes towards sustainability. In other words, for consumers to hold a positive view of technology, they must first perceive it as valuable (Mostaghel & Chirumalla, 2021).

H2: Perceived value of sustainable IoT products has a positive, direct, and significant effect on the attitude towards purchasing sustainable IoT products.

It is important to understand how consumers' purchase intentions are influenced by their attitudes towards sustainable IoT products. Mostaghel and Chirumalla (2021) reference the dual-processing models presented by Chaiken and Maheswaran (1994), which explain that two major processing systems dictate human attitudes, namely the rational system and the experiential system. The rational system assesses attitudes by performing a cost-benefit analysis and is also based on ethical beliefs, whereas the experiential system relies on past experiences, be they effective or heuristic, to dictate attitudes.

Therefore, customers' belief-based perceived value is essential in influencing their attitudes towards a circular business. This indicates that companies marketing sustainable IoT products should focus on enhancing consumer attitudes towards their brands and products and emphasizing their products' positive attributes and benefits (Mostaghel & Chirumalla, 2021). By doing so, they can increase consumers' intention to purchase sustainable IoT products and ultimately contribute to adopting more sustainable and environmentally friendly technologies (Mostaghel & Chirumalla, 2021).

H3: The attitude towards sustainable IoT products has a positive, direct, and significant effect on the purchase intention of sustainable IoT products.

While direct correlations between personal characteristics and attitudes towards sustainable IoT products were not explicitly found, there is evidence suggesting that factors such as income level, education, and possibly age can influence consumer attitudes towards sustainable products in general. There is a growing concern about the depletion of natural resources and the increasing levels of waste generation. As a result, sustainable consumption has become a significant focus for both governments and society. However, the market share of sustainable products is still low due to inconclusive results on the factors influencing consumers' perception of sustainable products. This review suggests that multiple factors, potentially including personal characteristics, can influence consumer perceptions across different sustainability dimensions (Camilleri et al., 2023). Research examining sustainable consumption and production in Romania (Lakatos et al., 2018) found generational differences in attitudes towards the environment and sustainable practices. A study by Singhal and Malik (2018) focused on the relationship between female consumers' age, education, and income groups and their attitudes towards green cosmetic products. It found that income level impacts attitudes towards green products, with different income groups having varied attitudes towards pricing and recommendation of green cosmetic products.

H4a: Personal characteristics (age, education, income) have a positive, direct, and significant effect on attitude towards sustainable IoT products.

Hwang (2016) found that income did not alter the intentions to purchase ethically, but age significantly influenced buying behavior, distinguishing younger from older consumers. Chekima's et al. (2016) study in the same year highlighted that individuals with higher education levels were more likely to buy green products. Both studies, along with Michaelidou and Christodoulides (2011), considered personal attributes like age, gender, and education level as either moderating or controlling factors in purchasing intention. In and Ahmad (2018) investigated how the effect of demographic variables impacted consumers' intention to purchase sustainable products. This study investigated how age, education, and income work together to shape the customers' intention to purchase smartphones.

H4b: Personal characteristics (age, education, income) have a positive, direct, and significant effect on the intention to purchase sustainable IoT products.

The objective of analyzing customer attitudes and intentions is to learn what determines their actual buying actions. However, the gap between when a customer intends to make a purchase and when they actually do so complicate researchers' ability to track real purchasing behavior accurately (Mostaghel & Chirumalla, 2021). The study by Kim and Lee (2023) investigated the link between consumers' intention to buy sustainable products and their actual purchasing behavior. It found that the intention to purchase sustainable products significantly impacts actual purchase behavior. On the other hand, Jung et al. (2020) investigate the gap between attitudes and actual purchase intentions towards sustainable apparel in China. It emphasizes the importance of attitudes, behavioral intentions, and individual characteristics like demographics and psychographics in understanding sustainable consumer behavior. This research contributes to the dialogue on sustainable consumption by examining the factors influencing the intention to purchase sustainable apparel and exploring the role of consumption values and social norms in shaping sustainable consumption patterns.

H5: Purchase intention of sustainable IoT products has a positive, direct, and significant effect on purchase behavior of sustainable IoT products.

Based on these fundamental credentials and research hypotheses targeted in the current study, we have designed the theoretical model as entailed by Figure 1.

3.2. Methodology

The study was conducted in Romania, a country with an emerging economy, making it a worthy sample population. We, therefore, focus on Romanian consumers, leveraging data

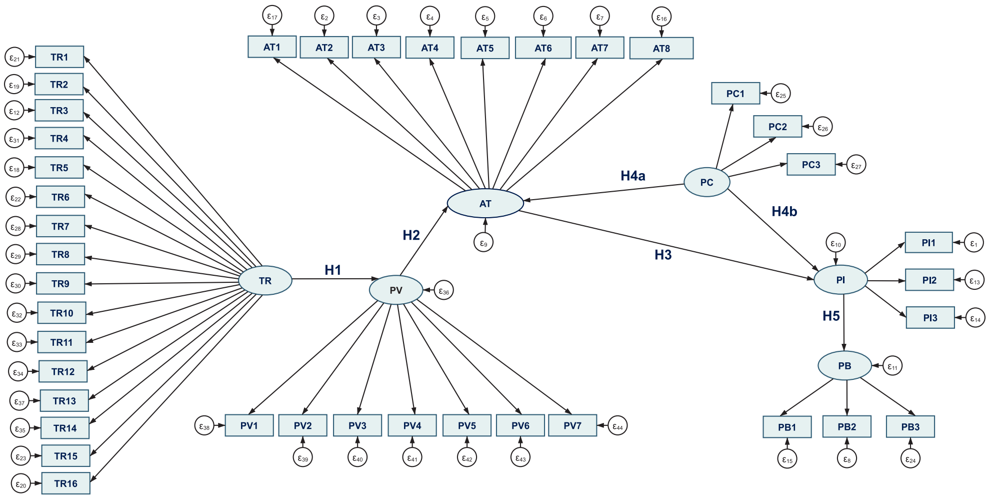

Figure 1. Research model (source: authors' design)

from respondents across diverse demographic and socio-economic groups. For primary data collection purposes, an online questionnaire was applied. Overall, 321 fully completed questionnaires were received. The survey was distributed via Google Forms. The survey revealed diverse demographics in terms of age, education, and income. The sample was obtained by disaggregating the population and sampling each sub-population – conceptually like stratified sampling – although disproportionate and non-probability based (Conner et al., 2017; Pace, 2021; Hossan et al., 2023; Shamsudin et al., 2024). The rationale behind this approach aligns with market research studies (Pace, 2021; Hossan et al., 2023; Shamsudin et al., 2024), where obtaining a fully representative random sample is often challenging. Instead, strategic sub-population sampling ensures that insights remain actionable and relevant, even when the sample distribution is not fully proportional to the general population. Furthermore, by capturing variations in key demographic attributes, this method enhances the study's ability to draw insights into behavioral patterns across distinct consumer segments.

To obtain a relatively representative global sample, the authors purposefully chose to capture variations in age, gender, and income, ensuring that the dataset reflects a broad spectrum of consumer behaviors and preferences relevant to the research objectives.

The sample skews toward younger respondents (61.1% aged 18–25), which is particularly relevant for studying trends in IoT adoption and sustainability, as younger demographics are often early adopters of technology (Szentesi et al., 2021). However, this age concentration may limit the applicability of findings to older consumer groups. Additionally, a large portion of the respondents earn less than $432 monthly, reflecting typical income distributions in Romania but potentially limiting the study's ability to explore the impact of higher income levels on IoT-related CE adoption.

Based on the questionnaire data provided, most of the respondents, constituting 61.1%, fall within the 18–25 age group, highlighting a young demographic. The next significant age bracket, 26–40 years, comprises 20.2% of the participants, indicating a lower but noteworthy representation of early to mid-career individuals. The 41–55 years age group follows with 13.7%, while those aged 56–70 years make up 4% of the sample. A minimal percentage, 0.9%, represents respondents over 70 years. The educational background of the 321 respondents is varied, with no one reporting a lack of formal education. A small fraction, 1.2%, completed secondary school, while a significant 46.6% have high school education. Professional or technical studies also account for 1.2% of the responses. Bachelor's degree holders represent 26.8% of the sample, followed by 19.9% with a master's degree. Lastly, 2.2% of the participants have earned a PhD. The income distribution among the 321 survey respondents reveals a broad range. The largest group, 32.4%, earns under $432 per month. Following, 24.3% earn between $432 and $863 per month. The next group, making up 17.1%, earns between $863 and $1,295 per month. A smaller portion, 10.3%, falls into the $1,295 to $1,727 per month range. Lastly, 15.9% of respondents earn over $1,727 per month (Appendix Table A1. Summary of statistics).

All the five measurement scales operationalizing the constructs and making up the questionnaire are widely used and adapted from the international literature to the national context. Therefore, "Technology readiness" was measured using the TRI 2.0 a 16 items scale developed by Parasuraman and Colby (2015). To measure "Perceived Value of sustainable IoT products" construct a 7 items scale was adapted from Mohd Suki (2016), while "Attitude towards sustainable IoT products" was measured using two measuring scales. Three items were adapted from Kazeminias' et al. (2016) scale for measuring attitude and five items were adapted from Mostaghels' and Chirumallas', 2021 scale for measuring attitude. For "Purchase Intention towards sustainable IoT products" a measuring scale was adapted from Mostaghel and Chirumalla (2021). This scale has 3 items measuring the intent to buy sustainable products. "Purchase Behavior towards sustainable IoT products" was also adapted from Mostaghel and Chirumalla (2021) and this 3 item scale assesses actual purchasing actions regarding sustainable products. All items were measured using the five-point Likert scale (1 – Strongly disagree, 2 – Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly agree). Several considerations stand behind the decision to use a five-point Likert scale instead of the commonly used seven-point scale in SEM studies. To begin with, the method proves more straightforward and user-friendly – particularly for respondents whose survey familiarity may vary (Isik & Yasar, 2015; Hasan et al., 2023). Therefore, by reducing cognitive burden and preventing respondent fatigue, this approach becomes effective in consumer studies where participants often lack advanced survey experience.

This study relies on structural equation modelling (SEM) to test the research hypotheses and estimate the general model based on the Maximum Likelihood Estimator (MLE). As our chosen methodological approach, SEM is a modern advanced technique, offering the unique advantage of simultaneously analyzing complex relationships between latent variables (Isik & Yasar, 2015; Hasan et al., 2023; Falebita & Kok, 2025). Moreover, SEM integrates measurement models with path analysis within a unified framework – unlike more conventional techniques such as multiple regression. This distinction is particularly relevant here because both Technology Readiness (TR) and Perceived Value (PV) are multi-dimensional constructs that demand a comprehensive evaluation of their measurement properties. In other words, SEM's capacity to model intricate relationships accurately, account for measurement error, and provide confirmatory analysis of theoretical models underscores its power for capturing robust empirical results.

To apply all these analysis methods, we used STATA 18. Figure 1 shows the complex design of the SEM model, executed in Stata. Using the Maximum Likelihood Estimation (MLE) method, the design thoroughly describes the direct, indirect, and overall connections for analyzing cross-sectional data. It investigates the connections among the following five crucial constructs: Technology Readiness (TR), Perceived Value (PV), Attitude (AT), Purchase Intention (PI) and Purchase Behavior (PB).

One of the advantages of SEM estimated by MLE is its ability to provide efficient and consistent parameter estimates even in the presence of certain model complexities, including multicollinearity. MLE accounts for multicollinearity issues by adjusting the standard errors of parameter estimates. In the presence of high correlations between predictors, MLE still provides consistent estimates of model parameters (Ramlall, 2016). Furthermore, Ramlall (2016) highlights that SEM is immune to the multicollinearity problem by virtue of the fact that multiple measures are needed to describe a latent construct.

With the help of this methodological design, the SEM's model configuration integrates both the measurement and structural aspects. Other scholars looking at similar subjects also adopted this application of SEM (e.g., Yieh et al., 2012; Pisitsankkhakarn & Vassanadumrongdee, 2020), because it facilitates linking different metrics for the five constructs included in this article.

Additionally, this study captures all such interrelations, incorporating specific adjustments for measurement errors to obtain accurate estimations of the connections among the latent constructs. Consequently, the SEM method is applied to validate the five research hypotheses of this study, scrutinizing the direct, indirect, and cumulative associations among the variables (both observable and latent), aligning with the established theoretical framework and hypotheses.

4. Results

This section is dedicated to empirical results, which aim to address the research hypotheses posited in the previous section. Through the application of SEM, we have evaluated the complex relationships between technology readiness, perceived value, consumer attitudes, intentions, and, ultimately, their purchase behaviors towards sustainable IoT products within

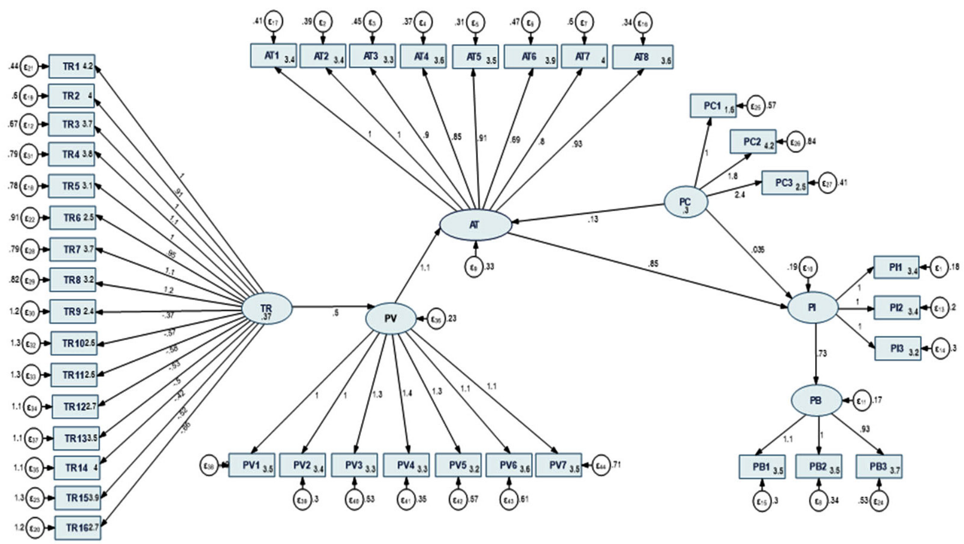

Figure 2. Results of the SEM model (source: authors' research in Stata 18)

the CE framework. Our analysis entails the intricate dynamics that influence consumer engagement with sustainable technologies, providing insightful revelations on the significant roles of technology readiness and perceived value in shaping consumer attitudes and purchase intentions. The SEM model results are included in Figure 2, and the structural analysis' primary outcomes are outlined in Table 1.

Table 1. Indirect and total effects captured by the SEM model through the MLE method (source: authors' contribution in Stata 18)

Variables	Coefficient	Standard error	Z	P>|z|	95% confidence interval	
AT						
PV	1.1356480	0.1133333	10.02	0.000	0.9135185	1.357777
PC	0.1265228	0.0761160	1.66	0.096	–0.0226618	0.275707
TR	0.5643606	0.0839656	6.72	0.000	0.3997911	0.728930
PI						
AT	0.8516676	0.0543043	15.68	0.000	0.745233	0.958102
PV	0.9671943	0.0982682	9.84	0.000	0.7745921	1.159796
PC	0.1432814	0.0814326	1.76	0.078	–0.0163236	0.302886
TR	0.4806476	0.0723287	6.65	0.000	0.3388859	0.622409
PB						
AT	0.6218230	0.0532122	11.69	0.000	0.517529	0.726117
PI	0.7301241	0.0511933	14.26	0.000	0.629787	0.830461
PV	0.7061718	0.0824315	8.57	0.000	0.544609	0.867734
PC	0.1046132	0.0596955	1.75	0.080	–0.0123879	0.221614
TR	0.3509324	0.0565179	6.21	0.000	0.2401594	0.461705

MLE-based SEM can handle redundancy in the model due to multicollinearity by using overall goodness-of-fit indices such as the chi-squared test, Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). These indices assess how well the model fits the data, even when multicollinearity is present (Kline, 2016). Therefore, we have performed several robustness tests, and the results are presented in Appendix, Tables A2–A4. According to the data detailed in Table A2, the "goodness-of-fit tests" cover a range of assessments, such as the likelihood ratio (comparing model vs. saturated, and baseline vs. saturated), RMSEA, information criteria (Akaike and Bayesian), baseline comparisons (CFI and TLI), and residual measurements (SRMR and the coefficient of determination, CD). The outcomes from these tests underscore the robustness and reliability of the SEM results, confirming their validity for economic interpretation.

Moreover, Table A3 presents Cronbach's alpha test results for scale reliability. The minimal value obtained in our model for Cronbach's alpha is 0.9138. This significantly surpasses the suggested minimum criterion of 0.7 and indicates that all measurement scales are reliable.

Wald's tests for equations related to the SEM models were also performed (Appendix Table A4). The chi-square values, along with their respective p-values of 0.0000 or close to it, indicate that the relationships or effects being tested are statistically significant. This means there's a very low probability that the observed relationships could have occurred by chance, affirming the strength and relevance of these relationships within our model. The chi-square values for the latent constructs, along with very significant p-values (0.0000), highlight the overall significance of these constructs within our research model. These results indicate that our model's constructs – attitudes, purchase intentions, purchase behaviors, and perceived value – are significantly influenced by the observed variables and relationships we've modelled. This part of the Wald test results reinforces the construct validity and the theoretical underpinnings of our SEM analysis.

The synthesized results obtained after the empirical testing of research hypotheses H1 to H5 are presented in Table 2.

Table 2. Results of testing the research hypotheses (source: author's research)

Hypotheses	Path Coefficient (β) and Standard Error	Significance	Result
H1: Technology readiness has a positive, direct, and significant effect on perceived value of sustainable IoT products.	TR → PV: 0.497 (0.0753)	*** $p < 0.001$	Accepted
H2: Perceived value of sustainable IoT products has a positive, direct, and significant effect on the attitude towards purchasing sustainable IoT products.	PV → AT: 1.136 (0.113)	*** $p < 0.001$	Accepted
H3: The attitude towards sustainable IoT products has a positive, direct, and significant effect on the purchase intention of sustainable IoT products.	AT → PI: 0.852 (0.0543)	*** $p < 0.001$	Accepted
H4a: Personal characteristics (age, education, income) have a positive, direct, and significant effect on attitude towards sustainable IoT products.	PC → AT: 0.127 (0.0761)	($p < 0.10$)	Partially Accepted
H4b: Personal characteristics (age, education, income) have a positive, direct, and significant effect on the intention to purchase sustainable IoT products.	PC → PI: 0.035 (0.0617)	($p < 0.10$)	Partially Accepted
H5: Purchase intention of sustainable IoT products has a positive, direct, and significant effect on purchase behavior of sustainable IoT products.	PI → PB: 0.730 (0.0512)	*** $p < 0.001$	Accepted

Findings for H1 entail that technology readiness has a positive, direct, and significant effect on perceived value of sustainable IoT products. The coefficient for Technology Readiness (TR) influencing Perceived Value (PV) is 0.497, with a statistically significant level at the 0.1% threshold. This indicates that as technology readiness increases, so does the perceived value of sustainable IoT products, which confirms H1. At the same time, it outlines how important technology readiness is in influencing consumer perceptions of value in sustainable IoT products.

However, according to H2, the perceived value of sustainable IoT products exerts a positive, direct, and significant influence on whether consumers purchase sustainable IoT products. A coefficient of 1.136, with a significant p-value of 0.000, reflects the positive influence of Perceived Value (PV) on Attitude (AT), which is strongly in favor of H2. Thus, it seems to confirm that a higher perceived value leads to a more positive attitude towards purchasing sustainable IoT products. This also correlates with the third hypothesis, H3, namely that the attitude towards sustainable IoT products has a positive, direct, and significant effect on the purchase intention of sustainable IoT products. The coefficient from Attitude (AT) to Purchase Intention (PI) is 0.852, also with a p-value of 0.000, which validates H3, showing that a positive attitude towards sustainable IoT products significantly increases the intention to purchase them. Additionally, H4a posits that personal characteristics (age, education, income) have a positive, direct, and significant impact on the attitude towards sustainable IoT products, while H4b posits that personal characteristics (age, education, income) have a positive, direct, and significant impact on the intention to purchase sustainable IoT products.

Personal Characteristics (PC) present a path coefficient of 0.127 to AT with a p-value of 0.096 and 0.035 to PI with a p-value of 0.078, trending toward significance. While not conclusively supporting H4a and H4b within the conventional $p < 0.05$ criterion, there's evidence of a positive relationship, suggesting that personal characteristics may influence attitude and purchase intention towards sustainable IoT products.

These two hypotheses could be argued to find support within a 10% significance level, suggesting a potential positive correlation between personal characteristics and attitude towards sustainable IoT products and purchase intention towards sustainable IoT products. However, this interpretation depends on the acceptance of a 10% threshold.

The last hypothesis, H5, states that purchase intention of sustainable IoT products has a positive, direct, and significant effect on purchase behavior of sustainable IoT products. The path coefficient from Purchase Intention (PI) to Purchase Behavior (PB) is 0.730, significant at the 0.1% level, robustly supporting H5. This confirms that stronger intentions to purchase sustainable IoT products lead to higher actual purchase behavior.

5. Discussion

The study explores the impact of integrating the CE and the IoT from a consumer perspective, particularly regarding sustainable IoT products. CE aims to maximize the economic value of products, components, and materials while minimizing environmental impact. IoT plays an important role in enabling this through data-driven insights for resource optimization.

The paper focuses on the role of technology readiness in shaping consumer attitudes and intentions toward sustainable IoT products. This is an underexplored area, particularly in the context of the circular economy, where previous studies primarily focused on organizational transitions rather than consumer readiness to adopt new technologies. This paper introduces a comprehensive empirical framework that captures the multifaceted nature of consumer behavior towards sustainable IoT products by including technology readiness, perceived value, attitudes, purchase intentions, and purchase behavior, thus addressing a gap in models that integrate all these variables to predict consumer actions effectively.

The positive influence of optimism (a TR dimension) on perceived value corroborates findings by Parasuraman and Colby (2015), who identified optimism as a driver of favorable attitudes toward new technologies. Similarly, our study supports assertions by Venkatesh et al. (2003) regarding the role of perceived ease of use and usefulness (parallels to perceived value) in fostering technology adoption.

Furthermore, our observation of insecurity as a barrier to perceived value aligns with Yieh et al. (2012), who argued that trust issues often inhibit technology acceptance.

Similarly, Blut and Wang's (2020) meta-analysis reveals that negative dimensions – namely, insecurity and discomfort – can significantly inhibit customer perceived value while simultaneously limiting the adoption of new technologies. One might ask whether addressing consumer anxiety and insecurity is not, in fact, essential for unlocking the full potential of IoT-enabled solutions; indeed, these findings underscore that very point.

Turning to the realm of Circular Economy (CE), previous studies have meticulously analyzed organizational readiness – for instance, Kirchherr et al. (2017) have provided in-depth insights into this area – whereas our findings emphasize the relatively underexplored consumer perspective. In this light, our research helps to close the information gap by illustrating how individual-level factors such as Technology Readiness (TR) and Perceived Value (PV) shape attitudes toward CE adoption. As highlighted by Szilagyi et al. (2022), individual factors are of prime importance in encouraging consumer engagement with sustainable transitions, while Camacho-Otero et al. (2018) demonstrated that addressing consumer behavior is fundamental to promoting sustainable consumption practices.

Furthermore, cultural differences exert a profound impact on technology adoption and sustainability perceptions. For example, Venkatesh et al. (2012) expanded on the Unified Theory of Acceptance and Use of Technology (UTAUT), demonstrating that variables such as hedonic motivation, price value, and habits can vary considerably across different cultural settings. In a similar vein, when examining attitudes toward low-carbon technologies, Scheller et al. (2024) highlighted that perceived benefits and adoption behaviors are influenced by cultural contexts, suggesting, perhaps, that additional cross-cultural research is needed to fully comprehend how individual traits and contextual influences shape technology adoption and sustainability perceptions.

The present research also confirmed a positive association between higher levels of technology readiness and the perceived value of sustainable IoT products. This means that consumers tend to place a higher value on sustainable IoT products, the more comfortable and optimistic they feel about using the technology. Undeniably, consumer attitudes towards these products are significantly influenced by how consumers perceive value, both in terms of cost savings and environmental benefits and energy efficiency. We can state that consumers with a strong intention to purchase sustainable IoT products actually follow a purchasing behavior, thus marking a clear transition from mere intention to actual purchase.

Finally, our findings indicate a significant correlation between consumer awareness of sustainable products and their purchasing intentions – a connection supported by a growing body of literature. For instance, Gazzola et al. (2020) and Musova et al. (2021) both emphasize the critical role of environmental awareness in influencing consumer behavior. Musova et al. (2021) posit that as consumers become more informed about the environmental and societal impacts of their choices, their preference for sustainable products increases; this trend is consistent with what we observed in our sample. Moreover, Gazzola et al. (2020) underscore the influence of education and media on sustainable consumption practices, which may explain the demographic characteristics seen in our study. Notably, Rehman et al. (2024) found that price sensitivity can weaken the relationship between environmental concern and the intention to purchase eco-minded products, while Blas Riesgo et al. (2023) reported in the fashion industry that certain economic factors may drive buyers to prioritize price and quality over sustainability. The results of our research are particularly relevant for Romania, given local economic conditions, cultural attitudes regarding environmental responsibility and sustainable products, aspects that reveal awareness of the need for sustainability.

Based on all these landmarks, our research adds to the academic discourse by providing empirical data and theoretical evidence into the dynamics of consumer behavior in relation to sustainability and technology adoption. It contributes to understanding how consumer decisions regarding sustainable IoT products are impacted by technology readiness, perceived value, attitude, and purchase intentions. In the context of CE, this research is vital because the rollout of sustainability requires a better understanding of what drives consumer engagement with eco-friendly technologies.

This study also shows the way in which Technology Readiness (TR) dimensions – optimism, innovativeness, discomfort, and insecurity – and Perceived Value (PV) are interconnected when it comes to shaping consumer attitudes toward sustainable products enabled by IoT. Whereas previous research looked at these aspects independently, our results offer new insights by proving how TR dimensions moderate or amplify the influence of PV on consumers' attitudes through the lens of the pronounced cultural and economic variability existing in Romania.

Moreover, our study entails the moderating role of specific demographic elements, such as income and age, providing a detailed picture of how these variables shape TR and PV interactions. This finding aligns with those of Rojas-Méndez et al. (2017), who also underscore that education and age significantly influence how technology is adopted across cultures. Their study confirms that education routinely predicts readiness to adopt new technology, reiterating how important it is in shaping consumer attitudes.

Younger consumers typically appraise circular, IoT-based initiatives with an innate optimism and a keen drive for innovation – qualities that form the foundation of high technology readiness (Negm, 2023). By contrast, older individuals, who often report lower technology readiness, tend to adopt a more pragmatic approach when evaluating perceived value, favoring concrete, measurable benefits over the sheer novelty of technological advancements. Notably, higher levels of education seem to bolster the link between technology readiness and perceived value, implying that education moderates how consumers interpret and assess IoT applications within a circular economy framework (Kolade et al., 2022).

Economic capacity, too, plays an important role. Consumers endowed with greater financial resources are more apt to consider sustainable technologies as not only accessible but also worthy of investment in circular initiatives. As Roy et al. (2018) have demonstrated, wealthier consumers tend to display a sharper recognition of the intrinsic value of IoT technologies, coupled with a heightened willingness to absorb associated costs. Similarly, Ganesh and Nagadeepa (2024) argue that affordability and the perceived benefits of technology are decisive drivers of purchase intentions for IoT devices. It is challenging to find if these economic factors function simultaneously as both catalysts and filters in the technology adoption process.

By incorporating the notion of perceived value with environmental attitudes and purchase intentions, our research extends the conventional framework of consumer behavior to include sustainable IoT products. Moreover, rather than relying solely on intrinsic environmental concerns, consumers also weigh pragmatic factors – such as product affordability and ease of access – when making decisions. This perspective is supported by Rehman et al. (2024), who identified price sensitivity as a primordial factor in green purchasing decisions. Simultaneously, the findings of Blas Riesgo et al. (2023) suggest that economic considerations often overshadow sustainability-related motivations. These insights compel us to critically reexamine traditional models that may exaggerate ethical imperatives while underestimating practical constraints (Gazzola et al., 2020; Musova et al., 2021).

By demonstrating how TR dimensions impact PV and attitudes, current research broadens this perspective and bridges the gap between theoretical models and consumer adoption practices. Therefore, our findings have several managerial implications. Businesses should invest in technologies and processes that boost the security, privacy, and reliability of their products. Understanding the factors that influence consumer trust and perceptions towards IoT products can help businesses tailor their marketing strategies to highlight the features of their sustainable products. In the current business landscape, firms are grappling with the challenge of transitioning smoothly to CE. This struggle is magnified by the dual pressures from policymakers and consumers to meet sustainability targets. Consumers are revising their attitudes towards sustainability and consumption, increasingly demanding transparency and action towards sustainability and CE objectives. Their inquiries often extend deep into the supply chain, touching on issues such as material sourcing, production conditions, and human rights abuses. Given these consumer concerns, merely proclaiming sustainability credentials is insufficient. Retailers must adopt tangible, urgent actions to avoid losing customers. From a managerial perspective, our study underscores actionable strategies for enhancing consumer engagement with sustainable IoT products like: segment-specific marketing- companies should tailor their communication strategies to address varying levels of TR among different demographic segments; lower-income groups may require more targeted campaigns highlighting affordability and long-term cost benefits of sustainable IoT products; enhancing perceived value businesses can focus on increasing PV by showcasing tangible benefits of sustainable IoT products, such as environmental impact reduction, cost savings, and ease of use. Highlighting these benefits in consumer-friendly terms (e.g., through testimonials and infographics) can foster stronger attitudes toward adoption; educational campaigns- to address insecurity and discomfort, companies should invest in educational campaigns and hands-on demonstrations, reducing barriers to adoption by building trust in IoT technologies. Workshops, online tutorials, and transparent information about product safety can mitigate consumer resistance; collaboration between businesses and policymakers can foster an ecosystem that incentivizes sustainable consumption, such as subsidies for IoT products that enhance CE practices. Companies should use IoT tools for transparency. Blockchain can be used for product tracking or real-time usage analysis, to educate and engage consumers in sustainable consumption. An example is smart home devices that display real-time energy savings or CO_2 reductions, reinforcing green behaviors. Also, companies can move from ownership-based models to performance-based models that align directly with CE principles. Companies can lease IoT devices with predictive maintenance for product longevity and smart sensors in electronic waste disposal systems can track and optimize product recycling. For consumers with high TR, companies should offer cutting-edge IoT-enabled sustainability features, such as AI-powered energy optimization in smart devices. Companies should reduce adoption barriers for those with low TR with simplified onboarding processes, user-friendly IoT interfaces, and transparent sustainability benefits. Last but not least, companies should emphasize both functional and ecological values (e.g., extended product life cycles, IoT-powered energy efficiency reports).

This study provides valuable insights for retailers and retail managers, shedding light on the factors that significantly influence customers' purchasing intentions and behaviors. By leveraging the proposed model, they can reassess and reflect upon the key factors, variables, and metrics affecting purchasing intentions and behavior toward sustainable IoT products. It is recognized that the primary drivers of circular solution adoption are customers' characteristics, including their knowledge, understanding, experience, social concerns, and other psychological factors. The model offered in this study comprehensively addresses these aspects, providing a holistic view of the influences on customers' purchase intentions and behavior. This framework can be used to tailor companies' business strategies based on their product/service, and their customer pool. Testing the model with certain offers can help managers understand their customers' behavior, enabling more effective targeting and engagement strategies.

6. Conclusions

Our investigation contributes four primary insights to the current scholarly dialogue. Regarding sustainable Internet of Things (IoT) products, our study highlights that technology readiness (TR) is an important determinant of consumer attitudes. In addition, by centring the consumer's perspective in the circular economy (CE) dialogue, we address a gap in earlier research that predominantly focused on how organizations shift toward CE. Our work further presents an empirically grounded framework that captures the multifaceted dynamics of consumer behavior – an indispensable aspect of promoting circular economic practices. Lastly, we clarify the key factors driving both purchasing intentions and consumer attitudes toward sustainable IoT products. Overall, our findings call for concerted efforts by businesses and policymakers to nurture an environment that supports the uptake of sustainable technologies, a prerequisite for a resilient circular economy.

Achieving a robust circular economy fundamentally depends on a deep understanding of consumer intentions and behaviors. As consumer profiles diversify and evolve, companies are increasingly challenged to decode these emerging patterns. The ongoing shift from traditional, linear business models to circular systems presents a significant challenge, particularly given the paucity of models that fully capture the heterogeneity of consumer behavior.

The results of this research provide actionable strategies for practitioners and policymakers. To effectively capture the market for sustainable IoT products, companies will need to create communication approaches that not only highlight environmental benefits, but also emphasize practical advantages, such as cost efficiency and superior product quality. Moreover, by segmenting the target audience and tailoring messages to distinct consumer profiles – whether those driven primarily by environmental ideals or by economic considerations – businesses can more precisely adjust their branding and positioning strategies to align with the evolving priorities of modern consumers.

Looking ahead, future research should build on these insights by exploring how additional demographic factors affect the predictive success of models related to purchasing intentions and behavior. Although our study concentrated on key target groups for IoT adoption within the Romanian socio-economic context – a setting characterized by ongoing digitalization and sustainability initiatives – broadening the demographic scope would likely enhance the generalizability of these findings. Subsequent studies might, therefore, consider a more representative distribution across variables such as age and income. While our primary focus was on sustainable IoT products, the conceptual framework we propose could serve as a foundational tool for research across diverse industries, enabling the exploration of contextual factors that influence purchasing intentions and behaviors toward CE products. However, it is important to acknowledge that Romania's emerging market status, with its relatively modest income levels and variable technological infrastructure, may limit the applicability of these findings to other regions. Moreover, cultural nuances in Romania – especially regarding sustainability and technology adoption, which must contend with issues of price sensitivity and trust – may result in consumer behavior that differs from that observed in higher-income countries.

Our research entails the nuanced role of demographic characteristics, such as age and education, in shaping consumers' Technology Readiness (TR) and their Perceived Value (PV) of IoT-enabled CE products. The observed interactions suggest that targeted interventions aimed at particular demographic segments could enhance the effectiveness of IoT-driven sustainable strategies. Further investigation into these dynamics is needed to extract actionable insights for policymakers and businesses pursuing sustainable technological adoption. Future studies should strive to encompass a broader spectrum of demographic groups, delving into their unique traits and assessing how these differences impact the predictive accuracy of purchasing intentions and behaviors.

The sampling approach is one of the research limitations, which, while conceptually similar to stratified sampling, is disproportionate and non-probability-based. This method was chosen to ensure a broad representation of demographic variations in age, gender, and income while maintaining practical feasibility. However, the dominance of low-income respondents in the sample may limit the generalizability of findings, particularly regarding higher-income consumers' adoption of sustainable IoT products. Although income was included as a moderating variable in the analysis, the lower representation of high-income respondents may affect the robustness of conclusions drawn for this segment.

Future studies could address this limitation by employing stratified random sampling or targeted recruitment strategies to achieve a more balanced representation across income levels. Longitudinal research designs could offer a more robust exploration of the evolution of TR and PV, and their influence on consumer attitudes and behaviors over time. This approach would further enhance the complex interplay among the model's determinants and clarify their respective impacts.

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Author contributions

Luminita Bozdog and Bogdana Glovatchi conceived the study. Grațiela Georgiana Noja, Gabriela Mircea, Tomasz Dorożyński and Andrea Imperia were responsible for the development of the data analysis, methodology, software and econometric modelling. Luminita Bozdog was responsible for data collection and interpretation. All authors contributed to the writing, editing, and review of the final manuscript.

Disclosure statement

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.

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APPENDIX

Table A1. Summary of statistics (source: authors' research)

Variable	Category	Frequency	Percent (%)
Age	18–25	196	61.1
Age	26–35	81	25.3
Age	36–45	27	8.4
Age	46+	17	5.2
Education	High School	110	34.3
Education	Bachelor's	139	43.3
Education	Master's/Ph.D.	72	22.4
Income (USD/month)	< $432	130	40.5
Income (USD/month)	$432–$864	115	35.7
Income (USD/month)	> $864	76	23.8

Table A2. Goodness-of-Fit tests for the SEM model (source: authors' research in Stata 18)

Fit statistic	Value	Description
Likelihood ratio (model vs. saturated)		
chi2_ms(734)	3055.326	"model vs. saturated"
p > chi2	0.000	
chi2_bs(780)	8234.487	"baseline vs. saturated"
p > chi2	0.000	
Population error		
RMSEA	0.099	"Root mean squared error of approximation"
90% CI, lower bound	0.096	
upper bound	0.103	
pclose	0.000	"Probability RMSEA <= 0.05"
Information criteria		
AIC	32585.844	"Akaike's information criterion"
BIC	33061.046	"Bayesian information criterion"
Baseline comparison		
CFI	0.689	"Comparative fit index"
TLI	0.669	"Tucker–Lewis index"
Size of residuals		
SRMR	0.017	"Standardized root mean squared"
CD	0.978	"Coefficient of determination"

Table A3. Alpha Cronbach (source: authors' research in Stata 18)

Alpha Cronbach						
Test scale = mean(standardized items)						
Item	Obs	Sign	Item-test correlation	Item-rest correlation	Interitem correlation	Alpha
TR3	321	+	0.5030	0.4634	0.2201	0.9167
TR5	321	+	0.3887	0.3441	0.2231	0.918
TR2	321	+	0.5870	0.5521	0.2179	0.9157
TR16	321	–	0.2445	0.1957	0.2269	0.9197
TR1	321	+	0.5852	0.5501	0.2179	0.9157
TR6	321	+	0.4586	0.4168	0.2213	0.9172
TR15	321	–	0.2123	0.1628	0.2278	0.9200
TR7	321	+	0.4090	0.3652	0.2226	0.9178
TR8	321	+	0.4495	0.4074	0.2215	0.9173
TR9	321	+	–0.0618	–0.1123	0.2350	0.9230
TR4	321	+	0.5064	0.4670	0.2200	0.9167
TR10	321	–	0.1804	0.1304	0.2286	0.9204
TR11	321	–	0.2287	0.1795	0.2273	0.9198
TR12	321	–	0.2437	0.1948	0.2269	0.9197
TR13	321	–	0.2603	0.2118	0.2265	0.9195
TR14	321	–	0.1753	0.1252	0.2288	0.9204
PV1	321	+	0.6538	0.6231	0.2161	0.9149
PV2	321	+	0.6263	0.5938	0.2168	0.9152
PV3	321	+	0.5002	0.4605	0.2202	0.9167
PV4	321	+	0.6132	0.5799	0.2172	0.9154
PV5	321	+	0.5498	0.5127	0.2188	0.9162
PV6	321	+	0.6059	0.5721	0.2174	0.9155
PV7	321	+	0.5954	0.5609	0.2176	0.9156
AT1	321	+	0.6987	0.6711	0.2149	0.9144
AT2	321	+	0.7000	0.6725	0.2149	0.9143
AT3	321	+	0.6796	0.6507	0.2154	0.9146
AT4	321	+	0.7088	0.6820	0.2146	0.9142
AT5	321	+	0.7114	0.6848	0.2146	0.9142
AT6	321	+	0.6083	0.5746	0.2173	0.9155
AT7	321	+	0.5626	0.5261	0.2185	0.9160
AT8	321	+	0.7029	0.6756	0.2148	0.9143
PC1	321	+	0.1144	0.0637	0.2304	0.9211
PC2	321	+	0.2545	0.2058	0.2267	0.9196
PC3	321	+	0.3147	0.2677	0.2251	0.9189
PI1	321	+	0.7419	0.7176	0.2138	0.9138
PI2	321	+	0.7313	0.7062	0.2141	0.914
PI3	321	+	0.6834	0.6548	0.2153	0.9145
PB1	321	+	0.6689	0.6392	0.2157	0.9147
PB2	321	+	0.5897	0.5549	0.2178	0.9157
PB3	321	+	0.6061	0.5723	0.2174	0.9155
Total scale					0.2204	0.9188

Table A4. Wald tests for equations (source: authors' research in Stata 18)

	Chi2	df	p-value
Observed			
TR3	0	0	.
TR5	56.72	1	0.000
TR2	73.61	1	0.000
TR16	24.75	1	0.000
TR1	91.12	1	0.000
TR6	53.08	1	0.000
TR15	17.46	1	0.000
TR7	57.82	1	0.000
TR8	59.15	1	0.000
TR9	9.5	1	0.002
TR4	80.97	1	0.000
TR10	18	1	0.000
TR11	19.69	1	0.000
TR12	18.35	1	0.000
TR14	13.7	1	0.000
TR13	17.42	1	0.000
PV1	0	0	.
PV2	130.69	1	0.000
PV3	109.72	1	0.000
PV4	129.06	1	0.000
PV5	101.04	1	0.000
PV6	95.6	1	0.000
PV7	82.87	1	0.000
AT2	0	0	.
AT3	244.17	1	0.000
AT4	221.64	1	0.000
AT5	261.68	1	0.000
AT6	151.77	1	0.000
AT7	161.26	1	0.000
AT8	256.67	1	0.000
AT1	296.36	1	0.000
PC1	0	0	.
PC2	91.01	1	0.000
PC3	77.89	1	0.000
PI1	0	0	.
PI2	552.93	1	0.000
PI3	440.04	1	0.000
PB2	0	0	.
PB1	240.78	1	0.000
PB3	148.97	1	0.000
Latent			
PV	43.52	1	0.000
AT	102.64	2	0.000
PI	248.44	2	0.000
PB	203.41	1	0.000