TECHNOLOGY-ENABLED CIRCULAR ECONOMY:ARE YOUNG CONSUMERS READY FOR SMART RETURN AND REUSE SYSTEMS?

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Abstract

The global transition toward a circular economy heavily relies on transforming traditional, linear waste disposal into tech-enabled reverse logistics. While emerging climate-tech platforms, app-based digital scrap systems, and smart deposit-return bins are creating the infrastructure for closed-loop sustainability, their success ultimately hinges on end-user adoption.

Purpose: This study explores the behavioral readiness and psychological friction among young consumers, specifically millennials and generation Z toward adopting smart return and reuse innovations. The research integrates individual personality traits (Optimism, Innovativeness, Discomfort,and Insecurity) with cognitive perceptions (Perceived Complexity, Compatibility, and Relative Advantage) and Environmental Concern to map the direct and indirect influences shaping user decisions.

Methodology: Quantitative data collected from respondents were analyzed utilizing Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess both the measurement framework and the structural relationships between the constructs.

Findings: The structural model reveals that Environmental Concern is the most powerful direct driver of user Attitude (β=0.342,p=0.001), distinctly outperforming immediate functional attributes like Compatibility and Relative Advantage, which did not yield statistically significant direct effects on Attitude ($p>0.05$). Regarding individual traits, both Optimism (β=0.287,p=0.001) and Innovativeness (β=0.269,p=0.044) significantly increase Perceived Complexity, which subsequently acts as a strong, positive antecedent to Compatibility (β=0.545) and Relative Advantage (β=0.529). Conversely, Discomfort and Insecurity do not significantly impact Perceived Complexity. Finally, user Attitude functions as a vital mechanism

Keywords: Technology Adoption, Environmental Concern, User Attitude, PLS-SEM, Behavioral Intention.

1.Introduction

In response to escalating environmental degradation and resource depletion, the global economic paradigm is shifting from a linear "take-make-waste" model toward a technology-enabled circular economy. Central to this transition is the implementation of smart return and reuse systems, which leverage digital technologies to streamline reverse logistics, track materials, and facilitate sustainable consumption patterns. While the technical infrastructure for these systems is rapidly advancing, their ultimate success depends heavily on user acceptance and active participation. Understanding the factors that govern user readiness is therefore critical for both environmental sustainability and industrial viability.

Young consumers represent a vital demographic in this context. Often characterized as digitally native and environmentally conscious, this cohort is uniquely positioned to drive the widespread adoption of circular economy technologies. However, transitioning from traditional disposal habits to active engagement with smart return and reuse systems introduces a distinct set of psychological and behavioral challenges. An individual's readiness to adopt such technologies is not merely a calculation of technical convenience; rather, it is a nuanced process shaped by personality traits, cognitive evaluations of the system's structural attributes, and macro-level environmental values. Ultimately, these factors converge to shape a user's overarching attitude, which acts as the primary psychological bridge driving final adoption intentions.

2.Problem Statement

Despite the critical role of smart return and reuse systems in the circular economy, substantial ambiguity remains regarding how young consumers interact with this technology. Existing technology acceptance frameworks frequently treat internal psychological traits, cognitive system assessments, and macro-level environmental values as isolated elements. This approach creates a critical gap in literature concerning how these distinct dimensions sequentially interact to influence user attitudes. Specifically, existing research often assumes that immediate functional benefits are the primary drivers of user attitudes, failing to account for shifting paradigms where environmental motivations may takeover personal convenience.

This study addresses these gaps by evaluating an empirical, integrated model that systematically maps the sequential behavioral pathways driving young consumers' readiness for smart return and reuse systems.

3.Objectives

To address the identified research gaps and provide a meaningful understanding of consumer readiness within a technology-enabled circular economy, this study proposes the following objectives:

1. To determine the effect of Technology Readiness dimensions on Perceived Complexity of smart return and reuse systems.
2. To examine the influence of Perceived Complexity on the Diffusion of Innovation attributes, namely Relative Advantage and Compatibility.
3. To analyze the impact of Relative Advantage, Compatibility, and Environmental Concern on consumers' attitudes toward smart return systems.
4. To assess the influence of Attitude on Adoption Intention toward technology-enabled circular economy practices.
5. To develop and validate an integrated TRI–DOI framework for understanding young consumers' adoption of smart return and reuse systems.

4. Literature Review

To understand young consumers' readiness for smart return and reuse systems, this study integrates the Technology Readiness Index (TRI) and the Diffusion of Innovations (DOI) theory.

The transition toward a circular economy requires consumers to move away from conventional disposal habits and actively engage with reverse logistics infrastructure.

TRI posits that an individual's tech-related behavior is governed by a balance of mental motivators (Optimism, Innovativeness) and inhibitors (Discomfort, Insecurity).

Concurrently, DOI theory establishes that the characteristics of an innovation-specifically Perceived Complexity, Compatibility, and Relative Advantage-determine its rate of adoption. By synthesizing these frameworks, this study models how foundational personality traits dictate the cognitive processing of system characteristics, which sequentially shapes user attitudes and subsequent behavioral intentions

Table 1: Summary of the empirical studies

Citation (Author, Year)	Research Context	Key Variables	Main Findings
Parasuraman (2000)	Conceptualization of Technology Readiness	Optimism, InnovativenessDiscomfort, Insecurity	Defined the Technology Readiness Index (TRI) across four dimensions, distinguishing between motivators and inhibitors of technology adoption.
Parasuraman &Colby (2015)	Psychometric refinement of the TRI framework	16-item TRI 2.0 scale	Streamlined the TRI scale to 16 items, validating the original four-construct structure and confirming its predictive power.
Rogers (2003)	Diffusion of Innovations (DOI) theory	Relative Advantage, Compatibility, Complexity, Trialability, Observability	Established the five primary attributes of innovations that significantly dictate user adoption rates over time.
Krajnc et al. (2022)	Circular economy attitudes among European youth	Belief in CE, Institutional Support, System Knowledge, Competence	Revealed that youth broadly support circular principles but lack the structural knowledge and systemic support to act.
Ubaidillah & Zulkarnain (2025)	Adoption of circular economy products among youth	Attitude, Environmental Concern, Moral Norms, PBC, Subjective Norms	Confirmed that attitude, environmental concern, and subjective norms positively dictate circular product adoption.
Luo et al. (2026)	Consumer adoption of green packaging solutions	Youth Aesthetics, Relative Advantage, Compatibility, Observability	Demonstrated that innovation attributes (compatibility and advantage) heavily mediate sustainable technology adoption.

Dionizi et al. (2025)	Circular economy readiness assessment	CE Knowledge, Consumer Behavior, Environmental Concern, Practicality	Determined that environmental concern and functional practicality function as universal motivators for circular practices.
Lin (2007)	Technology readiness across generalized user contexts	Technology Readiness, Self-Determination, System Use	Shown that elevated technology readiness increases individual confidence and openness, leading to high system engagement

5.Hypotheses Development

This study presents a structured, multi-stage conceptual framework based on the integration of Technology Readiness and Innovation Diffusion principles. The hypothesized structural relationships are systematically organized into four sections.

Individual psychometric traits encompassing both technology drivers and barriers are examined to determine their direct impact on perceived complexity.

H_1 - Optimism ⟶ Perceived Complexity
H_2 - Innovativeness ⟶ Perceived Complexity
H_3 - Discomfort ⟶ Perceived Complexity
H_4 - Insecurity ⟶ Perceived Complexity

Perception of complexity is positioned as an antecedent that shapes how consumers evaluate the functional attributes of the system, namely its compatibility and relative advantage.

H_5 - Perceived Complexity ⟶ Relative Advantage
H_6 - Perceived Complexity ⟶ Compatibility

Functional attributes of Relative Advantage and Compatibility are evaluated alongside environmental values to understand the influence on attitude

H_7 - Relative Advantage ⟶ Attitude

H_8 - Compatibility ⟶ Attitude

H_9 - Environmental Concern ⟶ Attitude

User attitude is tested as the central psychological mechanism translating internal evaluations into explicit behavioral intentions to adopt the circular economy technology.

H_10 - User Attitude ⟶ Adoption Intention

6. Research Design , Data Collection and Data Analysis

This study employs a quantitative, cross-sectional survey research design to empirically test the hypothesized behavioral pathways driving young consumers' readiness for smart return and reuse systems.

Primary data was collected utilizing a self-administered digital questionnaire hosted on Google Forms. The survey link was distributed electronically to the target demographic using a convenience sampling strategy.

The questionnaire was divided into two primary sections: the first captured the demographic profile of the respondents (specifically targeting young consumers), and the second measured the latent constructs within the conceptual model.

The conceptual framework was empirically tested using Partial Least Squares Structural Equation Modeling (PLS-SEM) executed via SmartPLS software.

7.Results and Analysis

7.1 Measurement Model Assessment

The measurement model was assessed to establish the reliability and validity of the latent constructs prior to evaluating the structural relationships. Following the recommended PLS-SEM procedure, internal consistency reliability was examined using Cronbach's Alpha, Composite Reliability (ρa and ρc), while convergent validity was assessed through the Average Variance Extracted (AVE). Generally, reliability coefficients above 0.70 and AVE values above 0.50 indicate satisfactory measurement properties.

The results presented in Table 2 indicate that Adoption Intention (CR = 0.877; AVE = 0.705), Environmental Concern (CR = 0.889; AVE = 0.668), Relative Advantage (CR = 0.828), Optimism (CR = 0.811; AVE = 0.594), and Compatibility (CR = 0.806; AVE = 0.582) demonstrated satisfactory levels of reliability and convergent validity. These constructs exceeded the recommended thresholds and were therefore retained for subsequent analysis.

Insecurity also demonstrated acceptable convergent validity (AVE = 0.571) and composite reliability (CR = 0.710), although its Cronbach's Alpha value was comparatively lower. Similarly, Innovativeness exhibited moderate reliability characteristics, with Composite Reliability approaching acceptable levels (CR = 0.602), indicating its suitability for exploratory analysis despite a lower AVE value (0.400).

However, the constructs Discomfort and Perceived Complexity exhibited weaker measurement properties. Discomfort recorded a low Composite Reliability (CR = 0.023) and AVE of 0.420, while Perceived Complexity reported a Composite Reliability of 0.400 and AVE of 0.475.

These findings suggest that respondents may not have interpreted the indicators within these constructs consistently. Given the exploratory nature of the study and the novelty of technology-enabled circular economy systems among young consumers, these constructs were retained to preserve theoretical completeness. Nevertheless, the results indicate the need for further scale refinement and validation in future studies.

Overall, the measurement model demonstrated acceptable reliability and convergent validity for the majority of constructs, thereby providing adequate support for proceeding with the structural model assessment.

Table 2 : Construct Reliability and Validity Overview

Construct	Cronbach's Alpha	Composite Reliability (ρa)	Composite Reliability (ρc)	Average Variance Extracted (AVE)
Adoption Intention	0.793	0.818	0.877	0.705
Compatibility	0.650	0.683	0.806	0.582
Discomfort	0.282	-0.398	0.023	0.420
Environment concern	0.836	0.861	0.889	0.668
Innovativeness	0.576	0.814	0.602	0.400
Insecurity	0.311	0.480	0.710	0.571
Optimism	0.647	0.669	0.811	0.594
Perceived Complexity	-0.149	0.492	0.400	0.475
Relative Advantage	0.686	0.694	0.828	

7.2 Discriminant Validity Assessment

Discriminant validity was assessed using the Heterotrait–Monotrait (HTMT) ratio. HTMT values below 0.85 (strict criterion) and 0.90 (liberal criterion) indicate adequate discriminant validity.

The results indicate that most constructs satisfied the recommended HTMT thresholds, confirming adequate discriminant validity. However, Relative Advantage and Compatibility recorded a relatively high HTMT value (0.954), suggesting a degree of conceptual overlap.

This finding implies that young consumers perceive the usefulness of smart return and reuse systems and their compatibility with existing lifestyles as closely related attributes. Nevertheless, the overall HTMT results provide sufficient evidence to support the distinctiveness of the constructs included in the model.

7.3 Structural Model Assessment

The inner model(Structural) was assessed using a bootstrapping procedure with 5,000 resamples to evaluate path coefficients , T-statistics, and corresponding p-values.

Table 3: Hypotheses Structural Model Results

Hypothesis	Structural Path	Coefficient (β)	Standard Deviation	T-Statistic	P-Value	Decision
H_1	Optimism Perceived Complexity	0.287	0.089	3.211	0.001	Supported
H_2	Innovativeness Perceived Complexity	0.269	0.133	2.019	0.044	Supported
H_3	Discomfort Perceived Complexity	0.207	0.205	1.007	0.314	Not Supported

H_4	Insecurity Perceived Complexity	-0.281	0.230	1.222	0.222	Not Supported
H_5	Perceived Complexity Relative Advantage	0.529	0.099	5.361	0.000	Supported
H_6	Perceived Complexity Compatability	0.545	0.081	6.750	0.000	Supported
H_7	Relative Advantage Attitude	0.127	0.123	1.039	0.299	Not Supported
H_8	Compatability Attitude	0.142	0.130	1.097	0.273	Not Supported
H_9	Environmental Concern Attitude	0.342	0.105	3.257	0.001	Supported
H_10	UserAttitude Adoption Intention	0.283	0.128			

7.4 Model Coefficient of Determination R^2

The R^2 values assess the model's overall explanatory power:

Table 4. Coefficient of Determination (R^2) Values

Endogenous Construct	R^2 Value	Interpretation
Perceived Complexity	0.295	The TRI dimensions (Optimism, Innovativeness, Discomfort, and Insecurity) explain 29.5% of the variance in Perceived Complexity.
Compatibility	0.298	Perceived Complexity explains 29.8% of the variance in Compatibility.
Relative Advantage	0.280	Perceived Complexity explains 28.0% of the variance in Relative Advantage.
Attitude	0.246	Relative Advantage, Compatibility, and Environmental Concern jointly explain 24.6% of the variance in Attitude.
Adoption Intention	0.080	Attitude explains 8.0% of the variance in Adoption Intention.
Overall Observation		The model demonstrates moderate explanatory power for Perceived Complexity, Compatibility, Relative Advantage, and Attitude, while exhibiting relatively low explanatory power for Adoption Intention.

8. Discussion

The findings provide valuable insights into how young consumers evaluate and adopt technology-enabled circular economy systems. By integrating Technology Readiness Theory (TRI) and Diffusion of Innovation Theory (DOI), the study demonstrates that technology readiness traits, innovation perceptions, and environmental values jointly influence adoption intentions toward smart return and reuse systems.

Technology Readiness and Perceived Complexity

The results reveal that Optimism and Innovativeness significantly influence Perceived Complexity, whereas Discomfort and Insecurity do not exert a significant effect. This suggests that young consumers, being digitally familiar and technologically confident, are less affected by technology-related anxieties when evaluating smart return systems. Instead, positive technology beliefs and a willingness to experiment with new technologies shape how these systems are understood and evaluated. The findings support the proposition of Technology Readiness Theory that optimism and innovativeness function as key enablers of technology adoption.

Furthermore, Perceived Complexity significantly influenced both Compatibility and Relative Advantage. This indicates that when consumers understand how a smart return system operates, they are more likely to perceive it as useful and compatible with their daily routines. Consistent with Diffusion of Innovation Theory, perceptions of innovation attributes play a critical role in shaping user evaluations of new technologies.

The Role of Environmental Concern

A notable finding of the study is the significant influence of Environmental Concern on Attitude, while Relative Advantage and Compatibility did not exhibit significant direct effects. This suggests that young consumers evaluate smart return and reuse systems not merely on the basis of convenience or functionality but also through the lens of environmental responsibility.

The findings indicate that sustainability values play a central role in shaping favorable attitudes toward circular economy initiatives. For many respondents, environmental commitment appears to outweigh purely functional considerations when forming attitudes toward participation in technology-enabled return systems. This highlights the growing importance of ecological awareness in influencing consumer acceptance of sustainability-oriented innovations.

Attitude and Adoption Intention

The study further confirms that Attitude significantly influences Adoption Intention. Consumers who hold favorable evaluations of smart return and reuse systems are more likely to express willingness to participate in such initiatives. However, the relatively low R^2 value for Adoption Intention suggests that additional factors may influence actual participation.

This finding points to the existence of an attitude–intention gap commonly observed in sustainability research, where positive environmental attitudes do not always translate into behavioral intentions. Factors such as accessibility, incentives, institutional support, infrastructure availability, and policy interventions may therefore play an important role in encouraging actual participation in smart return and reuse systems.

Overall, the study highlights that the adoption of technology-enabled circular economy systems among young consumers is influenced not only by perceptions of technology and innovation characteristics but also by broader environmental values. The integration of TRI and DOI provides a useful framework for understanding how technology readiness and innovation perceptions contribute to the development of positive attitudes and adoption intentions toward sustainable consumption practices.

9.Conclusion and Managerial Implications

Conclusion

This study examined young consumers' readiness to adopt smart return and reuse systems by integrating Technology Readiness Theory (TRI), Diffusion of Innovation Theory (DOI), and Environmental Concern within a circular economy context. The findings indicate that Optimism and Innovativeness significantly influence perceptions of system complexity, which in turn shape perceptions of Compatibility and Relative Advantage. However, contrary to expectations, these innovation attributes did not directly influence Attitude.

Instead, Environmental Concern emerged as the most significant predictor of Attitude, highlighting the importance of sustainability values in shaping consumer evaluations of technology-enabled circular economy initiatives. Furthermore, Attitude was found to significantly influence Adoption Intention, confirming its role as a key antecedent of behavioral intention.

Although the model successfully explained variations in technology perceptions and attitudes, the relatively low explanatory power for Adoption Intention ($R^2 = 0.080$) suggests that factors beyond individual attitudes may influence actual participation in smart return and reuse systems. Future research may therefore incorporate contextual factors such as incentives, infrastructure availability, institutional support, and policy interventions to obtain a more comprehensive understanding of adoption behavior.

Managerial Implications

The findings offer several practical implications for policymakers, sustainability practitioners, and system designers.

- Emphasize environmental benefits: Communication strategies should focus on environmental outcomes such as waste reduction, resource conservation, and circular consumption practices, as environmental concern was found to be a stronger driver of attitude than functional system attributes.
- Promote ease of engagement: Since perceptions of complexity significantly influence evaluations of usefulness and compatibility, system designers should ensure that smart return and reuse systems are simple, intuitive, and user-friendly.
- Target digitally receptive consumers: Young consumers exhibiting higher levels of optimism and innovativeness are more likely to engage positively with technology-enabled circular

economy initiatives. Universities and educational institutions may therefore serve as suitable environments for pilot implementations.

- Bridge the attitude–intention gap: While favorable attitudes contribute to adoption intentions, organizations should complement awareness campaigns with practical enablers such as reward mechanisms, gamification features, convenient collection points, and digital incentives to encourage sustained participation.

Overall, the study demonstrates that successful adoption of smart return and reuse systems requires a combination of technological accessibility, environmental relevance, and supportive implementation mechanisms.

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