Towards Greener Tech: Investigating University Students' Intentions to Purchase Sustainable Smartphones.

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ABSTRACT

Sustainable smartphone consumption can support the battle against the rising e-waste generation worldwide. This paper aims to examine university students' perceptions of sustainable smartphones and determine the factors influencing students' purchase intentions towards these products. Drawing on the Theory of Planned Behavior, this study investigates the influence of Environmental Consciousness, Perceived Consumer Effectiveness, and Perceived Quality Risk. A survey was conducted involving 121 university students from various countries around the world. Utilizing Partial Least Squares Structural Equation Modeling, the findings indicate that Environmental Consciousness and Perceived Consumer Effectiveness have a positive influence on students' purchase intentions for sustainable smartphones, while the relationship between Perceived Quality Risk and purchase intention was negative. The results of this thesis provide managers with valuable insights into university students' behavioral intentions toward sustainable smartphones, helping them develop effective marketing campaigns.

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Sustainable smartphones, green purchase behavior, environmental consciousness, perceived consumer effectiveness, perceived quality risk, purchase intention

1. INTRODUCTION

1.1 Background

Due to unsustainable consumption, our planet is facing severe environmental problems such as pollution, exhaustion of natural resources, and climate change (Ansu-Mensah, 2021; Shittu, 2020). As a result, consumers worldwide have become more concerned about the environment, which has encouraged them to focus more on their current consumption habits (Kerber et al., 2023). In the last few years, consumers have adopted a more eco-friendly purchase behavior, which has raised awareness of and demand for 'green' products (Jiang & He, 2022). These green products are seen as products that, during their manufacture, use, or disposal, do not negatively impact the environment (Couto et al., 2016). While the global consumer becomes more aware of their environmental impact and demand for green products is rising, the environmental impact of European consumption still increased by almost 4% in the period 2010-2021 (European Environment Agency, 2023).

Sustainability-wise, the electronics sector has built itself a bad reputation, thanks to its major contribution to global warming (Singh & Ogunseitan, 2022). Electronics significantly contribute to global carbon emissions; their contribution is estimated to range from 1.4% to 5.9% (Singh & Ogunseitan, 2022). More so, only mobile phones account for around 11% of the entire industry's environmental footprint (Global Electronics Council, 2021). As much as these gadgets improve our lives, they are also responsible for keeping our planet's climate in balance. In Europe, 93% of individuals aged 10 and older own a smartphone (ITU, 2023). Furthermore, it is forecast that the number of mobile phone users globally will increase by 1.5 billion between 2014 and 2029 (Statista, 2024). Simultaneously, while smartphone usage increases, Belkhir and Elmeligi (2018) predict a significant rise in smartphones' carbon emissions, which is mainly caused by high energy usage in mobile phone production and their short two-year average lifespan. For that reason, it is essential to encourage consumers to purchase sustainable smartphone alternatives. Therefore, understanding the variables impacting customers' intentions to buy such green products is essential.

Through the years, academics and professionals have paid significant attention to green consumption behavior. Several studies focused their research on finding variables that impact consumers' intentions toward green products. Some of the more recent studies focused on cognitive factors, which in this paper relate to how individuals perceive green products, for example: perceived value (Dangelico et al., 2022), perceived quality (Chandra Pant et al., 2024), and perceived risk (Tarabieh, 2021). Also, personality-specific constructs like environmental concern (Saari et al., 2021) and personal values, beliefs, and norms (Onel, 2024) have been investigated. However, most of the studies on green consumption behavior have only been carried out focusing on green products in general rather than emphasizing specific green product categories, which creates a call for research addressing specific green products. However, there are some previous studies that focused on specific sectors like fashion (e.g., Jacobs et al., 2018) and automobiles (e.g., Lin & Shi, 2022; Suhartanto et al., 2022).

Over the past few years, so-called refurbished phones have increased in popularity (IDC, 2023). These are second-hand phones that have been repaired and tested, eventually being sold for lower prices than new smartphones. Several previous studies focused their research on refurbished phones (e.g., Bigliardi et al., 2022; Nasiri & Shokouhyar, 2021), whereas Bigliardi et al. (2022) found that psychological factors, like environmental knowledge and green perceived value, were strong antecedents of consumers' intention to buy these products. More recently, besides refurbished phones, manufacturers like Fairphone, Teracube, and Shift have introduced what are known as sustainable smartphones, also referred to as green smartphones. These smartphones are not pre-owned and are claimed to be made of materials that are recycled or sourced in a more sustainable manner (Fairphone, 2023a). Furthermore, these mobile phones are made out of a number of different modules, which gives consumers the opportunity to repair or swap broken modules themselves. The main goal of producing sustainable smartphones is to increase smartphones' lifespans (Fairphone, 2023b). Recently, Kerber et al. (2023), Raj et al. (2023), and Zwicker et al. (2023) were some of the first studies that focused their research on green purchase behavior regarding sustainable smartphones. For instance, Kerber et al. (2023) found that environmental consciousness positively influences consumers' purchase intention for green smartphones.

1.2 Research gap

Despite the significant environmental impact of the mobile phone industry, studies on sustainable smartphones in particular are scarce. The little amount of research that has been investigating consumers' purchase decisions for sustainable smartphones has revealed the complexity of this phenomenon. This results in a call for further research on the underlying constructs and generalizations of the findings by investigating several demographic groups. Additionally, the current literature on sustainable smartphones misses a closer look at young consumers, such as university students. Little is known about how university students feel about and accept sustainable smartphones, as well as the variables that may influence this perception.

1.3 Purpose of the study

The purpose of this paper is to explore a theoretical model that incorporates environmental consciousness (EC), perceived consumer effectiveness (PCE), and perceived quality risk (PQR) as predictors of consumers' purchase intention towards sustainable smartphones. Furthermore, this study will contribute further to the existing literature by assessing university students. Since students are the consumers and decision-makers of the future, it is crucial to understand these individuals' consumption patterns. Consequently, this study aims to address the following research question:

How do Environmental Consciousness, Perceived Consumer Effectiveness, and Perceived Quality Risk influence university students' intentions to purchase sustainable smartphones?

1.4 Theoretical positioning

This study creates a theoretical model by integrating constructs from previous literature (Figure 1). Ajzen's (1991) Theory of Planned Behavior (TPB) is among the most influential psychological theories used to study sustainable consumption behavior. Yadav and Pathak (2017) highlighted the predicting power of TPB's three main constructs on green purchase intention. Through the years, various studies focused on expanding the TPB with additional factors to predict consumers' purchase intentions for green products. For this paper's model, the two constructs, EC and PCE, are selected from studies that have proven the predictive power of these additional factors in expanded TPB models. The last construct (PQR) is adapted from previous research that investigated consumers' perceived risks for refurbished and sustainable smartphones. In the theoretical background section of this paper, this will be explained in more detail.

1.5 Practical relevance

The study's findings, which explain university students' purchase intention towards sustainable smartphones, could aid policymakers and marketers in further adjusting their marketing strategies to the preferences of university students. This study aims to pinpoint essential elements in crafting an effective marketing strategy for green smartphones in particular. Understanding the way students partake in environmentally friendly product purchases would also help marketers and producers meet consumer demands, ultimately producing better, more protected, and healthier products.

1.6 Outline of the paper

The paper continues with the theoretical background, which forms the basis of this study. Following this, the methodology section is discussed, explaining the methods used in the research. Next, the results section reports the main findings of the study. Finally, the paper concludes with the discussion section.

2. THEORETICAL BACKGROUND

2.1 Sustainable smartphones

The amount of electronic devices consumed worldwide has drastically grown over the past 50 years (Belkhir & Elmeligi, 2018). Especially the number of smartphones is increasing quickly, due to increased market growth and smartphones' short lifespans (Belkhir & Elmeligi, 2018). In 2023, 78% of individuals worldwide, over the age of 10, owned a mobile phone (ITU, 2023). This global consumption pattern comes with great responsibility, as the smartphone industry is to blame for its high environmental impact. The carbon emissions caused by smartphones significantly grew by 730% between 2010 and 2022 (Belkhir & Elmeligi, 2018). E-waste, a common term for electronic waste, is a huge problem around the globe. In 2022, 62 million tonnes of electronic waste was generated worldwide (Baldé et al., 2024). Each year, the generation of e-waste is increasing by 2.6 million tonnes globally (Baldé et al., 2024). Of all the factors that contribute to this issue, smartphones are one of the largest causes of e-waste (Wilhelm et al., 2015). It's very important to deal with electronic waste responsibly because it causes environmental and health problems if not properly managed (Parvez et al., 2021).

Moreover, over the past few years, smartphones' lifespan has decreased to an average of 2 years (Belkhir & Elmeligi, 2018). More attention should be paid to increasing the lifespan of smartphones since it can greatly lessen the ecological impact of their production and use, resulting in lower waste, carbon emissions, and resource and energy usage (Wieser & Tröger, 2016). Furthermore, given that the manufacturing stage accounts for 80% of smartphones' greenhouse gas emissions (Rathnayake et al., 2022), using smartphones for longer periods would be helpful. The production of smartphones heavily relies on metals and non-biodegradable plastic, which contributes significantly to the environmental impact of smartphones (Nili et al., 2024). Moreover, the plastic components used for the production of conventional smartphones are complex and make it difficult to recycle smartphones (Raj et al., 2023).

Recycling is crucial in combating e-waste, but globally, only 17.4% of all the e-waste generated happens to be recycled in 2019. (Forti et al., 2020). Research stresses that to mitigate the harm caused by electronic waste, it is extremely important that, apart from government regulations meant to reduce e-waste, the demand for environmentally damaging electronics be lowered. Therefore, encouraging people to buy green mobile phones would be a key strategy (Ahmad & Zhang, 2020). In recent years, mobile phone manufacturers, such as Fairphone, have started to use recycled materials and develop phones with modular designs. Fairphone claims to use recycled copper, post-consumer recycled plastic, and 100% recycled rare earth in its production (Fairphone, 2023).

Furthermore, facing the growing environmental impact of traditional smartphones, embracing modular designs stands out as a hopeful path toward crafting eco-friendly substitutes. Green smartphones' modular design, which enables the substitution and repair of distinct components, offers the potential for prolonging the lifespan of products and enhancing the recyclability of materials (Amend et al., 2022).

To sum up, due to the negative environmental impact of e-waste worldwide, shifting consumers' purchase patterns towards more eco-friendly electronics, such as sustainable smartphones, is a viable method to tackle environmental issues.

2.2 Green purchase behavior

Consumers' interest in consuming eco-friendly products and adopting green consumption has seen significant growth over the past years (Laureti & Benedetti, 2018; Paul et al., 2016). As a result, the phenomenon of green purchase behavior emerged, which is described as a consumption pattern where individuals consciously reduce their purchases of environmentally or socially harmful products. Instead, they opt for more sustainable, eco-friendly alternatives that are reusable and favorable to the environment (Jaiswal & Kant, 2018). These products can be referred to as green products, which are defined by Nimse et al. (2007) as products that "contain recycled materials, reduce waste, conserve energy or water, use less packaging, and reduce the amount of toxics disposed of or consumed." Green products exhibit eco-friendly characteristics at every stage of their life cycle, such as greater ecological benefits when compared to similar traditional products and lower natural resource consumption throughout manufacturing (Kerber et al., 2023).

Studies based on the purchasing process identified purchase intention as a fundamental component of the entire purchase process (Ahmad & Zhang, 2020). Therefore, previous research typically assesses green purchase behavior based on consumers' intention to buy green products (e.g., Fraccascia et al., 2023; Jaiswal & Kant, 2018). The term "green purchase intention" is often used in these studies and is identified as consumers' willingness, preference, and likelihood to purchase eco-friendly products. Most studies mainly investigated purchase intentions for green products in general (Jaiswal & Kant, 2018; Yadav & Pathak, 2017). However, some studies focused on specific product categories, such as electric vehicles (Rafiq et al., 2023; Sahoo et al., 2022) and sustainable clothing (Jacobs et al., 2018).

2.3 Theory of planned behavior

The Theory of Planned Behavior (TPB), introduced by Ajzen (1991), is among the most popular theories in the study of consumer behavior and is often used to comprehend the antecedents of consumer behavior toward sustainability (Costa et al., 2021; Yadav & Pathak, 2017). In previous literature, the TPB model has been widely used to investigate consumers' behavioral intentions toward green products, with behavioral intention identified as a direct antecedent of behavior (Ajzen, 2002; Yadav & Pathak, 2017). The Theory of Planned Behavior argues that three main constructs lead to the formation of behavioral intention: attitude toward the behavior, subjective norm, and perceived behavioral control (Ajzen, 1991).

It has been proven that these three factors are effective in predicting consumers' intentions to purchase sustainable goods (Judge et al., 2019; Yadav & Pathak, 2016). Through the years, numerous studies focused their research on expanding the TPB framework to better understand green purchase behavior (e.g., Murtiningrum et al., 2022; Panda et al., 2020). A large and

growing body of literature has investigated the variables affecting consumers' intention to purchase green products using TPB and its extensions (e.g., Costa et al., 2021; ElHaffar et al., 2023; Hamzah & Tanwir, 2021). Previous research indicates that Environmental Consciousness (EC) is associated with one of TPB's constructs; attitude toward the behavior (Chen et al., 2018; Mohiuddin et al., 2018). For that reason, in this study's theoretical model, attitude toward the behavior is substituted with EC to explore EC's direct influence on purchase intention. Similarly, recent studies have identified a relationship between Perceived Consumer Effectiveness (PCE) and another of TPB's constructs: perceived behavioral control (PBC ; Fraccascia et al., 2023; Joshi & Rahman, 2015; Vermeir & Verbeke, 2008). Therefore, in this study, PBC is replaced with PCE to investigate the direct influence of PCE on purchase intention. Both constructs are incorporated in the theoretical model of this study (Figure 1).

2.4 Perceived risks

To highlight consumers' perceptions of the potential risks associated with sustainable smartphones, literature in related fields was reviewed. Consumers usually attempt to minimize risk as suggested by the Theory of Perceived Risk (Mitchell, 1992), which implies that consumers' purchase intention is reduced where there is a high perception of risk. Recent studies have applied the Theory of Perceived Risks to evaluate consumers' purchase intentions for green products (Magnier et al., 2019; Polyportis et al., 2022). For instance, Magnier et al. (2019) studied the relationship between perceived risks and consumers' purchase intentions for products made of recycled ocean plastic.

Furthermore, research on consumers' assessments of products made from recycled materials has indicated the perceived risks that might prevent consumers' purchase intentions of sustainable smartphones (Kuah & Wang, 2020; Polyportis et al., 2022). These studies showed that, especially, the quality and reliability of recycled products are doubted by consumers.

To investigate if university students perceive risks associated with the quality and reliability of sustainable smartphones and to examine if these perceptions influence their purchase intention for these products, Perceived Quality Risk is incorporated into this study's theoretical model (Figure 1). However, the primary underlying theoretical framework of this study is the Theory of Planned Behavior. Perceived Quality Risk is included as an additional construct of interest to provide further understanding of the potential barriers to purchasing sustainable smartphones.

2.5 Environmental consciousness

There is a large volume of published studies describing the role of environmental consciousness in shaping behavioral intentions within the green consumerism literature (e.g., Bittar, 2018; Choudhury et al., 2024; Kerber et al., 2023). As presented in Bittar's (2018) study, an environmentally conscious consumer comprehends the environmental challenges confronting our society, engages in eco-friendly behaviors, and shows a preference for products that are environmentally friendly and sustainable. This understanding is further supported by Brochado et al. (2017), who highlight that environmentally conscious consumers are individuals who consider the environmental consequences of their consumption behavior when making purchase decisions. Environmental Consciousness, as a construct in this study, encompasses both environmental consciousness and environmental awareness within the literature on green consumption.

On the one hand, some studies explored the indirect effect of environmental consciousness or awareness on purchase intention. For instance, environmental awareness is found to be positively associated with attitude toward the environment (Chen et al., 2018; Mohiuddin et al., 2018). Moreover, these studies state that environmental attitude positively influence consumers' green purchase intentions (Chen et al., 2018; Esmaeilpour & Bahmiary, 2017; Mohiuddin et al., 2018). Xu et al. (2020) explored how environmental awareness impacts the three TPB constructs: attitude, subjective norm, and perceived behavioral control, and subsequently, how these factors impact consumers' intentions to buy eco-friendly furniture.

In the context of sustainable smartphones, the success or effectiveness of sustainable smartphones relies on whether consumers intend to purchase them. In terms of sustainability, consumers need to recognize that sustainable modular smartphones facilitate the reuse of mobile phones, circularity, and a less negative impact on the environment (Amend et al., 2022). Therefore, understanding the relationship between environmental consciousness and consumers' purchase intentions is of great importance.

Other studies have looked into the direct relationship between environmental consciousness and green purchase intentions. Choudhury et al. (2024) found a significant effect of environmental consciousness on consumers' purchase intentions for green products. More intriguingly, Kerber et al. (2023) observed that environmental consciousness positively impacts the purchase intention for sustainable smartphones in southern Brazil. Regarding this theoretical background, the following hypothesis is proposed:

H1. *Environmental Conciousness positively influences university students' intentions to purchase sustainable smartphones.*

2.6 Perceived consumer effectiveness

Perceived Consumer Effectiveness is the idea consumers have about how much their behaviors can contribute to solving ecological problems and the extent to which the consumer wants to take part in sustainable practices (Lavuri, 2022). Within the context of sustainability, PCE measures how much consumers' consumption habits result in better mitigation and resolution of ecological issues (Kamalanon et al., 2022). Moreover, consumers who are aware of and have knowledge about these issues are more likely to think about the repercussions of their purchases, which empowers them to make green purchases and reduce pollution (Higueras-Castillo et al., 2019).

Furthermore, it has been found that consumers who believe their actions can make a difference in addressing ecological problems are more likely to engage in sustainable behaviors (Ellen et al., 1991; Gleim et al., 2013). This consumer mindset is crucial to fostering a culture of sustainability and driving positive change. Additionally, when PCE is high, it is more likely that people will develop positive attitudes toward green products (Vermeir & Verbeke, 2008).

On the one hand, studies investigated the indirect effect of PCE on green purchase intention through Aizen's proposed constructs. For instance, Higueras-Castillo et al. (2019) found that PCE has a moderating effect on the relationship between attitude and the intention to buy electric and hybrid cars.

On the other hand, studies started to look into the direct influence of PCE on consumers' intentions to purchase green products. Some of these studies have substituted PCE for perceived behavioral control, similar to this study, to test PCE's influence on green purchase intentions (Fraccascia et al., 2023; Vermeir & Verbeke, 2008). In Vermeir & Verbeke's (2008) study, they measured the influence of perceived consumer effectiveness, among other constructs, on consumers' intention to purchase sustainable dairy products. More recently, Fraccascia et al. (2023) investigated the influence of PCE, alongside other

factors, on peoples' purchase intentions for products made from industrial waste. In both studies, it was found that PCE has a significant positive influence on consumers' intentions to purchase these environmentally friendly products. More intriguingly, Raj et al. (2023) focused their study on green smartphones specifically. Their research found a positive relationship between PCE and consumers' intentions to purchase green smartphones. Accordingly, the following hypothesis is proposed:

H2. *Perceived Consumer Effectiveness positively influences university students' intentions to purchase sustainable smartphones.*

2.7 Perceived quality risk

In the literature on green purchase behavior, several studies have conducted studies on the influence of perceived risk on consumers' green purchase intentions (e.g., Tarabieh, 2021; Wang & Tian, 2023). Moreover, people attempt to avoid negative outcomes rather than look for favorable outcomes. Consumers tend to hold off on a purchase if they feel there is a high risk involved. Thus, the buyer is more likely to choose a product that they believe to be less risky (Tarabieh, 2021). Therefore, lowering perceived risk favorably affects consumers' intention to purchase products, leading to a negative influence of perceived risk on the purchase intention of consumers (Sheikh et al., 2023). In Yang et al.'s (2016) study about risk perception in e-commerce, performance (or functional) risk was found to positively influence overall perceived risk. Among financial risk, psychological risk, and social risk, performance risk was demonstrated to be the highest predictor of overall risk (Yang et al., 2016).

In the context of sustainable smartphones, the fact that these mobile phones are partially made from recycled materials may lead to higher perceived risks among consumers. Products that consist of recycled materials are assessed not only for their environmental advantages but also for their potential risks. Consumers frequently believe that recycled products are of lower quality compared to conventional new products (Polyportis et al., 2022). According to Kuah & Wang (2020), performance risk is a major barrier for consumers when deciding whether to buy products made of recycled materials. In their study, conducted in Asia, low quality and reliability were found to have a negative influence on consumers' purchase intentions for products made of recycled materials. Akkucuk (2011) identified functional risk, particularly for durable goods, as a key factor that consumers consider when assessing these products. In 1972, Jacoby and Kaplan conceptualized Perceived Quality Risk (PQR) as the potential that a product would not function the way it was supposed to. In this study, PQR is used to assess the functional risk. While a large body of literature investigated risk perception for products made of recycled materials, Raj et al. (2023) looked specifically into green smartphones. In their research, they discovered a negative influence of Perceived Quality Risk on consumers' purchase intentions of green smartphones. Based on the literature, the following hypothesis is introduced:

H3. *Perceived Quality Risk negatively influences university students' intentions to purchase sustainable smartphones.*

2.8 Theoretical model

In this paper, a theoretical model is shown to study the influence of Environmental Consciousness, Perceived Consumer Effectiveness, and Perceived Quality Risk on purchase intention (Figure 1). The different relationships between the constructs in the model are based on studies mentioned in the theoretical background of this paper. First, the path direction of Environmental Consciousness is based on the study of Kerber et al. (2023). Secondly, PCE's path direction is adapted from research conducted by Fraccascia et al. (2023) and Vermeir and Verbeke (2008). Thirdly, the suggested relationship between Perceived Quality Risk and purchase intention is based on research by Raj et al. (2023).

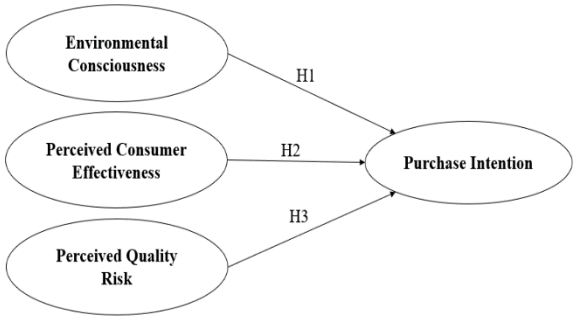

Figure 1. Theoretical model

Note(s): Adapted from Kerber et al. (2023), Fraccascia et al. (2023), Vermeir & Verbeke (2008), and Raj et al. (2023)

3. METHODOLOGY

3.1 Data collection

In this study, primary data was collected using quantitative research in the form of an online survey. The data used for analysis considers university students worldwide, gathered during a one-week period in May 2024. Snowball and convenience sampling methods were employed, which are common in consumer behavior studies (Yadav & Pathak, 2016, 2017). Participants were recruited through the following social media platforms: WhatsApp, Facebook, Instagram, and LinkedIn. To uphold ethical standards, the survey is approved by the ethics committee of the University of Twente. Participants were clearly informed that participation was voluntary and that they had the option to withdraw at any point. To prevent common method bias, participants were assured that their responses would remain anonymous and that there were no right or wrong answers. Participants were encouraged to share their personal perceptions.

3.2 Construct measurement

All of the questions that are included in the survey are derived from existing literature. The questionnaire consisted of a total of 25 items. After questioning participants' age and origin, participants' familiarity with the concept of sustainable smartphones is measured using a Likert scale ranging from "Not familiar at all" to "Extremely Familiar". Additionally, to measure participants' prior experience with sustainable smartphones, they were asked to choose one of the following answers: "I currently own and use a sustainable smartphone," "No, I have never owned or used a sustainable smartphone," and "Not sure/Prefer not to answer." To ensure that participants were relatively familiar with sustainable smartphones, a brief description was provided at the beginning of the survey.

For the remaining of the questionnaire, a five-point Likert scale with multiple items was used to collect the data for each construct, similar to the research of Fraccascia et al. (2023). The scales have a range of 1 = "strongly disagree" to 5 = "strongly agree. The five-point Likert scale is also chosen to decrease inpatient participants' levels of frustration and improve the

Table 1. Socio-demographic characteristics (N = 121)

Measure	Items	Frequency	Percent (%)
Age	18-24	99	81.8
	25-34	20	16.5
	35-44	2	1.7
Familiarity	Not familiar at all	58	47.9
	Slightly familiar	39	32.2
	Moderately familiar	20	16.5
	Very familiar	3	2.5
	Extremely familiar	1	0.8
Usage	I currently own and use a sustainable smartphone	5	4.1
	I have owned a sustainable smartphone in the past	2	1.7
	No, I have never owned or used a sustainable smartphone	104	86
	Not sure/ Prefer not to answer	10	8.3
Origin	Netherlands	59	48.8
	Europe	95	78.5
	Asia	11	9.1
	North- America	10	8.3
	South-America	2	1.7
	Africa	3	2.5

Note(s): Own calculations

quality and rate of response (Sachdev & Verma, 2004).

The scale for the first construct, Environmental Consciousness (EC), is measured by six items, replicated from Kerber et al's. (2023) study, which also investigated EC's impact on purchase intention for sustainable smartphones specifically. The replication of this scale ensures consistency and comparability with previous findings, which is crucial for validating and extending existing knowledge. The same applies to the other two constructs. For Perceived Consumer Effectiveness the scale consists of four items, adapted from Raj et al. (2023). Further, perceived quality risk is measured by five items, adapted from Raj et al. (2023). Finally, purchase intention (PI) is made up of five items, adopted from Raj et al. (2023). The items used for EC, PCE, PQR, and PI can be found in the appendix (Appendix 2).

3.3 Model estimation method

In this research, the PLS-SEM methodology is employed to measure and analyze the relationships in the model. This study aims to validate the theoretical model while also providing managerial implications. PLS-SEM seemed to be well-suited for this purpose, due to its causal-predictive nature (Magno et al., 2022). This unique characteristic makes PLS-SEM a suitable method in this paper since it allows the author to simultaneously assess the underlying theoretical constructs (causal paths) and predict outcomes. PLS-SEM's ability to blend causal modeling with predictive power makes it a strategic choice for research that seeks to achieve a well-rounded understanding of complex phenomena from a prediction perspective (Hair et al., 2021). In addition, PLS-SEM is chosen because it performs especially well with small sample sizes and reflective constructs (Hair et al., 2021). Earlier studies on green purchase behavior similarly used PLS-SEM (e.g., Rafiq et al., 2023; Suhartanto et al., 2022). The main purpose of this study is to predict consumers' intention to purchase green smartphones and subsequently draw implications from the relationships in the model.

3.4 Sampling

While the aim was to obtain around 100 usable responses, a total of 137 respondents were initially collected. However, the survey included a screening question to make sure that every participant was a university student. Responses from participants who did not meet this requirement were excluded. Furthermore, incomplete surveys were also excluded from the analysis. After cleaning the data, 121 usable survey responses were used for analysis. The age of participants ranges from 18 to 44 years old, although the majority are 18 to 24 years old (81.8%) and 25-34 years old (16.5%). The participants primarily reported that they were not familiar at all (47.9%) or slightly familiar (32.2%) with sustainable smartphones. Also, the great majority of respondents indicate that they have never owned or used a sustainable smartphone before (86%). Most of the participants originate from Europe (78.5%), of which 59 are from the Netherlands (see Table 1 for participants' socio-demographic characteristics). In total, participants from 18 different European countries were included in the sample. A total of 26 participants are from countries outside of Europe (Appendix 1).

4. RESULTS

4.1 Measurement model evaluation

According to the procedure recommended by Hair and Alamer (2022) and Hair et al. (2019), the measurement model is tested first before proceeding to analyze the structural model. The steps outlined by Hair and Alamer (2022) are followed to assess the reflective measurement model. First, the indicator loadings and p-values are estimated. The initial questionnaire included six Environmental Consciousness items, four Perceived Consumer Effectiveness items, four Perceived Quality Risk items, and six Purchase Intention items (Appendix 2). The results indicate that the outer loading values for items EC_2, EC_3, and PI_4 were significantly below the proposed threshold of 0.70 (Hair et al., 2019). Following the literature's recommendations, these items were excluded from the final model. In the end, four Environmental Consciousness items, four Perceived Consumer Effectiveness items, four Perceived Quality Risk items, and five Purchase Intention items were included in the final model used for path analysis.

As shown in the appendix (Appendix 3), each indicator loading is significantly higher than the suggested threshold of 0.70. Only EC_1 is slightly below the threshold (0.685). Nevertheless, if respectable results are found for other measures, such as the average variance extracted (AVE), values between 0.40 and 0.70 can be acceptable (Hair et al., 2019). Since the AVE value for Environment Consciousness is above the threshold, it is assumed to be acceptable.

Next, the internal consistency reliability for each construct is evaluated using Cronbach's alpha (α) and Composite Reliability (CR). The threshold of .70 for both measures seems to be deemed acceptable and is commonly used in PLS-SEM studies (Hair et al., 2019). Appendix 3 demonstrates that the values for each construct exceed the threshold of .70, indicating their acceptability.

Furthermore, I used the average variance explained (AVE) values to assess the convergent validity of each construct. Typically, if values reach .50 or higher, it suggests that the

construct has convergent validity (Hair et al., 2019). The average variance explained by all the constructs is higher than the .50 threshold, as shown in the appendix (Appendix 3). Therefore, both reliability and convergent validity are assumed to be established.

For the assessment of discriminant validity, the heterotrait-monotrait ratio of correlations (HTMT) criterion is used (Henseler et al., 2015). This measure indicates how distinct the construct is from other constructs considered in the study (Table 2). Most values are below the most conservative threshold of 0.85 (Henseler et al., 2015). Except the HTMT value for Environmental Consciousness and Perceived Consumer Effectiveness is above this threshold, they are therefore similar in concept. However, since it is still below the more liberal threshold of 0.9, it is assumed that discriminant validity is established (Henseler et al., 2015).

Table 2. Discriminant validity assessment.

	HTMT
Perceived Consumer Effectiveness ↔ Environmental Consciousness	0.855 (0.559; 0.855)
Purchase Intention ↔ Environmental Consciousness	0.813 (0.591; 0.813)
Purchase Intention ↔ Perceived Consumer Effectiveness	0.712 (0.410; 0.712)
Perceived Quality Risk ↔ Environmental Consciousness	0.386 (0.127; 0.386)
Perceived Quality Risk ↔ Perceived Consumer Effectiveness	0.308 (0.122; 0.308)
Perceived Quality Risk ↔ Purchase intention	0.624 (0.283; 0.624)

Note(s): HTMT = Heterotrait-Monotrait Ratio of Correlations

4.2 Structural model evaluation

After evaluating the measurement model, the structural model was assessed.. First, the structural model regressions should be examined for potential collinearity issues (Hair et al., 2019). Each variance inflation factor (VIF) value in the inner model is below 3.3. The highest value is 1.473, indicating that the model is considered free from common method bias (Kock, 2015).

In addition, the magnitude and significance of the path coefficients are examined. The path coefficients for each relationship in the model demonstrate a significant result. The path coefficients of Environmental Consciousness (0.431) and Perceived Consumer Effectiveness (0.223) indicate a positive influence on Purchase Intention, whereas for Perceived Quality Risk (-0.325), this relationship is negative (see next page; Table 3). However, the f^2 effect size of the relationship between PCE and PI is below the threshold of 0.15, which demonstrates a small effect size (Cohen, 1988).

Next, the PLS model was assessed using the coefficient of multiple determination (R^2) of the model. The R^2 value for Purchase Intention of 0.507 indicates that 50.7% of the variance in purchase intention is explained by the independent variables in the model. This is higher than 50%, indicating that the model's explanatory power is moderate (Hair et al., 2019). The R^2 value is assessed by comparing it to those of similar studies in the sustainable consumption literature. For instance, in Raj et al.'s. (2023) study, the R^2 value for purchase intention was 0.432. Furthermore, the study of Siyal et al. (2021) explained 50.6% of the variance in purchase intention. Since this study's R^2 value (0.507) does not deviate significantly from those in other studies, it is assumed to be acceptable.

Lastly, the model's predictive power is assessed with PLSpredict, suggested by Shmueli et al. (2019). First, the Q^2predict for each indicator is higher than 0, indicating that the assessment of prediction statistics can proceed (Shmueli et al., 2019). PLSpredict is used to compare linear regression model (LM) predictions with PLS-SEM analysis results. As shown in Table 4, each indicator in the PLS-SEM analysis shows lower RMSE (or MAE) values than the LM model, which demonstrates strong predictive power (Shmueli et al., 2019).

Table 3. Path coefficients

Path	Path coefficient	PCI	f^2
EC → PI	0.431***	(0.280; 0.572)	0.257
PCE → PI	0.223***	(0.080; 0.385)	0.070
PQR → PI	- 0.325***	(-0.464; -0.182)	0.208

Note(s): ***p < 0.01, PCI = percentile confidence interval (95%). Two-tailed test.

5. DISCUSSION

The purpose of this study is to investigate the influence of Environmental Consciousness, Perceived Consumer Effectiveness and Perceived Quality Risk on university students' purchase intentions for sustainable smartphones. This study's theoretical model was developed based on a literature review of leading academic articles in the field, ensuring the method's consistency and statistical validity. The assessment of the measurement model and structural model confirmed the measures' accuracy and acceptability.

First, this study discovered that Environmental Consciousness positively influences university students' intention to purchase sustainable smartphones, as hypothesized (H1). The present findings seem to be consistent with other research (Choudhury et al., 2024; Kerber et al., 2023). Kerber et al. (2023) also found a positive relationship between Environmental Consciousness (EC) and the intention to purchase greener smartphones in the south of Brazil.

Table 4. PLSpredict results

Construct	Indicator	Q^2predict	PLS-SEM_RMSE	PLS-SEM_MAE	LM_RMSE	LM_MAE
Purchase Intention	PI_1	0.390	0.720	0.566	0.751	0.598
	PI_2	0.373	0.780	0.629	0.808	0.629
	PI_3	0.268	0.908	0.744	0.957	0.762
	PI_5	0.373	0.729	0.598	0.754	0.611
	PI_6	0.178	0.856	0.680	0.942	0.742

Moreover, in Choudhury et al.'s. (2024) study, EC was identified as the second most important construct influencing consumers' green purchase intention in India. In contrast to these previous studies, this study's sample consisted of mostly young (18-24 year old) university students from Europe. Despite the differences in age, education, and origin between the studied samples, the results appeared to be consistent. This may prove that the influence of Environmental Consciousness remains significant across different contexts.

The results of this study also indicate that Perceived Consumer Effectiveness (PCE) positively influences university students' intention to purchase sustainable smartphones, as hypothesized (H2). This indicates that students are more likely to purchase sustainable smartphones if they believe their purchase decisions can contribute to protecting the environment. This result supports the findings of earlier research (Fraccascia et al., 2023; Jaiswal & Kant, 2018; Raj et al., 2023). Fraccascia et al.'s (2023) findings, show PCE as the strongest predictor of purchase intention for industrial symbiosis (IS) products, among Italian consumers. Examples of IS products are electronics, such as smartphones, made from industrial plastic and wood waste. Raj et al. (2023) studied respondents from India's highest income-per-capita states and also found support for the positive relation between PCE and consumers' purchase intention for green smartphones. The consistent findings across diverse samples may suggest a robust relationship between PCE and consumers 'willingness to purchase more eco-friendly products.

Finally, this study reports a negative influence of Perceived Quality Risk (PQR) on sustainable smartphone purchase intention among university students, as hypothesized (H3). The results suggest that consumers have doubts about the quality and performance of sustainable smartphones, which prevents them from buying these smartphone alternatives. These findings corroborate the results of Raj et al. (2023), who also identified a negative relationship between PQR and the intention to purchase eco-friendly smartphones in India.

5.1 Theoretical implications

This paper aims to understand the complexity of consumers' purchase decisions by drawing on the Theory of Planned Behavior. The TPB is applied in this study to the context of sustainable smartphones and university students' intentions to buy them. Therefore, TPB's applicability is expanded further towards this specific demographic group and green product category. The outcomes from this research confirm theoretical assumptions made in previous extended TPB models (Fraccascia et al., 2023; Kerber et al., 2023; Vermeir & Verbeke, 2008), which strengthens the credibility of the TPB model (and its extensions).

In this study, Perceived Quality Risk is treated as an additional construct of interest. The results for PQR indicate that for sustainable electronics, especially smartphones, it might be necessary to look beyond the TPB framework and investigate external factors that could impact consumers' purchase intentions. Interdisciplinary approaches may be considered in contexts where perceived risks play significant roles in consumers' purchase decisions. This may result in the use of more nuanced models that consider internal motivations (as explained by TPB) and perceived risks related to purchase decisions.

5.2 Practical implications

The results for each construct investigated in this study provide valuable insights for marketers and policymakers. First of all, the findings for Environmental Consciousness proved that increasing environmental consciousness among university students can enhance students' intentions to purchase sustainable smartphones. This shows that it is all the more important that policymakers ensure that companies are transparent about the positive or negative environmental impact of their products. Because of that, university students are able to learn about the environmental consequences of their consumption patterns and, therefore, become more environmentally conscious. In addition, it is recommended that providers of sustainable smartphones target their marketing campaigns at environmentally conscious university students, since these students seem to have higher intentions to purchase sustainable smartphones.

Furthermore, the results for Perceived Consumer Effectiveness should encourage policymakers and marketers to make university students realize that purchasing sustainable smartphones contributes to protecting the environment. Students need to feel that their contributions are meaningful in order for them to purchase these smartphone alternatives. First, policymakers should stimulate the education of university students about the important role sustainable electronics have in reducing e-waste problems worldwide. Besides, sustainable smartphone producers should focus their marketing campaigns strongly on effectively communicating the positive impact that their sustainable smartphones have on the environment. Based on these implications, the consumption of sustainable smartphones among university students can be increased.

Lastly, the results of this study showed that university students who had a bad perception of sustainable smartphone quality and reliability were less likely to have the intention to purchase sustainable smartphones. Therefore, it is recommended that marketers dispel any doubts about sustainable smartphones' quality and reliability. For example, firms producing sustainable smartphones could implement quality assurance programs in the form of warranties and return policies. Additionally, marketers should expose university students to positive reviews from previous users. This study identified drivers as well as a barrier for university students to shape purchase intentions for sustainable smartphones. Following the above-mentioned recommendations can hopefully help increase the consumption of sustainable smartphones.

5.3 Limitations and future research

Finally, this study has some limitations that are important to mention. First, this study only implements a quantitative research method. This can be seen as a general limitation since the researcher did not observe and talk with participants about their responses, which raises the questions whether the data collected from them is always accurate. In the survey participants had a limited choice for their answers in the form of closed-end questions, which led to limited insights into the thoughts and motivations of the participants in this study. Future studies could also incorporate qualitative approaches. For instance, future studies could conduct additional in-depth interviews and/or focus groups to find richer insights into university students' purchase decisions regarding sustainable smartphones.

The current research was also limited by a sample that primarily consists of university students from the Netherlands and other European countries, which may not accurately represent university students globally. In the sample, participants from Asia, Africa, and North and South America were underrepresented (Appendix 1). As a result, this research failed to acknowledge the difference in cultures among university students globally. Future research should involve university students from more countries around the world. As a result, comparative research will be able to determine how culture

affects students' purchase intention for sustainable smartphones.

Thirdly, this study has mainly focused on those university students who showed no or limited familiarity or experience with sustainable smartphones. Consequently, the results cannot be generalized since this study did not take into account the perceptions of students who have used or are familiar with sustainable smartphones. Dangelico et al. (2022) found that consumers who knew about the existence of a sustainable clothing item were more likely to have the intention to purchase the product; the same applied to consumers who had previously purchased it. It would be interesting to see a future study investigate if familiarity and previous experience with sustainable smartphones impact university students' willingness to buy these smartphone alternatives.

Lastly, the current research only analyzes the purchase intentions of university students. Purchase intention does not always translate into actual purchases, according to previous research (Peña-García et al., 2020). Therefore, future studies could investigate whether university students with the intention of purchasing a sustainable smartphone also actually purchase this product.

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7. APPENDICES

Appendix 1. Origin of participants

Continent	Country	Frequency
Europe	Belgium	3
	Cyprus	1
	Czechia	1
	Estonia	1
	France	1
	Germany	8
	Greece	1
	Hungary	2
	Italy	2
	Lithuania	1
	Moldova	2
	Poland	3
	Portugal	1
	Romania	1
	Sweden	1
	The Netherlands	59
	Ukraine	2
	United Kingdom	5
Asia	Afghanistan	1
	Azerbaijan	1
	China	4
	India	1
	Malaysia	1
	Russia	1
	Sri Lanka	1
	Vietnam	1
North America	Canada	2
	Panama	1
	Mexico	3
	USA	4
South America	Argentina	1
	Venezuela	1
Africa	Egypt	2
	Tunisia	1

Note(s): Own calculations

Appendix 2. Item operationalization

Construct	Item ID	Item	From
Environmental Consciousness	EC1	I feel that I am also responsible for the preservation of the environment	Kerber et al. (2023)
	EC2	Buying environmentally friendly products helps in the conservation of natural resources.	
	EC3	Buying environmentally friendly products helps to prevent climate change.	
	EC4	I make an effort to buy more sustainable products.	
	EC5	I make an effort to diminish my consumption of goods and resources in order to protect the environment.	
	EC6	I stop buying a product when I discover its negative impact on the environment.	
Perceived Consumer Effectiveness	PCE1	Consumers can protect the environment by buying sustainable smartphones.	Raj et al. (2023)
	PCE2	I think about how purchasing sustainable smartphones will conserve the environment.	
	PCE3	I make a positive impact on the environment by purchasing a sustainable smartphone.	
	PCE4	Individuals' behaviour, such as buying a sustainable smartphone, makes a difference in the environment.	
Perceived Quality Risk	PQR1	I am not convinced about sustainable smartphones' quality – regular smartphones might have better quality.	Raj et al. (2023)
	PQR2	I am concerned that sustainable smartphones may experience frequent malfunctions and require regular servicing.	
	PQR3	I think that the product quality of sustainable smartphones may not meet expectations.	
	PQR4	I think a sustainable smartphone has a limited lifespan	
Purchase Intention	PI1	I am interested in purchasing a smartphone that is more environmentally friendly.	Raj et al. (2023)
	PI2	I would choose a greener option next time I purchase a new smartphone.	
	PI3	I would consider switching brands in order to purchase a sustainable smartphone.	
	PI4	When I look for a new smartphone to purchase, I compare the usual options with a more environmentally friendly product version.	
	PI5	I intend to buy a more environmentally friendly smartphone next time.	
	PI6	If I had to choose between standard equipment and its environmentally friendly version, I would choose the environmentally friendly one.	

Note(s): The results indicate that the outer loading values for items EC_2, EC_3, and PI_4 were significantly below the proposed threshold of 0.70 (Hair et al., 2019). Following the literature's recommendations, these items were excluded from the final model used for analysis.

Appendix 3. Indicator loadings, reliability and convergent validity

Construct	ItemID	Item	Loading	PCI	ρ_A	AVE
Environmental Consciousness	EC_1	I feel that I am also responsible for the preservation of the environment.	0.685***	(0.474; 0.803)	0.805	0.597
	EC_4	I make an effort to buy more sustainable products.	0.856***	(0.777; 0.903)		
	EC_5	I make an effort to diminish my consumption of goods and resources in order to protect the environment.	0.824***	(0.756; 0.881)		
	EC_6	I stop buying a product when I discover its negative impact on the environment.	0.710***	(0.554; 0.808)		
Perceived Consumer Effectiveness	PCE_1	Consumers can protect the environment by buying sustainable smartphones.	0.725***	(0.427; 0.848)	0.790	0.596
	PCE_2	I think about how purchasing sustainable smartphones will conserve the environment.	0.790***	(0.697; 0.883)		
	PCE_3	I make a positive impact on the environment by purchasing a sustainable smartphone.	0.797***	(0.691; 0.868)		
	PCE_4	Individuals' behaviour, such as buying a sustainable smartphone, makes a difference in the environment.	0.774***	(0.555; 0.864)		
Perceived Quality Risk	PQR_1	I am not convinced about sustainable smartphones' quality – regular smartphones might have better quality.	0.870***	(0.800; 0.924)	0.891	0.710
	PQR_2	I am concerned that sustainable smartphones may experience frequent malfunctions and require regular servicing.	0.863***	(0.745; 0.919)		
	PQR_3	I think that the product quality of sustainable smartphones may not meet expectations.	0.895***	(0.849: 0.926)		
	PQR_4	I think a sustainable smartphone has a limited lifespan	0.733***	(0.552; 0.835)		
Purchase Intention	PI_1	I am interested in purchasing a smartphone that is more environmentally friendly.	0.847***	(0.778; 0.895)	0.902	0.697
	PI_2	I would choose a greener option next time I purchase a new smartphone.	0.909***	(0.870; 0.939)		
	PI_3	I would consider switching brands in order to purchase a sustainable smartphone.	0.774***	(0.669; 0.845)		
	PI_5	I intend to buy a more environmentally friendly smartphone next time.	0.904***	(0.873; 0.933)		
	PI_6	If I had to choose between standard equipment and its environmentally friendly version, I would choose the environmentally friendly one.	0.724***	(0.571; 0.821)		

Note(s): ***$p < 0.01$; PCI = percentile confidence interval (95%). ρ_A = Construct Reliability. AVE = Average Variance Extracted. Two-tailed test