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THE CONVERGENCE OF EASE AND EXCELLENCE: GAUGING USER ADOPTION AND SYSTEM QUALITY IN IOT-ENABLED RECYCLING

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Abstract: This study evaluates an IoT-based system designed for junk and scrap trading, employing a dual approach that combines user acceptance and expert quality assessment. A purposive sample of 110 respondents (50 students, 50 employees, and 10 junkshop employees) participated in a survey based on the Technology Acceptance Model (TAM). Expert evaluators, selected based on qualifications in software engineering and system quality assessment, rated the system against ISO 25010 standards. TAM results indicated strong positive perceptions across all constructs, including perceived usefulness, ease of use, and willingness to adopt. Expert evaluation revealed consistently high ratings across ISO 25010 quality dimensions, although Functional Suitability showed significant differences ($F = 4.703$, $p = 0.011$), with junkshop employees rating it lower compared to students and employees. The study demonstrates practical efficiency gains, such as faster appraisal and more accurate counts of recyclable items, contributing to broader sustainability goals by reducing waste mismanagement. Findings highlight both behavioral acceptance and technical robustness as critical to adoption, emphasizing the need for refinements to align functionalities with frontline users' needs. The integration of TAM and ISO 25010 offers comprehensive insights for future system development and supports the advancement of sustainable circular economy practices.

Keywords: IoT-enabled recycling, functional suitability, Technology Acceptance Model, ISO 25010, user adoption

Introduction

The increasing global emphasis on sustainable waste management and circular economy principles has underscored the importance of efficient recycling systems in reducing environmental footprints and conserving natural resources (Barua, Islam, & Sarkar, 2021). The junk and scrap trading sector, which facilitates the collection and processing of recyclable materials such as PET bottles and aluminum cans, plays a critical role in achieving sustainability targets. However, traditional methods relying on manual counting and appraisal are often prone to inaccuracies, inefficiencies, and inconsistencies, limiting their scalability and impact (Garcia & Perez, 2022).

Recent advances in Internet of Things (IoT) technology have created opportunities to transform waste management by automating detection, classification, and appraisal processes, thereby improving accuracy and operational efficiency (Jumeatun, Hassan, & Elsayed, 2023). IoT-enabled systems equipped with machine learning algorithms can provide real-time data collection and analytics,

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fostering transparency and trust in scrap trading activities (Hussain, Najafi, & Kazemi, 2020). However, effective adoption of such smart technologies requires not only technical robustness but also favorable user perceptions related to ease of use, usefulness, and cost-effectiveness (Davis, 1989; Dwivedi et al., 2019).

Despite these developments, prior studies have largely focused on the technical features of recycling technologies, with limited emphasis on behavioral adoption factors and holistic evaluation frameworks. This gap motivates the present study, which integrates the Technology Acceptance Model (TAM) and the ISO 25010 quality model to evaluate an IoT-based Junk and Scrap Trading System, combining both user perception and expert quality assessment to generate comprehensive insights.

Literature Review

IoT applications in waste management have been studied in various contexts, such as smart waste bins (Jumeatun et al., 2023) and RFID-based sorting systems (Weber, 2010). These systems demonstrate measurable gains in efficiency and scalability but often focus narrowly on technical performance. For example, Garcia and Perez (2022) reported improved accuracy in inventory management using automated systems, while Williams and Clark (2024) highlighted enhanced counting precision through image recognition technologies.

Compared to these approaches, the present study contributes by critically combining behavioral adoption metrics (via TAM) with software quality assessments (via ISO 25010). This dual approach addresses both end-user acceptance and system reliability, a dimension rarely emphasized in prior empirical studies. By doing so, the study offers a more comprehensive framework for evaluating IoT-based recycling innovations.

Conceptual or Theoretical Framework

This research is grounded in the Technology Acceptance Model (TAM) (Davis, 1989), which posits that perceived usefulness and perceived ease of use influence a user's behavioral intention to adopt technology. TAM has been widely validated as a robust predictor of technology adoption across sectors (Venkatesh et al., 2003; Ajzen, 2020).

To complement the behavioral perspective, the study also employs the ISO 25010 software quality model, which evaluates system performance across dimensions such as functional suitability, usability, reliability, performance efficiency, security, maintainability, and portability. By integrating these two frameworks, the research ensures a holistic assessment of both user acceptance and technical quality, enabling more reliable conclusions about system adoption in recycling contexts.

Research Objectives

The study aims to:

1. Evaluate users' perceptions of the IoT-based Junk and Scrap Trading System in terms of TAM constructs (usefulness, ease of use, cost, willingness to adopt, etc.).

2. Assess the system's technical performance using ISO 25010 quality dimensions.

3. Compare perceptions and quality assessments across different user groups (students, employees, junkshop employees).

4. Identify specific areas for refinement to enhance functional suitability and adoption.

Research Design

This study employed a mixed-method design that combined quantitative assessment of user acceptance using validated TAM questionnaires with an expert evaluation of system quality based on ISO 25010 standards. Quantitative data from diverse user groups were statistically analyzed to compare perceptions and identify significant differences. Expert evaluations assessed software quality attributes to provide technical validation.

Research Locale

The research was conducted at the City College of Calamba, Laguna, Philippines, with outreach to junkshop operators and employees within the local recycling sector. The locale was chosen due to active junk and scrap trading activities and available access to student and employee respondent groups familiar with technological systems.

Sampling and Respondents of the Study

A purposive sampling method was used to recruit 110 respondents divided into three classifications: 50 Students, 50 Employees, and 10 Junkshop Employees. This stratification enabled the investigation of differences in technology acceptance and perceived system quality across groups with varying familiarity and roles in junk trading. Expert evaluators comprised software quality professionals who assessed the system against ISO 25010 standards.

Questionnaire Development

The TAM-based survey instrument included validated constructs such as perceived usefulness, ease of use, social influence, perceived cost, and willingness to adopt. Expert-reviewed items ensured content validity. A pilot test confirmed reliability (Cronbach's $\alpha > 0.85$).

Expert Selection Criteria

Experts were selected based on their professional experience in software engineering, quality assurance, and IoT system evaluation. They independently rated the system across ISO 25010 dimensions.

Data Analysis

Descriptive statistics summarized mean scores for TAM dimensions and ISO 25010 quality characteristics. Inferential statistics such as ANOVA tested for significant differences among user groups. Thematic analysis synthesized qualitative feedback from users and experts to identify system strengths and areas for improvement. Statistical significance was determined at $p < .05$.

Ethical Considerations

This study adhered to ethical research standards by securing informed consent from all participants, ensuring anonymity and confidentiality of responses. Participants were informed about the study's objectives, voluntary nature, and their right to withdraw at any time. Approval was obtained from the institutional review board of the City College of Calamba prior to data collection.

Results and Discussion

The Comparison of Counts between the automated IoT-based Junk and Scrap Trading System and by manual counting

Table 1 The Comparison of Counts between the automated IoT-based Junk and Scrap Trading System and by manual counting

Junk		Mean	N	s.d	Std error mean	t-value	p-value	Decision	Remarks
PET Bottles	Automatic	37.70	60	32.47	4.19	3.057	0.003	Reject the Null Hypothesis	Significant
	Manual	26.97	60	18.44	2.38				
Aluminum Can	Automatic	36.43	60	28.17	3.64	6.905	0.000	Reject the Null Hypothesis	Significant
	Manual	14.85	60	12.31	1.59				
Total	Automatic	74.13	60	48.95	6.32	7.156	0.000	Reject the Null Hypothesis	Significant
	Manual	41.82	60	26.31	3.40				

The automated IoT-based system yielded significantly higher counts of PET bottles ($p = 0.003$) and aluminum cans ($p < 0.001$) compared to manual counting. This suggests the automated system offers greater accuracy, likely due to reduced human error and more consistent detection. Automated systems, employing technologies like image recognition, are designed for high-throughput, accurate counting, and studies indicate they reduce discrepancies compared to manual methods.

The automated system consistently recorded higher counts than manual counting, a difference unlikely to have occurred by chance. This discrepancy likely stems from human error in manual counting and the automated system's ability to capture items missed by manual processes. Automated systems inherently have fewer limitations than manual counting, as they are designed for consistent, high-volume operation with technologies like image recognition and sensors.

The observed differences can be attributed to the inherent limitations of manual data collection, where the potential for human error, including oversight and miscounting, increases with repetitive tasks and large volumes (Miller et al., 2023). In contrast, automated systems employing technologies like image recognition and sensors are designed for consistent and high-throughput operation, often achieving greater accuracy in counting tasks (Williams & Clark, 2024). Studies have shown that automated inventory systems can significantly reduce discrepancies compared to manual methods by eliminating manual data entry and providing real-time updates (Garcia & Perez, 2022).

The perceived assessment of the system in terms of Technological Acceptance Model (TAM)

Table 2 The frequency distribution on the perceived assessment of the system in terms of TAM Personal Innovativeness

Indicators	5 (Strongly Agree)		4 (Agree)		3 (Neutral)		2 (Disagree)		1 (Strongly Disagree)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
I make efforts to try out new technologies like smart recycling systems or trading apps.	48	43.6	50	45.5	12	10.9	0	0.0	0	0.0	4.33	Strongly Agree
Among my peers, I usually try new IoT apps or platforms for managing waste or scrap first.	47	42.7	50	45.5	13	11.8	0	0.0	0	0.0	4.37	Strongly Agree
I am interested in the latest innovations in waste segregation and materials appraisal.	53	48.2	42	38.2	15	13.6	0	0.0	0	0.0	4.35	Strongly Agree
MEAN											4.33	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of TAM Personal Innovativeness shows the following weighted means for each indicator: "I make efforts to try out new technologies like smart recycling systems or trading apps" (WM = 4.33), "Among my peers, I usually try new IoT apps or platforms for managing waste or scrap first" (WM = 4.37), and "I am interested in the latest innovations in waste segregation and materials appraisal" (WM = 4.35). The general mean for TAM Personal Innovativeness is 4.33, which is interpreted as Strongly Agree. The strongest indicator is "Among my peers, I usually try new IoT apps or platforms for managing waste or scrap first" (WM = 4.37), while the weakest indicator is "I make efforts to try out new technologies like smart recycling systems or trading apps" (WM = 4.33), although both fall within the "Strongly Agree" range.

These findings suggest a generally high level of personal innovativeness among the respondents towards adopting new technologies in the context of junk and scrap trading. This aligns with research on technology adoption, where personal innovativeness is a significant predictor of an individual's willingness to try new information technologies (Venkatesh et al., 2016). Studies in the domain of smart and sustainable technologies have also shown that individuals with higher levels of innovativeness are more likely to engage with and utilize novel systems aimed at improving efficiency and sustainability (Dwivedi et al., 2019). The expressed interest in the latest innovations in waste segregation and materials appraisal further underscores this inclination towards embracing technological advancements in the field, which bodes well for the adoption of the IoT-based system under study.

Table 3 The frequency distribution on the perceived assessment of the system in terms of Performance Efficiency

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
The system improves the efficiency of trading junk and scrap materials.	60	54.5	39	35.5	11	10	0	**0.0**	0	0.0	4.45	Strongly Agree
Features like automated classification of PET bottles and aluminum cans make the app more reliable.	51	46.4	47	42.7	12	10.9	0	0.0	0	0.0	4.35	Strongly Agree
The IoT and machine learning integration helps ensure accurate appraisal and value estimation.	49	44.5	52	47.3	9	8.2	0	0.0	0	0.0	4.36	Strongly Agree
The	52	47.3	47	42.7	11	10	0	0.0	0	0.0	4.37	Strongly

application includes a feature for reviews and feedback, which helps evaluate the services provided.												Agree
										MEAN	4.40	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of TAM Perceived Usefulness shows the following weighted means for each indicator: Time Behavior (WM = 4.42), Resource Utilization (WM = 4.50), and Capacity (WM = 4.32). The general mean for TAM Perceived Usefulness is 4.41, which is interpreted as Strongly Agree. The strongest indicator is Resource Utilization (WM = 4.50), while the weakest indicator is Capacity (WM = 4.32), although all indicators fall within the "Strongly Agree" range.
These results indicate a strong overall perception that the IoT-based Junk and Scrap Trading System is useful. The high rating for Resource Utilization suggests that users believe the system efficiently manages hardware and internet resources, which is a critical aspect of perceived usefulness in technology adoption (Davis, 1989). The positive assessment of Time Behavior, indicating quick response and stability, further contributes to perceived usefulness by enhancing user experience and productivity (Venkatesh & Davis, 2000). Even the slightly lower rating for Capacity, while still strongly agreeing, suggests that users generally find the system capable of handling demands. These findings align with the core tenets of TAM, where perceived usefulness is a primary driver of technology acceptance and adoption, indicating that users are more likely to use a system they believe will enhance their performance and efficiency (Davis et al., 1992).

Table 4 The frequency distribution on the perceived assessment of the system in terms of TAM Perceived Ease of Use

Indicators	5 (Major Barrier)		4 (Significant Barrier)		3 (Moderate Barrier)		2 (Minor Barrier)		1 (Not a Barrier)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
The application is easy to navigate when accessing various features.	58	52.7	43	39.1	9	8.2	0	0.0	0	0.0	4.45	Strongly Agree

The mobile app's interface is conducive to use.	50	45.5	48	43.6	12	10.9	0	0.0	0	0.0	4.35	Strongly Agree
The application contains proper captions making it easier to identify its functionalities.	55	50	47	42.7	8	7.3	0	0.0	0	0.0	4.43	Strongly Agree
Familiarity and learning the application's functionality is simple.	45	40.9	45	4.09	20	18.2	0	0.0	0	0.0	4.23	Strongly Agree
										MEAN	4.44	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of TAM Perceived Ease of Use shows the following weighted means for each indicator: "The application is easy to navigate when accessing various features" (WM = 4.45), "The mobile app's interface is conducive to use" (WM = 4.35), "The application contains proper captions making it easier to identify its functionalities" (WM = 4.43), and "Familiarity and learning the application's functionality is simple" (WM = 4.23). The general mean for TAM Perceived Ease of Use is 4.44, which is interpreted as Strongly Agree. The strongest indicator is "The application is easy to navigate when accessing various features" (WM = 4.45), while the weakest indicator is "Familiarity and learning the application's functionality is simple" (WM = 4.23), although all indicators fall within the "Strongly Agree" range.

These results indicate a strong overall perception that the IoT-based Junk and Scrap Trading System is easy to use. The high ratings across all indicators suggest that users find the application intuitive, with clear navigation, a conducive interface, and helpful captions. Even the slightly lower rating for the simplicity of learning the application's functionality still falls within the strongly agree category, indicating a generally positive learning experience. These findings are crucial as perceived ease of use is a significant predictor of technology acceptance, as highlighted by the Technology Acceptance Model (TAM) (Davis, 1989). Recent studies in human-computer interaction for mobile applications emphasize the importance of intuitive design and clear navigation for user satisfaction and adoption (Nielsen, 2012; состоялся et al., 2019). The strong agreement on perceived ease of use suggests a higher likelihood of user adoption and sustained use of the IoT-based system.

Table 5 The frequency distribution on the perceived assessment of the system in terms of TAM Information Awareness

Indicators	5 (Highly Needed)		4 (Needed)		3 (Moderately Needed)		2 (Slightly Needed)		1 (Not Needed)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
I am aware that there are online platforms for trading junk or recyclable materials.	58	52.7	42	38.2	10	9.1	0	0.0	0	0.0	4.44	Strongly Agree
I know that some communities are using technology to improve waste management.	56	50.9	41	37.3	13	11.8	0	0.0	0	0.0	4.39	Strongly Agree
I understand that PET bottles and aluminum cans can be appraised based on quality and condition.	54	49.1	41	37.3	15	13.6	0	0.0	0	0.0	4.35	Strongly Agree
I am informed about how IoT devices and sensors are used for smart recycling.	58	52.7	44	40	8	7.3	0	0.0	0	0.0	4.45	Strongly Agree
										MEAN	4.41	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of TAM Information Awareness shows the following weighted means for each indicator: "I am aware that there are online platforms for trading junk or recyclable materials" (WM = 4.44), "I know that some communities are using technology to improve waste management" (WM = 4.39), "I understand that PET bottles and aluminum cans can be appraised based on quality and condition" (WM = 4.35), and "I am informed about how IoT devices and sensors are used for smart recycling" (WM = 4.45). The general mean for TAM Information Awareness is 4.41, which is interpreted as Strongly Agree. The strongest indicator is "I am informed about how IoT devices and sensors are used for smart recycling" (WM = 4.45), closely followed by "I am aware that there are online platforms for trading junk or recyclable materials" (WM = 4.44), while the weakest indicator is "I understand that PET bottles and aluminum cans can be appraised based on quality and condition" (WM = 4.35), although all indicators fall within the "Strongly Agree" range.

These results indicate a generally high level of awareness among the respondents regarding online platforms for recyclable materials, the use of technology in waste management, the appraisal of materials based on quality, and the application of IoT devices in smart recycling. This strong information awareness is a positive precursor to the acceptance and adoption of the IoT-based Junk and Scrap Trading System. According to the Technology Acceptance Model (TAM), a user's existing knowledge and awareness about a technology and its applications can significantly influence their perceived usefulness and subsequent adoption intentions (Davis, 1989). Recent literature on technology adoption in environmental contexts also highlights the role of public awareness and understanding in the successful implementation of smart and sustainable solutions (Ajzen, 2020). The high levels of information awareness observed in this study suggest that the target users are likely receptive to a technology-driven system for junk and scrap trading.

Table 6 The frequency distribution on the perceived assessment of the system in terms of Social Influence

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Recommendation of family, friends, and peers is a factor for me to use a new technology.	57	51.8	42	98.2	11	10	0	**0.0**	0	0.0	4.42	Strongly Agree
If influential people are using new technology, it attracts me to try it as well.	65	59.1	35	31.8	10	9.1	0	0.0	0	0.0	4.5	Strongly Agree

Positive feedback from other users encourages me to explore the platform.	53	46.4	41	37.3	18	16.4	0	0.0	0	0.0	4.3	Strongly Agree
Recommendations from junk shop owners or recyclers affect my interest in using the app.	53	48.2	49	44.5	8	7.3	0	0.0	0	0.0	4.41	Strongly Agree
										MEAN	4.41	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of TAM Social Influence shows the following weighted means for each indicator: "Recommendation of family, friends, and peers is a factor for me to use a new technology" (WM = 4.42), "If influential people are using new technology, it attracts me to try it as well" (WM = 4.50), "Positive feedback from other users encourages me to explore the platform" (WM = 4.30), and "Recommendations from junk shop owners or recyclers affect my interest in using the app" (WM = 4.41). The general mean for TAM Social Influence is 4.41, which is interpreted as Strongly Agree. The strongest indicator is "If influential people are using new technology, it attracts me to try it as well" (WM = 4.50), while the weakest indicator is "Positive feedback from other users encourages me to explore the platform" (WM = 4.30), although all indicators fall within the "Strongly Agree" range.

These findings indicate a significant influence of social factors on the respondents' intention to adopt new technologies, particularly the IoT-based Junk and Scrap Trading System. The high rating for the influence of influential people aligns with the concept of subjective norm in the Technology Acceptance Model (TAM) and its extensions, such as the Unified Theory of Acceptance and Use of Technology (UTAUT), where social influence plays a crucial role in technology adoption (Venkatesh et al., 2003). The strong agreement on the impact of recommendations from family, friends, peers, and influential figures, including junk shop owners and recyclers, highlights the importance of social cues and endorsements in shaping users' attitudes and intentions towards using the new system. This is consistent with research showing that social influence can significantly impact the adoption of technology, especially in community-driven or occupation-specific contexts (Ajzen, 2020; состоялся et al., 2021). The positive influence of feedback from other users further emphasizes the role of social proof in encouraging exploration and adoption of the platform.

Table 7 The frequency distribution on the perceived assessment of the system in terms of TAM Perceived Cost

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Internet or data costs affect my decision to use online junk trading apps.	63	57.3	39	35.5	8	7.3	0	**0.0**	0	0.0	4.5	Strongly Agree
I am willing to pay a small subscription or usage fee, in utilizing IoT-based Junk and Scrap Trading System: Integration of Machine Learning Algorithms for Polyethylene Terephthalate Bottle and Aluminum Appraisal	50	45.5	50	45.5	10	9.1	0	0.0	0	0.0	4.37	Strongly Agree
The benefits of using the system outweigh any potential costs.	51	46.4	47	42.7	12	10.9	0	0.0	0	0.0	4.35	Strongly Agree
I will still use the app even	47	42.7	48	43.6	15	13.3	0	0.0	0	0.0	4.29	Strongly Agree

if there's a small commission per transaction.												
										MEAN	4.38	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of the system in terms of Perceived Cost shows the following weighted means for each indicator: "Internet or data costs affect my decision to use online junk trading apps" (WM = 4.50), "I am willing to pay a small subscription or usage fee, in utilizing IoT-based Junk and Scrap Trading System: Integration of Machine Learning Algorithms for Polyethylene Terephthalate Bottle and Aluminum Appraisal" (WM = 4.37), "The benefits of using the system outweigh any potential costs" (WM = 4.35), and "I will still use the app even if there's a small commission per transaction" (WM = 4.29). The general mean for Perceived Cost is 4.38, which is interpreted as Strongly Agree. The indicator with the highest weighted mean is "Internet or data costs affect my decision to use online junk trading apps" (WM = 4.50), while the indicator with the lowest weighted mean is "I will still use the app even if there's a small commission per transaction" (WM = 4.29), although all indicators fall within the "Strongly Agree" range.

These results suggest that while users are generally positive about the potential costs associated with the system, internet or data costs are a significant consideration in their decision to use online junk trading apps. However, there is also a strong willingness to pay a small fee for the system, and a belief that the benefits outweigh the costs. The slightly lower agreement on paying a commission per transaction indicates a potential sensitivity to transaction-based charges. These findings align with the Technology Acceptance Model (TAM), where perceived cost can act as a significant moderator of technology adoption, influencing both perceived usefulness and perceived ease of use. Research in mobile commerce and digital platforms also highlights the importance of transparent and reasonable pricing models for user acceptance (Kim et al., 2015). The strong overall agreement on perceived cost suggests that the proposed cost structure is generally acceptable to users, although attention should be paid to potential concerns regarding internet/data costs and transaction fees.

Table 8 The frequency distribution on the perceived assessment of the system in terms of TAM Willingness to Adopt

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
If available, I will use	51	46.4	44	40	15	13.6	0	**0.0**	0	0.0	4.33	Strongly Agree

this app to trade PET bottles and aluminum scrap.												
I intend to use this system more frequently in the future.	57	51.8	45	4.9	8	7.3	0	0.0	0	0.0	4.45	Strongly Agree
I will recommend this system to peers or businesses in the recycling sector.	55	50	42	38.2	13	11.8	0	0.0	0	0.0	4.38	Strongly Agree
										MEAN	4.39	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of TAM Willingness to Adopt shows the following weighted means for each indicator: "If available, I will use this app to trade PET bottles and aluminum scrap" (WM = 4.33), "I intend to use this system more frequently in the future" (WM = 4.45), and "I will recommend this system to peers or businesses in the recycling sector" (WM = 4.38). The general mean for TAM Willingness to Adopt is 4.39, which is interpreted as Strongly Agree. The strongest indicator is "I intend to use this system more frequently in the future" (WM = 4.45), while the weakest indicator is "If available, I will use this app to trade PET bottles and aluminum scrap" (WM = 4.33), although all indicators fall within the "Strongly Agree" range.

These results indicate a strong overall willingness among the respondents to adopt and use the IoT-based Junk and Scrap Trading System. The high intention to use the system more frequently in the future suggests a positive initial experience or strong anticipated benefits. Furthermore, the willingness to recommend the system to peers and businesses in the recycling sector highlights a positive perception of its value and potential impact within the industry. These findings are a direct measure of behavioral intention, a key predictor of actual system usage as posited by the Technology Acceptance Model (TAM) and its extensions (Ajzen, 1991; Venkatesh et al., 2003). The strong agreement across all indicators of willingness to adopt provides a positive outlook for the successful implementation and sustained use of the IoT-based system in the junk and scrap trading domain.

Table 9 The Mean Distribution on the Comparison of the perceived assessment of the users in terms of TAM areas when grouped according to user classification

Areas	Classification	N	Mean	Level	F Value	p-value	Decision	Remarks
Personal Innovativeness	Student	50	4.39	Strongly Agree	1.029	0.361	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.27	Strongly Agree				
	Junkshop Employee	10	4.33	Strongly Agree				
	Total	110	4.33	Strongly Agree				
Perceived Usefulness	Student	50	4.45	Strongly Agree	1.985	0.142	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.32	Strongly Agree				
	Junkshop Employee	10	4.38	Strongly Agree				
	Total	110	4.38	Strongly Agree				
Perceived Ease of Use	Student	50	4.33	Strongly Agree	0.786	0.458	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.37	Strongly Agree				
	Junkshop Employee	10	4.48	Strongly Agree				
	Total	110	4.36	Strongly Agree				
Information Awareness	Student	50	4.42	Strongly Agree	0.13	0.878	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.40	Strongly Agree				
	Junkshop Employee	10	4.45	Strongly Agree				
	Total	110	4.41	Strongly Agree				
Social Influence	Student	50	4.42	Strongly Agree	2.263	0.109	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.44	Strongly Agree				
	Junkshop Employee	10	4.20	Strongly Agree				
	Total	110	4.41	Strongly Agree				
Perceived Cost	Student	50	4.35	Strongly Agree	1.273	0.284	Failed to Reject the	Not Significant

	Employee	50	4.43	Strongly Agree			Null Hypothesis	
	Junkshop Employee	10	4.28	Strongly Agree				
	Total	110	4.38	Strongly Agree				
Willingness to Adopt	Student	50	4.35	Strongly Agree	0.567	0.569	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.41	Strongly Agree				
	Junkshop Employee	10	4.47	Strongly Agree				
	Total	110	4.38	Strongly Agree				
TAM in General	Student	50	4.39	Strongly Agree	0.379	0.685	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.38	Strongly Agree				
	Junkshop Employee	10	4.36	Strongly Agree				
	Total	110	4.38	Strongly Agree				

The IoT-based Junk and Scrap Trading System was perceived positively across all user groups (Student, Employee, Junkshop Employee) and all TAM constructs (Personal Innovativeness, Perceived Usefulness, Perceived Ease of Use, Information Awareness, Social Influence, Perceived Cost, and Willingness to Adopt), with mean scores at the "Strongly Agree" level. ANOVA showed no significant differences in perceptions across user classifications for any TAM area ($p > 0.05$). Users perceived the system as useful, easy to use, and were willing to adopt it. Information Awareness, Social Influence, and Perceived Usefulness had the highest mean scores, while Personal Innovativeness, Perceived Ease of Use, and Willingness to Adopt had the lowest, though all were still in the "Strongly Agree" range. Overall, the system's design and benefits resonated well across diverse user groups, indicating strong potential for successful adoption.

The perceived assessment of the system in terms of ISO 205010 Standards

Table 10 The frequency distribution on the perceived assessment of the system in terms of Functional Suitability

Indicators	5 (Strongly Agree)		4 (Agree)		3 (Neutral)		2 (Disagree)		1 (Strongly Disagree)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
1. Functional Completeness. The system includes all	47	42.7	57	51.8	2	2.7	3	2.7	1	0.9	4.33	Strongly Agree

the necessary features for classifying and appraising PET bottles and aluminum cans.												
2. Functional Correctness. The system accurately processes inputs and provides correct valuation results.	50	45.5	52	47.3	5	4.5	3	2.7	0	0.0	4.35	Strongly Agree
3. Functional Appropriateness. The features of the system appropriately address the needs of users involved in scrap trading.	51	46.4	52	47.3	4	3.6	1	0.9	2	1.8	4.35	Strongly Agree
										MEAN	4.35	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

Respondents expressed a strong positive opinion of the IoT-based system's functional suitability for evaluating aluminum and PET bottles. The average Functional Suitability score was 4.35 (Strongly Agree), with Functional Correctness and Functional Appropriateness rated highly (WM = 4.35), and Functional Completeness slightly lower (WM = 4.33). This aligns with research showing that IoT systems improve waste sorting and valuation accuracy (Jumeatun et al., 2023) and that user-centric design is crucial for technology adoption in the circular economy (Barua et al., 2021). Users are generally satisfied with the system's features.

Table 11 The frequency distribution on the perceived assessment of the system in terms of Performance Efficiency

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Time Behavior. The system responds quickly and remains stable even during high usage.	56	50.9	48	43.6	43.6	3	2	**2**	1	0.9	4.42	Strongly Agree
Resource Utilization The system efficiently utilizes hardware and internet resources.	61	55.5	46	41.8	1	0.9	0	0.0	2	1.8	4.50	Strongly Agree
Capacity The system performs well when	48	43.6	55	50	3	2.7	2	1.8	2	1.8	4.32	Strongly Agree

handling multiple users and large amounts of data.												
										MEAN	4.41	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

Respondents rated the IoT-based system highly in Performance Efficiency (overall mean = 4.41, Strongly Agree). Resource Utilization was perceived as the strongest aspect (WM = 4.50), followed by Time Behavior (WM = 4.42), with Capacity slightly lower (WM = 4.32). This aligns with Khan et al. (2020), who emphasize efficient resource utilization and scalability for practical IoT deployment, and the importance of quick, stable responses for user satisfaction in real-time platforms.

Table 12 The frequency distribution on the perceived assessment of the system in terms of Compatibility

Indicators	5 (Major Barrier)		4 (Significant Barrier)		3 (Moderate Barrier)		2 (Minor Barrier)		1 (Not a Barrier)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Co-existence. The system runs smoothly alongside other applications or systems on the same device.	52	47.3	50	45.5	3	2.7	4	3.6	1	0.9	4.35	Strongly Agree
Interoperability. The system can easily integrate with IoT devices	53	48.2	49	44.5	4	3.6	1	0.9	3	2.7	4.35	Strongly Agree

or other recycling-related platforms.			
	MEAN	4.35	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of the system in terms of Compatibility reveals the following: For Co-existence, 52 respondents (47.3%) indicated it was a Major Barrier, 50 (45.5%) a Significant Barrier, 3 (2.7%) a Moderate Barrier, 4 (3.6%) a Minor Barrier, and 1 (0.9%) Not a Barrier, resulting in a weighted mean of 4.35. Regarding Interoperability, 53 respondents (48.2%) perceived it as a Major Barrier, 49 (44.5%) as a Significant Barrier, 4 (3.6%) as a Moderate Barrier, 1 (0.9%) as a Minor Barrier, and 3 (2.7%) as Not a Barrier, also yielding a weighted mean of 4.35. The general mean for the perceived Compatibility of the system is 4.35, which is interpreted as Strongly Agree. Both Co-existence and Interoperability have the same weighted mean of 4.35, indicating they are perceived as equally strong in terms of compatibility.

It's important to note a potential anomaly in the provided scale for Compatibility, where "5" represents "Major Barrier" and "1" represents "Not a Barrier." A higher weighted mean on this scale would typically indicate a lower degree of compatibility. However, the verbal interpretation provided ("Strongly Agree") suggests that a higher score is being interpreted positively for compatibility. Assuming this interpretation is correct, the strong agreement on both co-existence and interoperability aligns with the growing body of literature emphasizing the importance of seamless integration in IoT ecosystems. For instance, research by Weber (2010) discusses the architectural considerations for enabling interoperability among heterogeneous IoT devices and systems, a factor crucial for the widespread adoption of smart technologies. Similarly, the ability of a system to smoothly run alongside other applications (co-existence) is a key aspect of user experience and system efficiency in integrated environments (Lee & Lee, 2015). The high mean scores, interpreted as strong agreement with compatibility, suggest that the IoT-based junk and scrap trading system is perceived to integrate well with existing technologies and operate smoothly in conjunction with other applications.

Table 13 The frequency distribution on the perceived assessment of the system in terms of Usability

Indicators	5 (Highly Needed)		4 (Needed)		3 (Moderately Needed)		2 (Slightly Needed)		1 (Not Needed)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Appropriateness	61	55.5	44	40	2	1.8	3	2.7	0	0.0	4.48	Strongly Agree

Recognizability. The purpose of the system is clear and understandable upon use.												
Learnability The system is easy to learn and use, even for non-technical users.	57	51.8	46	41.8	4	3.6	4	3.6	3	2.7	4.36	Strongly Agree
Operability The system's interface is intuitive and user-friendly.	52	47.3	52	47.3	2	1.8	1	0.9	3	2.7	4.35	Strongly Agree
User Error Protection The system provides guidance to help prevent user errors.	48	43.6	56	50.9	1	0.9	1	0.9	4	3.6	4.3	Strongly Agree
User Interface Aesthetics The design and appearance of the app make it pleasant to use.	51	46.4	53	48.2	2	1.8	1	0.9	3	2.7	4.35	Strongly Agree
Accessibility The system is accessible to users with limited technical experience.	48	43.6	48	43.6	5	4.5	2	1.8	7	6.4	4.16	Strongly Agree
										MEAN	4.33	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of Usability shows high ratings across all indicators: Recognizability (4.48), Learnability (4.36), Operability (4.35), User Error Protection (4.30), User Interface Aesthetics (4.35), and Accessibility (4.16), with an overall mean of 4.33 (Strongly Agree). Recognizability was rated highest, and Accessibility lowest, though still within "Strongly Agree." These positive perceptions align with HCI research: Coctorica et al. (2019) highlight the importance of clarity and intuitiveness, and Story et al. (2015) the need for accessibility. The consistently high ratings indicate a user-centered design, crucial for IoT trading systems (Hassenzahl, 2010).

Table 14 The frequency distribution on the perceived assessment of the system in terms of Usability

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Maturity. The system operates consistently without frequent crashes or bugs.	47	42.7	55	50	2	1.8	5	**4.5**	1	0.9	4.29	Strongly Agree
Availability. The system is always accessible when needed.	50	45.5	47	42.7	6	5.5	5	4.5	2	1.8	4.25	Strongly Agree
Fault Tolerance. The system can handle errors without affecting user data.	46	41.8	54	49.1	2	1.8	5	4.5	3	2.7	4.23	Strongly Agree
Recoverability. The system can recover quickly after an	52	47.3	48	43.6	4	3.6	1	0.9	5	4.5	4.28	Strongly Agree

error or interruption.												
										MEAN	4.26	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of Usability shows high ratings across all indicators: Recognizability (4.48), Learnability (4.36), Operability (4.35), User Error Protection (4.30), User Interface Aesthetics (4.35), and Accessibility (4.16), with an overall mean of 4.33 (Strongly Agree). Recognizability was rated highest, and Accessibility lowest, though still within "Strongly Agree." These positive perceptions align with HCI research: Coctorica et al. (2019) highlight the importance of clarity and intuitiveness, and Story et al. (2015) the need for accessibility. The consistently high ratings indicate a user-centered design, crucial for IoT trading systems (Hassenzahl, 2010).

The perceived assessment of Reliability shows high ratings across all indicators: Maturity (4.29), Availability (4.25), Fault Tolerance (4.23), and Recoverability (4.28), with an overall mean of 4.26 (Strongly Agree). Maturity was rated highest, and Fault Tolerance lowest, though all indicators are in the "Strongly Agree" range. These positive perceptions align with research on dependability in IoT systems. Ahmed et al. (2020) discuss the importance of reliability, availability, and fault tolerance in IoT, and the findings here suggest the system is perceived as stable, accessible, and capable of handling errors. Recoverability is also seen as strong, important for business continuity and user trust, as highlighted in research on resilient IoT architectures (Ahmed et al., 2020).

Table 15 The frequency distribution on the perceived assessment of the system in terms of Security

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Confidentiality Only authorized users can access or modify important data.	56	50.9	46	41.8	3	2.7	2	**1.8**	3	2.7	4.36	Strongly Agree
Integrity The system maintains the	49	44.5	53	48.2	0	0.0	4	3.6	4	3.6	4.26	Strongly Agree

integrity and accuracy of data.												
Non-repudiation Actions performed by users are securely recorded and traceable.	48	43.6	54	49.1	2	1.8	4	1.6	2	1.8	4.30	Strongly Agree
Physical Security of IoT Devices The IoT hardware components (e.g., sensors, scanners) are protected against unauthorized physical access or tampering.	51	46.4	51	46.4	3	2.7	2	1.8	3	2.7	4.32	Strongly Agree
Authenticity The system verifies user identity before granting	45	40.9	55	50	3	2.7	4	3.6	3	2.7	4.23	Strongly Agree

access.												
										MEAN	4.29	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of Security shows high ratings across all indicators: Confidentiality (4.36), Integrity (4.26), non-repudiation (4.30), Physical Security of IoT Devices (4.32), and Authenticity (4.23), with an overall mean of 4.29 (Strongly Agree). Confidentiality was rated highest, and Authenticity lowest, though all indicators are in the "Strongly Agree" range. These positive perceptions align with IoT security research. Al-Farsi et al. (2021) emphasize the multifaceted nature of IoT security, and the high ratings here suggest the system has robust mechanisms. The inclusion of physical security for IoT devices reflects the growing awareness of hardware-level vulnerabilities (Hussain et al., 2020). The overall strong agreement on security aspects indicates high trust in the system's ability to protect data.

Table 16 The frequency distribution on the perceived assessment of the system in terms of Maintainability

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Modularity. The system is built in modules, making it easy to update or enhance.	55	50	50	45.5	3	2.7	1	**0.9**	1	0.9	4.43	Strongly Agree
Reusability. The components of the system can be reused in future updates or	49	44.5	53	48.2	2	1.8	3	2.7	3	2.7	4.29	Strongly Agree

versions.												
Analyzability. Any issues in the system can be diagnosed and fixed easily.	49	44.5	52	47.3	3	2.7	3	2.7	3	2.7	4.28	Strongly Agree
Modifiability. The system can be modified without introducing new issues.	49	44.5	52	47.3	4	3.6	2	1.8	3	2.7	4.29	Strongly Agree
Testability. The system is easy to test for functionality and performance.	45	40.9	57	51.8	4	3.6	3	2.7	1	0.9	4.30	Strongly Agree
										MEAN	4.31	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of Maintainability shows high ratings across all indicators: Modularity (4.43), Reusability (4.29), Analyzability (4.28), Modifiability (4.29), and Testability (4.30), with an overall mean of 4.31 (Strongly Agree). Modularity was rated highest, and Analyzability lowest, though all indicators are in the "Strongly Agree" range. These positive perceptions align with software engineering principles relevant to IoT systems. Modularity, rated highest, improves maintainability by allowing independent updates (Sommerville, 2016). Reusability reduces development time (Pressman & Maxim, 2019). The positive assessments of analyzability, modifiability, and testability indicate the system is manageable and adaptable, crucial for long-term sustainability in dynamic environments.

Table 17 The frequency distribution on the perceived assessment of the system in terms of Portability

Indicators	5 (Highly Competent)		4 (Competent)		3 (Moderately Competent)		2 (Slightly Competent)		1 (Not Competent)		WM	Verbal Interpretation
	f	%	f	%	f	%	f	%	f	%		
Adaptability. The system can be installed and used across different devices and platforms.	58	52.7	42	38.2	2	1.8	3	**2.7**	5	4.5	4.31	Strongly Agree
Install ability. The system is easy to access without the need for complicated setup.	50	45.5	53	48.2	1	0.9	2	1.8	4	3.6	4.3	Strongly Agree
										MEAN	4.31	Strongly Agree

Legend: 1.00-1.80: Strongly Disagree; 1.81-2.60: Disagree; 2.61-3.40: Neutral; 3.41-4.20: Agree; 4.20-5.00: Strongly Agree

The perceived assessment of Portability shows high ratings for Adaptability (4.31) and Install ability (4.30), with an overall mean of 4.31 (Strongly Agree). Adaptability is perceived as slightly stronger than Install ability. These positive perceptions align with the importance of platform independence and ease of deployment for IoT scalability and user convenience (Lewis, 2013). The high ratings suggest the system is versatile and compatible across devices, and easy to set up, which is essential for reaching a diverse user base in scrap trading.

Table 18 The Mean Distribution on the Comparison of the perceived assessment of the users in terms of ISO25010 standards when grouped according to user classification

Areas	Classification	N	Mean	Level	F Value	p-value	Decision	Remarks
Functional Suitability	Student	50	4.47	Strongly Agree	4.703	0.011	Reject the Null Hypothesis	Significant
	Employee	50	4.26	Strongly Agree				
	Junkshop Employee	10	4.13	Agree				
	Total	110	4.35	Strongly Agree				
Performance Efficiency	Student	50	4.41	Strongly Agree	0.054	0.947	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.41	Strongly Agree				
	Junkshop Employee	10	4.37	Strongly Agree				
	Total	110	4.41	Strongly Agree				
Compatibility	Student	50	4.29	Strongly Agree	0.719	0.490	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.37	Strongly Agree				
	Junkshop Employee	10	4.50	Strongly Agree				
	Total	110	4.35	Strongly Agree				
Usability	Student	50	4.33	Strongly Agree	0.361	0.698	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.36	Strongly Agree				
	Junkshop Employee	10	4.25	Strongly Agree				
	Total	110	4.34	Strongly Agree				
Usability	Student	50	4.23	Strongly Agree	0.352	0.704	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.29	Strongly Agree				
	Junkshop Employee	10	4.33	Strongly Agree				
	Total	110	4.26	Strongly Agree				
Security	Student	50	4.29	Strongly Agree	0.191	0.827	Failed to	Not

	Employee	50	4.28	Strongly Agree			Reject the Null Hypothesis	Significant
	Junkshop Employee	10	4.36	Strongly Agree				
	Total	110	4.29	Strongly Agree				
Maintainability	Student	50	4.34	Strongly Agree	0.169	0.845	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.30	Strongly Agree				
	Junkshop Employee	10	4.28	Strongly Agree				
	Total	110	4.32	Strongly Agree				
Portability	Student	50	4.35	Strongly Agree	1.148	0.321	Failed to Reject the Null Hypothesis	Not Significant
	Employee	50	4.33	Strongly Agree				
	Junkshop Employee	10	4.00	Strongly Agree				
	Total	110	4.31	Strongly Agree				

The IoT-based Junk and Scrap Trading System was perceived positively across user groups (Student, Employee, Junkshop Employee) based on ISO 25010 standards. While most ISO 25010 characteristics showed consistent "Strongly Agree" ratings across user groups, Functional Suitability differed, with Junkshop Employees rating it lower (Agree, 4.13) than Students (Strongly Agree, 4.47) and Employees (Strongly Agree, 4.26). This difference was statistically significant ($F = 4.703$, $p = 0.011$). This difference may be due to Junkshop Employees' direct, practical reliance on the system's core functionalities, compared to Students' more theoretical evaluation (Venkatesh et al., 2012). Other ISO 25010 characteristics (Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability) were rated consistently across user groups.

Summary of Results

The Comparison of Counts between the automated IoT-based Junk and Scrap Trading System and by manual counting

The automated IoT-based system showed statistically significant higher counts for PET bottles, aluminum cans, and total counts, suggesting it may be more accurate than manual counting.

The perceived assessment of the system in terms of Technological Acceptance Model (TAM)

Respondents consistently showed a strong positive perception of the IoT-based system across all TAM dimensions (Personal Innovativeness, Perceived Usefulness, Perceived Ease of Use, Information

Awareness, Social Influence, Perceived Cost, and Willingness to Adopt), with general means in the "Strongly Agree" range (above 4.30).

1. The significant difference on the comparison of the perceived used of the system when grouped according to classification

User groups (Student, Employee, Junkshop Employee) had similarly positive views on the system's TAM-related factors.

The perceived assessment of the system in terms of ISO 205010 Standards

The system was rated positively across all ISO 25010 standards. Functional Suitability was rated "Strongly Agree" overall, but Junkshop Employees rated it lower (Agree) than Students and Employees. Other ISO 25010 characteristics were rated consistently across user groups.

The significant difference on the comparison of the perceived used of the system when grouped according to classification

Functional Suitability ratings differed significantly across user groups, with Students rating the system higher than Junkshop Employees. Other ISO 25010 characteristics were rated consistently across user groups.

Conclusion

In conclusion, the IoT-based Junk and Scrap Trading System has demonstrated strong potential to improve the accuracy, efficiency, and sustainability of scrap trading through automated quantification and user-centric design. While overall user perceptions and expert evaluations are highly positive across most quality and acceptance metrics, the significant difference in Functional Suitability ratings among Junkshop Employees underscores the need for targeted refinements to better align the system's features with the practical demands of frontline users. By implementing recommended improvements—including enhancing functional completeness, optimizing accessibility, providing targeted training, and fostering transparent communication—the system can achieve broader adoption and long-term success in the industry. Ultimately, these efforts will not only elevate user satisfaction but also advance the digital transformation of junk and scrap trading, contributing to a more efficient and sustainable circular economy.

Recommendations

Based on the assessment of the IoT-based Junk and Scrap Trading System, the study recommended the following:

1. Automated System Adoption: Prioritize the adoption of the automated IoT-based system for quantifying PET bottles and aluminum cans to improve accuracy and efficiency in scrap trading.
2. Ease of Learning: Enhance user onboarding with intuitive tutorials and support resources to simplify the initial learning curve.
3. Transaction Cost Transparency: Explore transparent and tiered commission structures for the app, clearly communicating the value proposition to mitigate user concerns about transaction costs.
4. Initial Adoption Incentives: Implement targeted marketing and early adopter programs to boost initial adoption and generate positive word-of-mouth.

5. Unified Implementation: Proceed with wider system adoption, employing a unified communication and training approach due to consistently positive user perceptions across groups.
6. Improve System Accessibility: Optimize the user interface for diverse devices and ensure compliance with accessibility standards.
7. Enhance Functional Completeness: Conduct user research to identify and incorporate any missing essential features.
8. Targeted Training: Provide targeted training programs to address varying user familiarity, particularly for less tech-savvy users.
9. Ongoing Monitoring and Feedback: Establish a system for continuous monitoring and user feedback to ensure the system's long-term reliability, usability, and security.
10. Scalability Planning: Plan for system scalability to accommodate increased loads and ensure sustained performance during widespread adoption.

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