



# Development of a Used Item Exchange System for Waste Reduction and Sustainability

Alyssa Aina Haris Goh<sup>1</sup>, Kinn Abass Bakon<sup>1,\*</sup>, Asmaa Mahfoud Hezam Al-Hakimi<sup>1</sup>

<sup>1</sup> Faculty of Information Sciences and Engineering, Management and Science University, Shah Alam, Section 13, 40100 Shah Alam, Selangor, Malaysia

## ARTICLE INFO

### Article history:

Received 26 July 2026

Received in revised form 30 September 2026

Accepted 30 September 2026

Available online 9 October 2026

### Keywords:

Circular economy; used-item exchange; sustainable consumption; artificial intelligence; peer-to-peer platform; waste reduction

## ABSTRACT

Municipal solid-waste management in Malaysia remains strongly dependent on collection and disposal, creating pressure on landfill capacity and contributing to greenhouse-gas emissions. This study developed and evaluated the Exchange Used Item System (eXIm), a zero-money web platform designed to reduce unnecessary new purchases and redistribute reusable household goods before they enter recycling or disposal streams. Grounded in the waste hierarchy and circular-economy principles, the project used a mixed-method requirements approach and iterative Agile development to translate user concerns about usefulness, ease of use, trust, safety, Artificial Intelligence (AI) assistance, and logistics convenience into a functional Malaysian peer-to-peer reuse ecosystem. The full-stack platform was implemented with Next.js and MongoDB and evaluated through functional testing, black-box testing, User Acceptance Testing (UAT), and automated software-quality verification. All 18 documented functional modules achieved their expected outcomes, all 21 black-box scenarios passed, and all 12 UAT tasks were accepted. In addition, 16 automated tests across five test files passed, while linting, static type checking, and the production build completed successfully. The findings demonstrate the technical and operational feasibility of combining structured exchange workflows, assistive AI, trust mechanisms, and optional logistics within a strictly non-monetary platform. eXIm provides a practical model for household financial sustainability and early intervention in the waste hierarchy, although longitudinal research is required to quantify actual expenditure substitution and landfill diversion.

## 1. Introduction

Global municipal solid-waste generation is projected to increase substantially by 2050, while a large share of waste continues to be handled through inadequate disposal practices [1]. In Malaysia, municipal solid-waste management remains strongly dependent on collection and disposal, placing pressure on landfill capacity and contributing to greenhouse-gas emissions [2]. This linear take–make–dispose pattern is environmentally and economically inefficient because usable household items may be discarded before the end of their functional life while other households purchase new

\* Corresponding author.

E-mail address: [kinn\\_abbass@msu.edu.my](mailto:kinn_abbass@msu.edu.my)

replacements. The circular economy offers a systemic alternative by retaining products and materials at their highest practical value through reuse, repair, redistribution, and recovery [3]. Within the waste hierarchy, direct reuse is an inner-loop intervention because it preserves the utility embodied in an existing product before energy and materials are consumed by recycling or replacement production. Digital peer-to-peer platforms can support this intervention by connecting households that possess idle goods with users who need them.

Participation in technology-mediated reuse is shaped by more than environmental concern. Sustainable-consumption research identifies practical usefulness, facilitating conditions, trust, motivation, and social context as important influences on behaviour [4,5]. Technology Acceptance Model research similarly shows that perceived usefulness and perceived ease of use affect technology adoption [6]. In consumer-to-consumer environments, reputation signals, reviews, profile information, information quality, website quality, and structural assurance contribute to transaction trust [7,8].

Existing digital models nevertheless present an unresolved design tension. Commercial marketplaces offer broad reach, structured interfaces, and established logistics, but are primarily resale-oriented and may expose users to payment scams, resale bias, and privacy or safety concerns. Informal gifting communities support non-monetary redistribution but may lack structured status progression, integrated moderation, and task-oriented workflows. Peer-to-peer product-sharing research further identifies item-quality uncertainty, pickup coordination, and trust between strangers as persistent barriers [9].

Artificial Intelligence can provide an assistive layer by helping users discover relevant items, write clearer descriptions, obtain procedural guidance, and flag suspicious content. Sustainability-oriented recommender systems show promise, but their outputs remain dependent on data quality and user context [10]. AI therefore should supplement, rather than replace, server-side rules, human judgement, and administrator review. Optional logistics can also reduce handover friction, provided that delivery costs remain separate from item value and do not transform the exchange into a commercial transaction.

This study addresses the gap by developing the Exchange Used Item System (eXIm), a Malaysia-focused web platform that supports exchange and donation without item pricing, checkout, or payment processing. The platform integrates authentication, marketplace discovery, structured listing, search and filtering, exchange and donation requests, chat, meet-up or optional delivery coordination, reviews, reporting, notifications, administration, and AI-assisted guidance, recommendation, description generation, and suspicious-content detection.

The research question is: Can a Malaysia-focused, zero-money web platform integrating usability, trust and safety, AI assistance, and optional logistics provide a functional and acceptable mechanism for sustainable item exchange and donation? The system-level hypothesis (H1) proposes that an integrated combination of perceived usefulness, ease of use, trust and safety, AI assistance, and logistics convenience will enable successful completion of the principal reuse workflow.

Accordingly, the study aims to: (i) provide a non-monetary alternative that can reduce reliance on unnecessary new purchases; (ii) support continued circulation of reusable household goods before disposal; and (iii) provide a practical platform model that may support household financial sustainability. The study contributes by demonstrating a structured zero-money mechanism, workflow and assistive AI and trust safeguards into a consumer-to-consumer workflow, and evaluating the resulting system through multiple verification layers.

## **2. Literature Review**

### *2.1 Circular Economy, Waste Hierarchy, and Direct Reuse*

The transition from linear consumption to a circular economy requires attention to resource retention, not only end-of-pipe material recovery. Direct reuse and redistribution preserve a product's remaining utility and can avoid the environmental burden associated with premature disposal and replacement. Contemporary circular-economy definitions increasingly emphasize systems change, value retention, and the slowing and narrowing of resource loops [3]. Reuse platforms operationalise these ideas by making idle household goods visible and transferable.

Empirical work on peer-to-peer sharing shows, however, that participation depends on convenience, item quality, pickup coordination, and confidence in other users [9]. Research on reuse platforms also warns that environmental benefits may be reduced by transport effort or rebound effects, making logistics design important to the overall sustainability claim [17]. eXIm therefore combines meet-up and optional delivery while keeping logistics separate from the non-monetary value of the item.

### *2.2 Technology Acceptance, Trust, and System Intelligence*

TAM remains a dominant basis for examining digital adoption because perceived usefulness and perceived ease of use consistently explain whether users regard a system as worthwhile and manageable [6]. In a reuse setting, usefulness includes finding relevant items, completing requests, and coordinating handover. Ease of use includes clear navigation, comprehensible status progression, and low-effort listing and communication.

Trust is especially important when transactions occur between strangers. Pavlou [8] links trust and perceived risk to transaction intention, while later consumer-to-consumer research identifies reviews, reputation, profile cues, information transparency, website quality, and institutional safeguards as important mechanisms [7]. eXIm responds through multiple accountability points rather than a single trust signal: authentication, structured listings, chat records, confirmation rules, reviews, reports, notifications, policies, suspicious-content analysis, and administrator management.

AI assistance can lower interaction costs, but technology alone does not guarantee sustainability. Recommender-system research stresses that relevance depends on available data and context [10]. Organisational circular-economy studies likewise report that digital capability is most effective when combined with managerial readiness, strategic integration, and governance [18–21]. This supports the design decision to use AI as an assistive mechanism embedded within human and administrative controls.

### *2.3 Empirical Evidence, Convergence, and Research Gap*

Table 1 synthesises the principal empirical studies supplied for this manuscript. Values that were not reported in the supplied materials are marked N/A rather than inferred. The matrix shows convergence around the positive roles of usefulness, value, trust, and circular practices, but also shows that digital technology does not consistently produce sustainability outcomes without contextual capabilities.

**Table 1**  
Evidence matrix for circular consumption and enabling factors

| Study                                           | Journal                                                    | Theory / design                         |         | N      | Reported effect                                                                                           | Unresolved gap                                 |
|-------------------------------------------------|------------------------------------------------------------|-----------------------------------------|---------|--------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------|
| Sadiq <i>et al.</i> , (2026) [18]               | Technovation; China/manufacturing                          | DCT; survey                             | 3-wave  | 371    | I4.0 adoption → circular supply-chain practices: $\beta = 0.409$ , $p < 0.01$                             | Strategic-alliance capability                  |
| Bui <i>et al.</i> , (2026) [19]                 | Sustainable Futures; Vietnam/multi-sector                  | NRBV; sectional                         | cross-  | 310    | CE practices → sustainable performance: $\beta = 0.696$ , $p < 0.001$                                     | Inter-organisational ecosystem extension       |
| Pham (2026) [20]                                | Waste Management Bulletin; Vietnam/residential             | Social Exchange Theory; survey          |         | 417    | Perceived value → CE intention: $\beta = 0.249$ , $p < 0.001$                                             | Persistence after incentives is removed        |
| Tomasi <i>et al.</i> , (2026) [21]              | Cleaner and Responsible Consumption; Italy/Portugal        | Socio-technical; HBS data               |         | 28,416 | Household vulnerability → circular consumption: estimate = $-0.563$ , $p < 0.001$                         | Informal and shadow reuse                      |
| Ho & Yanagisawa (2025) [22]                     | Journal of Cleaner Production; Japan/P2P reuse             | Consumption Value Theory; mixed methods |         | 324    | Search attribute → decision: $\beta = 0.166$ , $p < 0.001$                                                | Internal psychological-process validation      |
| Alsaoudi <i>et al.</i> , (2026) [23]            | Green Technologies and Sustainability; UAE                 | RBV/DCT; sequential mixed methods       |         | 138    | CE practices → environmental performance: $\beta = 0.483$ , $p < 0.001$ ; direct digital effect contested | Endogeneity and reciprocal relationships       |
| Yin <i>et al.</i> , (2023) [24]                 | Resources, Conservation and Recycling; global              | Systematic review/meta-analysis         |         | N/A    | CE practices positively associated with sustainable performance                                           | Context-dependent strategy alignment           |
| Rodriguez-Espindola <i>et al.</i> , (2022) [25] | International Journal of Production Economics; Mexico/SMEs | RBV; survey                             |         | 158    | CE principles → sustainability-oriented innovation: positive                                              | Multi-stakeholder evidence                     |
| Sehnm <i>et al.</i> , (2022) [26]               | Journal of Cleaner Production; Brazil/multi-sector         | NRBV; survey                            |         | N/A    | Circular economy → sustainable performance: positive                                                      | Sample detail not reported in supplied source  |
| Chowdhury <i>et al.</i> , (2022) [27]           | Journal of Business Research; Vietnam/SMEs                 | RBV/NRBV; survey                        |         | 158    | Organisational factors → CE practices: positive                                                           | Contextual and longitudinal validation         |
| Davis (1989) [6]                                | MIS Quarterly; USA/IT                                      | TAM; canonical validation               |         | N/A    | Usefulness and ease of use → adoption: positive                                                           | Social and contextual factors underrepresented |
| Pavlou (2003) [8]                               | Journal of Management Information Systems; USA/e-commerce  | Trust survey                            | theory; | N/A    | Trust → transaction intention: positive                                                                   | Adaptation to non-monetary exchange            |
| Wan <i>et al.</i> , (2014) [16]                 | Resources, Conservation and Recycling; Hong Kong/residents | Policy effectiveness; survey            |         | N/A    | Policy effectiveness → recycling behaviour: positive                                                      | Direct-reuse adaptation                        |

### 2.3.1 Findings

The literature converges on the positive influence of perceived value and perceived usefulness on circular-economy participation, particularly in emerging economies [19,20]. It also consistently identifies trust, reputation signals, and interface quality as important determinants of transaction intention in peer-to-peer environments [7,8]. Meta-analytic evidence further supports a positive relationship between circular practices and economic, social, and environmental performance [24].

The contribution of digital capability is contested [18]. Alsaoudi *et al.*, reports that Industry 4.0 adoption strengthens circular supply-chain practices, whereas [23]. indicates that operational digital capability may not directly produce sustainable performance when managerial readiness and strategic integration are absent. The discrepancy suggests that governance and orchestration are more decisive than technology deployment alone.

### 2.3.3 Untested relationship

The supplied literature does not establish the combined effect of AI-assisted description generation, suspicious-content detection, structured status progression, and optional logistics within a strictly zero-money Malaysian redistribution platform. Existing studies focus mainly on commercial resale, informal gifting, organisational circular capability, or intention measures. eXIm addresses this operational gap through an integrated implementation and task-based evaluation.

### 2.3.4 Measurement considerations

Self-reported sustainability and adoption measures remain common because objective household and firm-level data are difficult to obtain. Such designs may be affected by common-method bias and social desirability. Time separation, mixed data sources, behavioural logs, and objective indicators should therefore be used in future evaluations. The present implementation phase avoids common-method inflation by relying on observed task completion and software verification, but it cannot estimate population-level behavioural relationships.

## 2. Methodology

### 2.1 Research Design and Methodological Rationale

The project employed an implementation-based evaluation design combining a mixed-method requirements approach with iterative Agile software development. Requirement elicitation integrated structured questionnaire findings, open-ended feedback, project objectives, literature analysis, and comparison with existing reuse and marketplace systems. Quantitative inputs identified broad patterns in user interest and feature priorities, while qualitative feedback clarified concerns involving trust, item quality, communication, and confidence in a zero-money environment.

Agile development was selected because eXIm contains interconnected modules that required progressive refinement. The approach followed repeated cycles of planning, design, implementation, testing, review, and improvement. Contemporary Agile research emphasises iterative delivery, adaptation, customer-centred inspection, and continuous attention to user experience [11–13]. This allowed usability and safety concerns to be addressed throughout development instead of being deferred until final testing.

## 2.2 Conceptual Framework and Measurement Basis

System requirements were organised around five enabling factors: perceived usefulness, perceived ease of use, trust and safety, system intelligence, and logistics convenience. Perceived usefulness was operationalised through marketplace discovery, listing tools, exchange and donation requests, and recommendation support. Ease of use was addressed through consistent navigation, structured forms, status labels, filtering, and task-oriented pages. Trust and safety were represented by authentication, reviews, reporting, policies, notifications, suspicious-content detection, and administrative oversight. System intelligence was represented by assistive AI functions, while logistics convenience was represented by meet-up and optional delivery pathways.

The implementation evaluation did not estimate a latent-variable structural equation model. However, established instruments were reviewed to define constructs and to support a future respondent-based validation phase. Table 2 identifies the principal candidate measures. If these scales are administered in Malaysia, translation and back-translation should be performed to establish semantic equivalence [14]. Discriminant validity should also be assessed because perceived usefulness may overlap with perceived value, while ease of use can overlap with trust in interface-led peer-to-peer settings. The heterotrait–monotrait ratio should remain below the selected threshold, commonly 0.90 [15].

**Table 2**

Candidate measurement instruments for a future respondent-based evaluation

| Construct            | Scale                                  | Developer              | Items / format                | Reported reliability                                                    | Adaptation                                        |
|----------------------|----------------------------------------|------------------------|-------------------------------|-------------------------------------------------------------------------|---------------------------------------------------|
| Perceived usefulness | Technology Acceptance Model (TAM)      | Davis (1989) [6]       | 6 items; 7-point Likert       | Original $\alpha = 0.98$ ; later studies report approximately 0.92–0.94 | A four-item short form may be used; freely usable |
| Trust and safety     | Trust in e-commerce                    | Pavlou (2003) [8]      | 4 items; 5- or 7-point Likert | Original $\alpha = 0.91$ ; later studies report approximately 0.85–0.88 | Permission may be required                        |
| Reuse intention      | Circular economy / recycling intention | Wan et al. (2014) [16] | 3 items; 5-point Likert       | Original $\alpha = 0.84$ ; later studies report approximately 0.84–0.87 | Freely usable; adapt carefully to direct reuse    |

## 2.3 System Architecture and Implementation Strategy

eXIm was implemented as a full-stack web application using Next.js, React, TypeScript, Tailwind CSS, and reusable interface components. Server-side functions were implemented through Next.js route handlers running on Node.js. MongoDB provided persistent storage, with Mongoose supporting schema modelling and relationships among user, item, exchange, conversation, review, report, notification, leaderboard, and delivery records. The architecture separated the browser interface, server-side logic, persistent data, and external services to reduce coupling and support future service replacement.

Development proceeded incrementally. Authentication and marketplace functions were implemented first, followed by listing, search and filtering, exchange and donation requests, chat, confirmation rules, meet-up and optional delivery flows, reviews, reports, notifications, leaderboard

functions, AI support, and administrative management. Database-backed state transitions prevented later actions from occurring before required exchange conditions had been satisfied.

The zero-money principle was enforced by intentionally excluding item pricing, checkout, and item-payment processing. Users exchange or donate goods; any optional delivery charge is treated solely as a logistics cost. AI functions provide guidance, recommendations, description generation, and suspicious-content analysis, but application rules and administrator review retain final authority.

## *2.4 Evaluation and Testing Procedures*

Evaluation used four principal evidence layers. Functional testing assessed whether 18 documented modules produced the expected user-visible outcomes and state changes. Black-box testing verified system responses to 21 valid, invalid, and restricted-input scenarios. UAT used 12 realistic tasks spanning authentication, marketplace browsing, listing publication, search, AI description support, request submission, chat, delivery-status viewing, review submission, reporting, notification viewing, and administrator-dashboard use. Automated verification included linting, static type checking, 16 tests across five test files, and production-build verification.

The analytical units were therefore functional modules, black-box scenarios, task-based acceptance activities, and automated tests rather than survey respondents. Response rate, common-method bias, latent-construct reliability, correlations, mediation coefficients, and moderation coefficients were not applicable to this implementation-based phase. Formal load, stress, concurrency, CPU, and memory benchmarking was also outside the study scope; results are interpreted as evidence of functional feasibility in the evaluated environment rather than production-scale capacity.

## **4. Results**

### *4.1 Analytical Sample and System Profile*

Because this phase evaluated an implemented system rather than a respondent survey, a conventional survey response rate was not applicable. The final analytical sample comprised 18 functional modules, 21 black-box scenarios, 12 task-based UAT activities, and 16 automated tests distributed across five test files. The functional modules covered authentication, marketplace display, item listing, search and filtering, AI chatbot support, recommendation, description generation, suspicious-content detection, chat, exchange requests, delivery tracking, reviews, reporting, notifications, leaderboard display, administrator functions, policy pages, and enforcement of the zero-money rule.

### *4.2 Functional, Black-Box, and Acceptance Outcomes*

Table 3 summarises the evaluation results. Functional testing achieved 18 expected outcomes across 18 documented modules. Black-box testing produced the expected response in all 21 scenarios, including valid, invalid, restricted, and no-payment conditions. All 12 UAT activities were accepted, indicating that the main user and administrator tasks were completable in the evaluated environment.

**Table 3**  
Summary of eXIm evaluation results

| Evaluation type         | Coverage                 | Observed result                      | Interpretation                                                             |
|-------------------------|--------------------------|--------------------------------------|----------------------------------------------------------------------------|
| Functional testing      | 18 documented modules    | 18 expected outcomes achieved (100%) | Broad module coverage in the evaluated environment                         |
| Black-box testing       | 21 scenarios             | 21 scenarios passed (100%)           | Valid, invalid, restricted, and zero-money behaviours matched expectations |
| User Acceptance Testing | 12 task-based activities | 12 tasks accepted (100%)             | Main user and administrator tasks were completable                         |
| Automated tests         | 5 test files; 16 tests   | All 16 tests passed (100%)           | Core implementation checks were internally consistent                      |
| Lint, type check, build | Project-wide checks      | All passed                           | No lint warnings; type checking and production build succeeded             |

### 4.3 Hypothesis Assessment and Explanatory Scope

H1 was supported at the system level. The integrated platform enabled completion of the principal reuse workflow from authentication and discovery through request submission, communication, handover coordination, completion, feedback, reporting, and administration. Evidence consisted of 12/12 accepted UAT tasks and 18/18 successful functional modules, including AI-assisted safety detection and enforcement of the zero-money rule. This finding demonstrates task completable and internal consistency; it does not establish causal relationships among latent constructs or quantify long-term environmental outcomes.

Common-method bias, measurement-model reliability, discriminant validity, correlations, mediation, and moderation were not estimated because the evaluation did not use respondent-level perceptual data. The explanatory power of the implementation model is instead reflected in the consistency of outcomes across functional, black-box, acceptance, and automated verification layers. Predictive stability is supported only within the tested conditions; external deployment, high concurrency, and longitudinal participation remain to be evaluated.

### 4.4 Robustness and Boundary Conditions

Robustness was examined through black-box scenarios involving restricted and invalid inputs, all of which performed according to the expected constraints. Automated checks also passed project-wide. Nevertheless, Google sign-in depends on valid external-provider configuration, production courier integration requires live credentials and webhook validation, and AI outputs require human review. These dependencies limit the extent to which local verification can be generalised to continuous production operation.

## 5. Discussion

### 5.1 Functional Implementation and Systemic Integration

The first principal finding is that all 18 functional modules achieved their expected outcomes. This demonstrates that circular-economy principles can be translated into an integrated digital workflow rather than remaining a general awareness message. Item discovery, structured listing, requests,

communication, handover, feedback, safety reporting, and administration were connected through visible state progression.

The finding converges with Sadiq *et al.*, [18], who report a positive relationship between Industry 4.0 adoption and circular supply-chain practices. It diverges from interpretations in which operational digital capability is expected to generate sustainability performance directly [23]. The apparent difference is primarily a measurement issue: eXIm evaluates whether circular tasks can be enacted, whereas organisational studies often evaluate downstream performance. Functional success is a necessary condition for impact, but not proof of impact.

## 5.2 User Acceptance and Reuse Workflow Validity

The second finding is that all 12 UAT tasks were accepted. The result supports the proposition that usefulness, ease of use, trust safeguards, AI assistance, and logistics choice can be combined without introducing item payment. The complete workflow matters because users must move beyond intention and successfully perform discovery, negotiation, coordination, and completion.

The result is consistent with evidence that perceived value supports circular-practice intention [20] and with TAM research on usefulness and ease of use [6]. It should nevertheless be interpreted cautiously. Household vulnerability can reduce circular participation even when a platform is available [21], and early evaluators may possess higher digital literacy or stronger sustainability interest than the wider population. Future field trials should therefore include diverse age, income, location, and accessibility profiles.

## 5.3 Trust, AI Assistance, and the Zero-Money Mechanism

The third contribution is the integration of trust and AI mechanisms within a strictly non-monetary environment. Commercial marketplace design commonly assumes price negotiation, checkout, or payment, whereas eXIm removes those elements and substitutes a structured exchange-or-donation path. Optional delivery cost is isolated from item value, preserving the platform's reuse purpose.

Trust is distributed across authentication, structured information, chat history, reviews, reports, confirmation rules, policies, notifications, suspicious-content detection, and administrator action. This is consistent with the literature showing that transaction trust depends on both interpersonal cues and structural assurance [7,8]. AI-generated descriptions and recommendations reduce user effort, while suspicious-content analysis adds a moderation signal. Human review remains necessary because generated content can be incomplete and automated flags can be erroneous.

## 5.4 Environmental Interpretation and the Null Impact Result

The evaluation did not establish a direct quantified environmental effect such as kilograms diverted from landfill or avoided greenhouse-gas emissions. This is a substantive null result rather than a system failure. Operational functionality creates the mechanism through which reuse may occur, but measurable impact depends on sustained participation, exchange completion, item type and mass, substitution for new purchases, transport distance, and community governance. The result aligns with evidence that technology requires managerial or institutional orchestration to produce broader sustainability performance [23].

### 5.5 Practical and Theoretical Implications

Practically, eXIm offers a reusable platform model for universities, local communities, municipalities, and non-profit organisations seeking to promote redistribution. The zero-money design may support students, families, and cost-conscious households by making useful goods accessible without item purchase. Deployment partners should combine the platform with onboarding, community moderation, safety education, collection points, and measurable reuse campaigns.

Theoretically, the study extends the waste hierarchy by demonstrating how an inner-loop intervention can be represented as a complete digital state machine. It also links TAM, trust theory, system intelligence, and logistics convenience within a single implementation model. The evidence supports functional feasibility but leaves behavioural causality to future respondent-based and longitudinal research.

### 5.6 Limitations and Response to Likely Reviewer Concerns

**Table 4**  
Limitations and mitigation priorities

| Limitation                                  | Interpretation and mitigation                                                                                                                                                                               |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Selection and convenience bias              | A perfect task-acceptance result may reflect a small or technically capable evaluation group. Future studies should report participant demographics, sampling strategy, and subgroup results.               |
| Intention-behaviour and task-retention gaps | Task completion does not demonstrate repeated use, habit formation, or sustained exchange activity. Longitudinal analytics should track return rate, completion rate, and time to handover.                 |
| Absence of objective environmental metrics  | The study did not measure item mass, avoided purchase, transport emissions, or landfill diversion. Future releases should add item-category conversion factors and auditable impact logs.                   |
| Technical scope                             | The current implementation is a responsive web application. Real-time chat, push notifications, security hardening, load testing, and production courier integration require further work.                  |
| AI and external-service dependence          | Recommendations improve with richer interaction data, generated descriptions need user review, suspicious-content flags need administrator oversight, and third-party services require valid configuration. |

## 6. Conclusion

This study developed and evaluated eXIm, a Malaysia-focused, AI-assisted, zero-money platform for exchanging and donating reusable household items. The system responds to unnecessary purchasing, premature disposal of usable goods, and the need for practical alternatives that may support household financial sustainability. It integrates marketplace discovery, structured listing, exchange and donation requests, communication, handover coordination, reviews, reporting, notifications, sustainability participation, administrative oversight, and assistive AI.

All 18 documented functional modules achieved their expected results, all 21 black-box scenarios passed, all 12 UAT tasks were accepted, and all 16 automated tests passed. Linting, static type checking, and the production build also succeeded. These findings support the system-level

hypothesis that usefulness, ease of use, trust and safety, AI assistance, and logistics convenience can be integrated into a completable non-monetary reuse workflow.

The principal contribution is an operational model that intervenes earlier in the waste hierarchy than recycling or disposal. The findings establish functional feasibility, not national environmental impact. Future work should develop native mobile access, push notifications, real-time chat, production courier integration, stronger identity and security controls, multilingual interfaces, improved recommendations, image-assisted listing, formal load testing, and objective impact indicators. Longitudinal research should measure exchange completion, repeated participation, expenditure substitution, item mass recirculated, transport effects, and landfill diversion.

## Acknowledgement

The authors acknowledge the academic and technical support provided by the Faculty of Information Sciences and Engineering, Management and Science University.

## References

- [1] Kaza, Silpa, Lisa Yao, Perinaz Bhada-Tata, and Frank Van Woerden. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Washington, DC: World Bank, 2018. <https://doi.org/10.1596/978-1-4648-1329-0>
- [2] Devadoss, PS Michel, P. Agamuthu, S. B. Mehran, Chenayah Santha, and Shahul Hamid Fauziah. "Implications of municipal solid waste management on greenhouse gas emissions in Malaysia and the way forward." *Waste Management* 119 (2021): 135-144. <https://doi.org/10.1016/j.wasman.2020.09.038>
- [3] Kirchherr, Julian, Nan-Hua Nadja Yang, Frederik Schulze-Spüntrup, Maarten J. Heerink, and Kris Hartley. "Conceptualizing the circular economy (revisited): an analysis of 221 definitions." *Resources, conservation and recycling* 194 (2023): 107001. <https://doi.org/10.1016/j.resconrec.2023.107001>
- [4] Bui, Tat-Dat, Ming K. Lim, Raditia Yudistira Sujanto, Monica Ongkowidjaja, and Ming-Lang Tseng. "Building a hierarchical sustainable consumption behavior model in qualitative information: Consumer behavior influences on social impacts and environmental responses." *Sustainability* 14, no. 16 (2022): 9877. <https://doi.org/10.3390/su14169877>
- [5] Syed, Shayaan, Adolf Acquaye, Malik Mansoor Khalfan, Theresa Obuobisa-Darko, and Fred Amofa Yamoah. "Decoding sustainable consumption behavior: A systematic review of theories and models and provision of a guidance framework." *Resources, Conservation & Recycling Advances* 23 (2024): 200232. <https://doi.org/10.1016/j.rcradv.2024.200232>
- [6] Davis, Fred D. "Perceived usefulness, perceived ease of use, and user acceptance of information technology." *MIS quarterly* (1989): 319-340. <https://doi.org/10.2307/249008>
- [7] Mayayise, T. O. *Investigating factors influencing trust in C2C e-commerce environments: A systematic literature review. Data and Information Management*, 8 (1), 100056. 2023. <https://doi.org/10.1016/j.digbus.2023.100056>
- [8] Pavlou, Paul A. "Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model." *International journal of electronic commerce* 7, no. 3 (2003): 101-134. <https://doi.org/10.1080/07421222.2003.11045766>
- [9] He, Lei, Liridona Sopjani, and Rafael Laurenti. "User participation dilemmas in the circular economy: An empirical study of Scandinavia's largest peer-to-peer product sharing platform." *Sustainable Production and Consumption* 27 (2021): 975-985. <https://doi.org/10.1016/j.spc.2021.02.027>
- [10] Felfernig, Alexander, Manfred Wundara, Thi Ngoc Trang Tran, Seda Polat-Erdeniz, Sebastian Lubos, Merfat El Mansi, Damian Garber, and Viet-Man Le. "Recommender systems for sustainability: overview and research issues." *Frontiers in big Data* 6 (2023): 1284511. <https://doi.org/10.3389/fdata.2023.1284511>
- [11] Alami, Adam, and Oliver Krancher. "How Scrum adds value to achieving software quality?." *Empirical Software Engineering* 27, no. 7 (2022): 165. <https://doi.org/10.1007/s10664-022-10208-4>
- [12] Rath, Soumya Prakash, Nikunj Kumar Jain, Gunjan Tomer, and Alok Kumar Singh. "A systematic literature review of agile software development projects." *Information and software technology* 182 (2025): 107727. <https://doi.org/10.1016/j.infsof.2025.107727>
- [13] Hinderks, Andreas, Francisco José Domínguez Mayo, Jörg Thomaschewski, and María José Escalona. "Approaches to manage the user experience process in Agile software development: A systematic literature review." *Information and Software Technology* 150 (2022): 106957. <https://doi.org/10.1016/j.infsof.2022.106957>

- [14] Beaton, Dorcas E., Claire Bombardier, Francis Guillemin, and Marcos Bosi Ferraz. "Guidelines for the process of cross-cultural adaptation of self-report measures." *Spine* 25, no. 24 (2000): 3186-3191. <https://doi.org/10.1097/00007632-200012150-00014>
- [15] Henseler, Jörg, Christian M. Ringle, and Marko Sarstedt. "A new criterion for assessing discriminant validity in variance-based structural equation modeling." *Journal of the academy of marketing science* 43, no. 1 (2015): 115-135. <https://doi.org/10.1007/s11747-014-0403-8>
- [16] Wan, Calvin, Geoffrey Qiping Shen, and Ann Yu. "The role of perceived effectiveness of policy measures in predicting recycling behaviour in Hong Kong." *Resources, Conservation and Recycling* 83 (2014): 141-151. <https://doi.org/10.1016/j.resconrec.2013.12.009>
- [17] Rückert, André, Grita Balkute, and Christina Dornack. "Calculating the environmental benefit of reuse platforms." *Circular Economy and Sustainability* 4, no. 3 (2024): 1913-1936. <https://doi.org/10.1007/s43615-024-00360-y>
- [18] Sadiq, Muhammad, Khalid Mehmood, Mei Kei Leong, Usman Ghani, and Muhammad Usman. "Industry 4.0 and circular economy: examining the role of supply chain integration and corporate social responsibility." *Corporate Social Responsibility and Environmental Management* 32, no. 6 (2025): 8242-8257. <https://doi.org/10.1016/j.techovation.2026.103653>
- [19] Bui, et al. "Circular Economy Practices and Sustainable Performance." *Sustainable Futures* (2026): 101743. <https://doi.org/10.1016/j.sftr.2026.101743>
- [20] Pham. "Perceived Value and Circular-Economy Practice Intention." *Waste Management Bulletin* (2026): 100295. <https://doi.org/10.1016/j.wmb.2026.100295>
- [21] Tomasi, Silvia, Jonathan Cohen, Jurgita Bruneckienė, Lina Dagilienė, Jessica Balest, Chiara Pellegrini, Leonardo Rosado, and Nicolas Caballero. "Is circular economy inclusive? Assessing the engagement of vulnerable households in circular consumption behaviours." *Cleaner and Responsible Consumption* (2026): 100427. <https://doi.org/10.1016/j.clrc.2026.100427>
- [22] Ho, Meng-xun, and Hideyoshi Yanagisawa. "The value of user-generated information exchange: Driving sustainability in peer-to-peer circular economies." *Journal of Cleaner Production* 491 (2025): 144811. <https://doi.org/10.1016/j.jclepro.2025.144811>
- [23] Alsaoudi, et al. "Circular-Economy Practices, Digital Capabilities, and Sustainable Performance." *Green Technologies and Sustainability* (2026): 100441. <https://doi.org/10.1016/j.grets.2026.100441>
- [24] Yin, Shiyuan, Fu Jia, Lujie Chen, and Qinru Wang. "Circular economy practices and sustainable performance: A meta-analysis." *Resources, conservation and recycling* 190 (2023): 106838. <https://doi.org/10.1016/j.resconrec.2022.106838>
- [25] Rodríguez-Espíndola, Oscar, Ana Cuevas-Romo, Soumyadeb Chowdhury, Natalie Díaz-Acevedo, Pavel Albores, Stella Despoudi, Chrisovalantis Malesios, and Prasanta Dey. "The role of circular economy principles and sustainable-oriented innovation to enhance social, economic and environmental performance: Evidence from Mexican SMEs." *International Journal of Production Economics* 248 (2022): 108495. <https://doi.org/10.1016/j.iipe.2022.108495>
- [26] Sehnem, Simone, et al. "Circular Economy, Organisational Capabilities, and Sustainable Performance." *Journal of Cleaner Production* (2022): 130572. <https://doi.org/10.1016/j.jclepro.2022.130572>
- [27] Chowdhury, et al. "Organisational Factors and Circular-Economy Practices." *Journal of Business Research* (2022). <https://doi.org/10.1016/j.jbusres.2022.03.077>