European Journal of Sustainable Development (2025), **14**, 3, 791-802 ISSN: 2239-5938
Doi: 10.14207/ejsd.2025.v14n3p791

Towards a Sustainable Future: Investigating Smartphone Recycling Intentions Among Saudi University Students

By Yasser Baeshen[1]

ABSTRACT:
This extant research aimed to explore the Saudi university students' attitudes and behaviors of towards smartphone recycling, using the Theory of Planned Behavior (TPB) model as the theoretical framework for proposed research model. Data was collected through a questionnaire, and 850 sample respondents were selected by convenience sampling method. The study assessed five hypotheses to determine participants' attitudes, subjective norms, perceived behavioral control, awareness of consequences and smartphone recycling intentions. Results show that while students generally held positive attitudes toward recycling, subjective norms, perceived behavioral control, and awareness of consequences emerged as the strongest predictors of recycling intentions. However, recycling intention did not significantly predict resell behavior, likely due to data privacy concerns. The findings highlight the role of cultural and normative influences in shaping recycling behavior in Saudi Arabia, a collectivist setting. This research contributes novel, policy-relevant evidence aligned with Vision 2030 goals on sustainability and circular economy development, offering practical insights for designing campus recycling programs, incentive mechanisms, and digital awareness campaigns to reduce the intention–behavior gap.

Keywords: Smartphone recycling, E-waste management, Sustainability, Consumer Behavior, Disposal attitude, Resell, Saudi Arabia.

1. Introduction

The worldwide cell phone subscribers reached 11.706 billion mobile connections worldwide in July 2023, which is more than the world population (Bankmycell, 2023). After two quarters of 2016, the total mobile penetration of the Saudi population was 152% (that stands to staggering 48 million cell phone subscribers) (CITC, 2016). Mobile phones have a comparatively short life as the innovation cycle has reduced, and they have become obsolete within over a year (Ongondo & Williams, 2011). As per the finding, 60% of replaced or obsolete phones are stockpiled by students instead of being sold in the second-hand market or sent for recycling operations (Ongondo & Williams, 2011). According to Ongondo and Williams (2011), roughly 61% of students have an extra cell phone; male students tend to replace their phones more often than females (Ongondo & Williams, 2011). It is estimated that smartphone waste will reach 877 million units by the year 2020 and 937 million units by 2025 (Guo & Yan, 2017). Annually, Arab Countries combined produce 40 million tons of electronic waste (Hakami, 2018). Saudi Arabia alone generates three million tons of e-waste annually. Most of the e-waste is dumped into landfills, but it

[1] PhD, Associate Professor, Department of Marketing, Faculty of Economics and Administration, King Abdulaziz University, Jeddah, Saudi Arabia.

contaminates groundwater in the region because obsolete mobile phones are more complicated to recycle as compared to traditional waste (Hakami, 2018). Among E-waste, obsolete mobile phones contain toxic elements that pose a greater environmental threat and some valuable metal units and chips that may be reused as replacements for raw materials, thereby saving resources to produce new mobile phones (Yin, Gao, & Xu, 2014). Saudi Arabia has initiated some strategic plans for setting up recycling projects, but there is a long way to go (Hakami, 2018). No substantial research can be found that covers the consumption patterns and disposal of smartphones among university students in Saudi Arabia. This research will be the first of its kind and will fill the gap that exists in the literature on recycling and contribute theoretically and practically to future academic research. Furthermore, fill a critical policy gap by generating Saudi-specific evidence on smartphone recycling among university students, directly linking to Vision 2030 priorities on environmental sustainability, circular economy development, and the management of electronic waste (Vision 2030, 2016).

Since the environment issue is a very important and current discussion point in the world, much research and literature are progressing, and the authors believe that this study will make a valuable contribution to the existing literature on Recycling and environmental sustainability. This current study, through a survey of university students in Saudi Arabia, will discover the patterns of consumption and developments in recycling attitudes, perceptions, and behaviors.

No substantial studies are found in the Saudi Arabian context on similar topics; therefore, this study will fill the gap in the literature. The most important utilization of this study will be for policymakers in the kingdom by providing insights to guide them in investing in recycling projects to serve the purpose of Vision 2030. The key objective of the research is to explore the intention to recycle smartphones and provide further evidence to resell them in the second-hand market to determine whether the strategy would be effective for e-waste management within the country.

This study contributes by providing critical analysis about the smartphone recycling attitudes and behaviors of students at universities in Saudi Arabia. Electronic waste, particularly smartphone waste, is a growing pollution problem in the Middle East and around the World. Due to the rise of environmental awareness globally, recent research studies and the Vision 2030 of the Kingdom stress the need to explore consumer behavior deeper to establish comprehensive recycling projects for a sustainable environment. This current study proposes to do a survey of university students to discover the patterns in dispositions and trends in students recycling attitudes and behaviors. This study has tried to comprehend smartphone recycling from the users' point of view, offer important factors that influence consumer attitude and behavior in Saudi Arabia, and aid in policymaking for recycling in the Kingdom.

2. Literature review

2.1 Theoretical background

The Theory of Planned Behaviour (TPB) offers a framework that can be used to investigate the factors that predict an individual's behaviour and actions. According to the TPB model, behaviour of individuals is a result of intentions, moreover behavioral

intentions are a predicted by the attitude towards the activity, subjective norms (SN), and perceived behavioral control (PBC) (Beck & Ajzen, 1991). The influence of subjective norms on recycling intentions is particularly relevant in collectivist cultures, where social approval and group conformity strongly guide individual behavior. Prior research in Saudi Arabia has shown that social pressures and shared values significantly shape pro-environmental actions (Soomro et al., 2022). Similar patterns have been documented in other collectivist contexts, such as China and India, where family expectations, peer influence, and social image amplify recycling behaviors and sustainable choices (Ma et al., 2018; Khan et al., 2019). This is consistent with the broader literature on collectivist value orientations, which emphasize harmony with social groups and responsiveness to normative pressures (Soomro, 2019). In the Saudi student context, family approval, peer conformity, and campus-led campaigns reinforce normative expectations, making subjective norms a culturally salient predictor of recycling intentions. These insights justify the use of the TPB framework in Saudi Arabia and help explain why normative factors may exert stronger effects here compared to more individualistic societies. Hence, Authors have utilized the TPB model and added few variables to extend the theory to understand the recycling intention of students towards smartphone recycling.

2.2 Attitude towards intention to recycle

Many The concept of "attitude" refers to a person's ideas and evaluations of a specific activity. According to Ru et al. (2019), an attitude is a person's subjective reaction to a specific circumstance, and this reaction can be either good or negative. In most cases, it refers to a consciously generated emotional state directed on a certain thing, problem, or organization (Aboelmaged, 2021). According to research carried out by Liu et al. (2019), attitude of consumers has been found to be major determinants of pro-environmental behavior. A positive attitude about recycling has a considerable impact on the recycling behavior (Kelly et al. 2006), and other studies have found the same thing (Tonglet et al., 2004; Soomro et al., 2021). This indicates that, on the whole, the body of research supports the notion that there is an established link between attitude regarding recycling and intentions to recycle.

2.3 Subjective Norms and Intention to Recycle

According to Ajzen (1991), the variable in the model subjective norms (SN) describes an individual's perception of the amount of pressure exerted by society regarding the question of whether they should engage in a certain behavior. The effect of social pressure happens when some people in your network and surroundings, such as your friends and family, have the potential to shape your actions. People have a tendency to act in a manner that is approved of by those who are physically close to them. Previous studies have shown that an individual's subjective norms do have a considerable impact on their intentions to act in a manner that is beneficial to the environment (Aboelmaged, 2021). Researchers Ma et al. (2018) investigated on Chinese farmers and found that psychological factors affected the intentions of the farmers to recycle their farming production waste. Further, they found that SN can substantially enhance farmers' intentions to recycling their trash, and they claimed that this improvement can be attributed to the influence of psychological factors. Khan et al. (2019) employed the TPB model to study behavioral

intentions to salvage or dispose of solid waste in the developing nation context. Several studies have shown a substantial positive association between SN and intention to recycle or return (Shaw, 2008; Wan et al., 2014), and these findings have been uncovered by a variety of researchers.

2.4 Perceived Behavioral Control (PBC) & Intention to Recycle

According to Ajzen (1991), PBC is explained as "people's perceptions of their ability to perform a particular behavior" It is a measurement of a person's conviction and command over a specific habit, which strengthens their commitment level to embrace that behavior. PBC has been investigated in a number of research projects as a predictor that has a strong beneficial impact on behavioral intention (Park and Ha, 2014; Khan et al., 2019; Bhutto et al., 2021), among others. In the setting of developing nations, research demonstrated that PBC is a strong variable that affects the domestic user's intention to recycle or discard outdated electronic devices at home every week (Kianpour et al., 2017).

2.5 Awareness of Consequences (AC) & Recycle Intention

According to Tonguet et al. (2004), the term "Awareness of Consequences" (AC) is defined as an individual's awareness of the repercussions that will result from his or her activities. AC was acquired by previous research (Wan et al., 2021). In recent times, AC has been one of the variables that has been introduced to the TPB model the most frequently. It is necessary to be aware of the potential outcomes of one's actions in order to make a decision to behave in a manner that is in accordance with the environmental development goals (Wan et al., 2021). According to Khan et al. (2019) research, an individual will have a positive attitude toward engaging in a certain action and will continue to do so if he or she believes that engaging in that conduct will result in beneficial outcomes. Tonglet et al. (2004) found that a person's attitude about recycling is a major predictor of their desire to recycle. Recent research conducted by Wan et al. (2021) found that being aware of potential repercussions has a significant impact on one's intention to use recyclable packaging. The TPB model ought to incorporate AC because there is significant evidence supporting its inclusion in the relevant body of research.

2.6 Recycling Intention & Reselling Behavior

According to the extensively held notion of TPB model (Ajzen, 1991), an intention can become a behavior. Since the term "sustainable consumer behavior" is vague and subject to variation (Hameed et al., 2021), we looked more closely at the phenomenon. In terms of recycling intention, it is possible to more clearly categorize a person's conduct into a number of aspects. Recycling is simply one part of the reuse, recycle, and reduce, despite its growing relevance (Soomro et al., 2021). Each product has a usable lifetime. Once products serve their intended purpose, they might not be further usable. These items can be disposed of in a variety of ways since the person no longer needs them. Reselling is one of the ways that customers can recoup some of the product's cost (Shim, 1995). The method through which consumers try to resell their old goods to someone who are looking for those goods. Reselling can be done to make money, to benefit others by giving them a high-quality product at a reasonable price, or else help the environment by preventing waste (Joung & Park-Poaps, 2011). On the other hand, the buyer of used goods claimed

that they resold a thing since they didn't want their undesirable item to be trashed immediately because it still had some perceived worth. Prior studies have produced important findings about consumers' intentions to recycle and resale certain types of garbage, such as textiles (Domina & Koch, 1999) and plastics (Khan et al., 2019).

2.7 Hypotheses of the Study

The hypotheses formulated from the above literature and proposed research model are presented below:

H1: Attitude of student has a positive significant impact on the smartphones recycling intention.

H2: Subjective norms of students have positive significant impact on smartphones recycling intention.

H3: PBC of students has a positive significant impact on smartphones recycling intention.

H4: Awareness of Consequences has a positive significant impact on smartphones recycling intention.

H5: Recycling intention of students has a significant impact on reselling behavior.

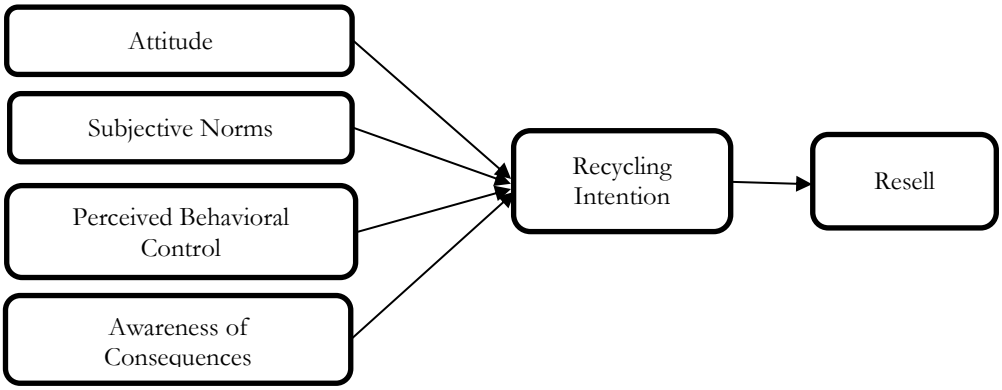

Figure 1. *Conceptual Research Model*
Sources: developed by the authors.

3. Methods

This study employed quantitative information, and to achieve the objectives of this study, a survey questionnaire was utilized to collect data for the study. The target sample size was 850 respondents chosen through convenience sampling to get a well-rounded representation from a few universities in Saudi Arabia. Past research indicates that consumer recycling attitudes and behaviors are the result of multiple factors (Bai, Wang, & Zeng, 2018).

The questionnaire had items with five options on the Likert Scale for all the variables to measure the attitude and intention of the respondents to recycle. The questionnaire instrument was designed by adopting the constructs and scales from past

studies (Soomro et al., 2021; Bai, Wang, & Zeng, 2018; Li, Yang, Song, & Lu, 2012). To ensure the validity of the measurement items in the Saudi context, the survey instrument underwent a process of cultural and linguistic adaptation. All items, originally drawn from prior studies, were first translated from English into Arabic and then back-translated into English to check for semantic consistency. A pretest with a small group of Saudi university students was conducted to confirm clarity, comprehension, and cultural appropriateness of the items. This adaptation process ensured that constructs such as subjective norms accurately reflected the realities of Saudi student life. Hence, Data was collected from the university-enrolled students in Jeddah, Taif, and Makkah through physically administered questionnaires. The reason why young students were targeted is because the university and government do many environmental and recycling campaigns among students on a regular basis, and past literature also suggests that educated folks possess more knowledge and awareness about eco-friendly products and sustainable practices (Hedlund, 2011; Han & Kim, 2010). Therefore, the sample unit was from university students, as an educated individual can easily understand the recycling perspective. Due to ethical reasons, the identities of the respondents were kept confidential. The primary data for the study was collected from 1st December 2023 to 21st March 2024. The descriptive statistics showed the demographic profiles in terms of gender were male (79 percent) and female (21 percent), and the majority (52.9 percent) belonged to the age bracket of below 18 years of age (refer to Table 1).

Table 1: Respondents' Profile

		Frequency	**Percentage**
Gender	Male	680	79.0
	Female	170	21.0
Age	Below 20	450	52.9
	20-30	250	29.4
	31-40	130	15.2
	41-50	20	2.3
	Above 50	0	0.0
Education	Diploma	125	14.7
	Undergraduate	545	64.1
	Graduate	150	17.6
	Doctoral	30	3.5

Sources: developed by the authors.

3.1. Reliability of data

The data collected was analyzed on SPSS 17 and SmartPLS 3.0 software. In the first stage, the data reliability check was conducted, further the data was analysed for validity and reliability through Cronbach's alpha. Next the structural model to test the hypothesis constructed was done. To check the data reliability and internal consistency through Cronbach's alpha was found that it exceeded the value of 0.70 (refer Table 2 in appendix). Further, composite reliability (CR) score for each item constructs were above

0.70 (Hair et al., 2014), this confirms the data being reliable and valid for further data analysis.

Table 2. Constructs Reliability

Constructs	Items	Sources	Loading	Cronbach's alpha	CR	AVE
Attitude	ATT1	Tonglet et al. (2004) and Soomro et al. (2021)	0.794	0.859	0.945	0.825
	ATT2		0.813			
	ATT3		0.945			
Subjective Norms	SN1	Tonglet et al. (2004) and Soomro et al. (2021)	0.911	0.910	0.941	0.829
	SN2		0.946			
	SN3		0.892			
	SN4		0.871			
Perceived Behavioral Control	PBC1	Tonglet et al. (2004) and Soomro et al. (2021)	0.761	0.708	0.767	0.669
	PBC2		0.745			
	PBC3		0.729			
	PBC4		0.830			
Consequence of Awareness	CA2	Tonglet et al. (2004) and Soomro et al. (2021)	0.810	0.746	0.825	0.663
	CA3		0.853			
	CA4		0.821			
Recycling Intention	RI1	Tonglet et al. (2004) and Soomro et al. (2021)	0.877	0.895	0.863	0.778
	RI2		0.835			
	RI3		0.927			
	RI4		0.887			
Resell	RS1	Domina and Koch (1999)	0.843	0.750	0.848	0.712
	RS2		0.758			
	RS3		0.841			

Sources: developed by the authors.

4. Results & Data Analysis

To test the relationship among the variables, Structure equation modelling on SmartPLS was used. The data analysis results (refer table 3) revealed that first four proposed hypotheses were found to be significant as the significance value $p > 0.05$. Hypothesis 1 was supported which stated that there is a positive relationship among attitude of students and smartphones recycling intention ($\beta=0.321$, $p < 0.000$). H2 stated that SN of students have positive significant impact on smartphones recycling intention as the results were significant ($\beta=0.246$, $p < 0.010$). H3 anticipated the positive relationship among PBC, and smartphone recycling intention. H3 was supported ($\beta=0.415$, $p < 0.000$); H4 proposed positive relationship among the AC and smartphone recycling intention was supported ($\beta=0.213$, $p < 0.000$). Lastly, H5 proposed there is relationship between recycling intention and resell, this hypothesis was not supported ($\beta=0.614$, $p < 0.000$).

Table 3: Hypotheses assessment summary

Hypotheses	Beta	p-values	t-values	Decision
ATT->RI	0.321	0.000	5.235	Supported
SN ->RI	0.246	0.010	3.459	Supported
PBC ->RI	0.415	0.000	4.534	Supported
CA ->RI	0.213	0.000	3.617	Supported
RI ->RS	0.422	0.614	1.255	Not supported

Note(s): The path is significant at a p-value of 0.05

5. Conclusion and Discussion

The e-waste recycling behaviour is not a very common practice in the KSA. The purpose of this study was to explore the motivational factors among students that have impact on recycling e-waste, particularly smartphones. The extant study adds value to the literature, firstly, investigates four antecedents of TBP, secondly, incorporates further category of reselling to dig deep into this important facet. Theoretically, this research added the element that influences post-purchase behavior of consumers. With these objectives in mind, five hypotheses were made, which were later supported on the basis of the results found during the data analysis. The major findings of the study are presented below:

1. The favourable attitude of the student had significant role towards smartphone recycling. This finding is consistent with the results of earlier studies in the recycling behaviour studies (Wan et al., 2012).
2. The subjective norms had significant effect on the student's intention to recycle when it came to smartphone recycling. The results of this study align with the findings of past research (Wan et al., 2012; Lizin et al., 2017). Hence, it can be implied that society's role pushes people to adopt sustainable behaviours like recycling.
3. The PBC on smartphone recycling intention had greatest impact. This revealed that the students those can control their behaviour could have the strongest inclination towards smartphone recycling. Findings are aligned with previous studies findings (Wan et al., 2012; Lizin et al., 2017).
4. The AC in the TBP model showed a significant positive impact on smartphone recycling intention. The results reveal the fact that individuals who have awareness of the outcome of their actions are the ones who will repeat this behaviour of recycling e-waste materials. Prior studies also found same results (Khan et al., 2019).
5. Reselling showed no significant factor in the model. These results reveal that students have no intention to resell, this could be due to data privacy. Although this option can be incentivized, if students are motivated to sell. Encouraging this behavior may generate financial gains for people.

This research clarified how Saudi university students feel about recycling their smartphones. Several crucial discoveries have come from the extensive study and analysis. Firstly, the survey found that while many students have a favourable attitude towards smartphone recycling, this view does not always translate into action. Clearly, there are obstacles and problems that need to be solved before student participation in recycling programs will increase. Although many students reported favourable attitudes toward recycling, this study confirms the persistence of an intention–behavior gap, where positive intentions do not consistently translate into action. Several barriers appear to underlie this gap in the Saudi campus context. Infrastructural barriers include the limited availability of accessible recycling bins or kiosks, while informational barriers arise from a lack of clear guidance on recycling procedures. Equally important are privacy and security concerns, as students fear potential data misuse when reselling or disposing of old smartphones. Addressing these barriers requires a sequenced and integrated roadmap. First, universities and policymakers should expand recycling infrastructure by installing visible and accessible e-waste collection points across campuses. Second, targeted digital and on-site awareness campaigns should address both environmental benefits and data security measures, thereby building trust and confidence among students. Finally, incentive mechanisms such as financial rewards, trade-in discounts, or green credit systems should be introduced to sustain participation.

While the significant role of subjective norms in shaping recycling intentions among Saudi students is consistent with findings in other collectivist societies such as China and Pakistan (Ma et al., 2018; Soomro, 2019), the strength of this effect contrasts with evidence from more individualistic contexts. Studies in Western countries such as the UK and the United States have often reported weaker or non-significant effects of subjective norms, as personal attitudes and perceived control tend to outweigh social influence in shaping pro-environmental behaviors (Tonglet et al., 2004; Kelly et al., 2006). This contrast highlights a boundary condition of the TPB model: in collectivist cultures, normative pressures are amplified through family expectations, peer conformity, and campus campaigns, whereas in individualistic cultures, subjective norms play a comparatively limited role. Recognizing this distinction helps explain cross-country variation in recycling intentions and suggests that exposure to strong campus campaigns in Saudi Arabia may further magnify the normative influence observed in this study.

The study also showed how societal pressure plays a part in moulding individuals' recycling habits. The influence of peers and people's sense of control over their own actions were both found to have a significant impact on people's motivation to recycle their smartphones. Making use of these social factors can be helpful in spreading recycling awareness among Saudi university students. Together, these steps would not only reduce the intention–behavior gap but also advance Saudi Arabia's Vision 2030 objectives of strengthening environmental sustainability.

6. Managerial Implications and Recommendations

This study helps researchers and policymakers address emerging countries' environmental and economic vulnerabilities. The findings suggest that government authorities and other non-governmental development groups should assess recycling

materials and create supportive structures to promote electronic waste recycling in public places and campuses. Authorities could also encourage recycling by promoting environmental knowledge, personal norms, and eco-friendly products. To start these initiatives, users, especially students, must be educated about recycling. Recycling education and promotion programs should be established. Recycling's environmental benefits must be highlighted. The government should also enhance waste management legislation and regulations to boost recycling and garbage management. These rules could improve Saudi Arabia's garbage disposal system. The government and schools must teach children, students, and adults about recycling. These institutions may promote recycling and sustainable habits in future generations by adding recycling instruction into their curriculum. Such research can be used to create effective curriculum, recycling-friendly facilities, and green marketing awareness campaigns to encourage people to recycle and resell.

7. Limitations of the Study and Future Research

This study has limitations; First, the sample was drawn using convenience recruitment from universities, which resulted in a pronounced male overrepresentation (79%). This gender imbalance constrains the generalizability of the findings and highlights the need for future studies to employ post-stratification weighting or probability-based sampling to correct for nonresponse bias. Second, that only students at universities were included in the sample, yet there are other entities that contribute a large quantity of e-waste, such as hospitals, education institutions, hotels, and industries. Probability sampling or any other sampling method can improve the results and findings. To broaden representativeness, subsequent studies should incorporate institutions beyond universities and consider a wider demographic mix.

The current study only focuses on smartphone e-waste; there are other types of waste, such as industrial and domestic solid waste. Future studies can overcome this limitation and validate the findings of this study with a different result. In the future studies, researchers can include other recycling materials such as electronic waste (TV, Radios etc), and plastic waste. The questionnaire can be distributed to a wider geographic coverage that includes urban, suburban, and rural areas; these will enhance the understanding of the difference in attitude among residents of small and big cities. More variables of actual behavior, such as reuse and donation, can be added to the research model to make it more extensive. Lastly, technology usage aspects can be added to recycling; therefore, studies in future can also add more variables such as recycling vending machines. These directions would not only strengthen empirical robustness but also generate actionable insights to support Vision 2030's environmental sustainability and circular economy goals.

Acknowledgment: This research project received funding from the Deanship of Scientific Research (DSR) at King Abdulaziz University, Jeddah, under grant no. (G: 692-120-1441). Authors thank the DSR for their support in this research project.

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