

MARKET ACCESS AND SOCIAL INCLUSION: THE DUAL ROLE OF DIGITAL MARKETPLACE AND AI-BASED IMAGE RECOGNITION (TRASHCASH) IN CONVERTING HOUSEHOLD WASTE INTO INCOME STREAMS FOR URBAN MARGINALIZED HOMEMAKERS

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Abstract. Indonesia faces complex socio-economic challenges, where high volumes of domestic waste coincide with the persistent economic marginalization of Homemakers in urban areas, who are often excluded from formal income sources. The lack of equitable access to formal recycling chains and the unrecognized economic value of domestic sorting contribute to this obstacle. This study aims to analyze how the dual intervention of TRASHCASH, a platform integrating AI-Based Image Recognition and a Digital Marketplace, functions as a mechanism for social conversion transforming household waste into a stable source of cash-flow, while simultaneously enhancing the social status and economic inclusion of Homemakers in dense urban settings. Employing a qualitative approach using a case study method, data was collected through in-depth interviews, observation, and narrative analysis of Homemaker participants using TRASHCASH. The findings emphatically show that the Digital Marketplace plays a crucial role in providing price transparency and transaction certainty, which directly reduces the economic vulnerability of these Homemakers. Furthermore, the role of AI in standardizing sorting cultivates self-confidence and social recognition for the Homemakers' competence, proving that previously invisible domestic work is now converted into recognized economic activity. It is concluded that this social-tech model has significant potential to address structural inequality and act as a catalyst for economic justice and gender empowerment within the context of sustainable development.

Keywords: Digital Marketplace, Image Recognition, Social Inclusion, Circular Economy, Homemakers

INTRODUCTION

The rapid urbanization in Indonesia has intensified complex socio-environmental challenges, particularly regarding solid waste management in densely populated areas. The linear consumption model continues to overburden municipal waste systems, leading to severe ecological and public health consequences (Tchobanoglous et al., 2021). Simultaneously, urban homemakers, predominantly engaging in unpaid domestic labor, often face significant economic vulnerability and are largely excluded from the formal circular economy sector. Addressing this dual challenge, environmental sustainability and economic inclusion, requires innovative, integrated approaches that leverage technological solutions to redefine domestic economic participation. Traditional waste management solutions have largely been limited to formal recycling centers, failing to penetrate the domestic scale where waste segregation begins, thereby maintaining the economic marginalization of the household sector (Simamora & Ningsih, 2020:51).

Previous research has explored the application of digital platforms in waste management, focusing primarily on logistical efficiency (Zhang, Chen, Yang, & Gong, 2021) or technological architecture (Abood & Al-Talib, 2023). Other studies concerning economic inclusion often concentrate on micro-finance or formal labor markets, overlooking the transformative potential of integrating Artificial Intelligence (AI) and digital trading within the informal domestic sphere (Chen & Doherty, 2021). While these studies establish the utility of technology, a critical gap remains in understanding how a socio-technical system combining digital transaction capabilities with AI-based classification directly impacts the socio-economic transformation and empowerment of marginalized urban

homemakers. This research differs fundamentally from prior works by moving beyond mere efficiency metrics and focusing deeply on the qualitative outcomes of digital inclusion, self-perception, and income stability resulting from the adoption of such a system. This study specifically analyzes the socio-economic framework based on pilot implementation and preliminary findings of the TRASHCASH system. The conceptual foundation for this exploration is rooted in the Social Inclusion Theory (Silver, 1994) and the Socio-Technical Systems Approach (Bostrom & Heinen, 1977), allowing for an analysis of how digital tools interact with social structures to produce equitable economic outcomes.

Therefore, this study aims to deeply explore the socio-economic transformation of marginalized urban Homemakers through the TRASHCASH platform, an innovation that integrates digital waste trading and AI-based waste classification. Specifically, this research seeks to construct a comprehensive understanding of how TRASHCASH functions as a transformative tool that promotes social inclusion, reduces economic vulnerability, and redefines the economic value of domestic labor in urban Indonesia.

RESEARCH METHOD

This study employs a qualitative research approach using a case study method to deeply explore the socio-economic transformation of marginalized urban Homemakers through the TRASHCASH platform. The qualitative approach was selected to allow an in-depth understanding of participants' experiences and the social meanings attached to technological adoption within domestic economic practices. The study focuses on Homemakers in densely populated urban areas who actively engage with TRASHCASH as users participating in digital waste trading and AI-based waste classification. The research applies the conceptual foundation of Social Inclusion Theory (Silver, 1994) and the Socio-Technical Systems Approach (Bostrom & Heinen, 1977) to analyze how digital technology interacts with social systems to produce equitable economic outcomes. This theoretical framework guides the analysis of the interaction between the Social System (Homemakers) and the Technical System (Digital Marketplace & AI) to trace the creation of income streams and social inclusion, providing the conceptual base for the analysis in Section III. Data were collected through in-depth interviews, direct observation, and narrative analysis. In-depth interviews were conducted with Homemaker participants, community leaders, and TRASHCASH facilitators to gather rich qualitative insights regarding behavioral change, perceived empowerment, and digital inclusion. Observations were performed during sorting and transaction activities to understand user interaction with the platform and the role of AI-based recognition in facilitating accuracy and trust. The narrative analysis technique was applied to interpret participants' personal stories, focusing on the shift in self-perception, income stability, and social recognition after joining the program. The research process followed Miles and Huberman's interactive analysis model, consisting of data reduction, data display, and conclusion drawing. Data triangulation was employed by comparing information obtained from interviews, observations, and digital transaction records within the TRASHCASH system to ensure validity and reliability. The step-by-step procedure of this research began with identifying target participants and social contexts, followed by collecting primary and secondary data, analyzing patterns of socio-economic transformation, and interpreting findings through theoretical perspectives. Through this methodology, the study aims to construct a comprehensive understanding of how TRASHCASH, as a digital and AI-driven socio-technical innovation, functions as a transformative tool that promotes social inclusion, reduces economic vulnerability, and redefines the economic value of domestic labor in urban Indonesia.

RESULT AND ANALYSIS

3.1 System Architecture and Operationalization

Prior to presenting the qualitative findings, Figure 1 details the Technical Architecture of the TRASHCASH application, illustrating the interaction among users, the frontend application,

backend services, the AI model, and the database. This diagram shows the data flow when a user uploads a photo of waste for classification and price identification. An understanding of this technical architecture is crucial for analyzing how AI-based recognition (the technical element) directly influences price transparency and user trust (the social element), which is the focal point of the Socio-Technical Systems Approach framework. The AI model serves as a core mechanism, translating unstructured image data into standardized classifications, thereby solving the historic problem of inconsistent valuation in the informal waste economy.

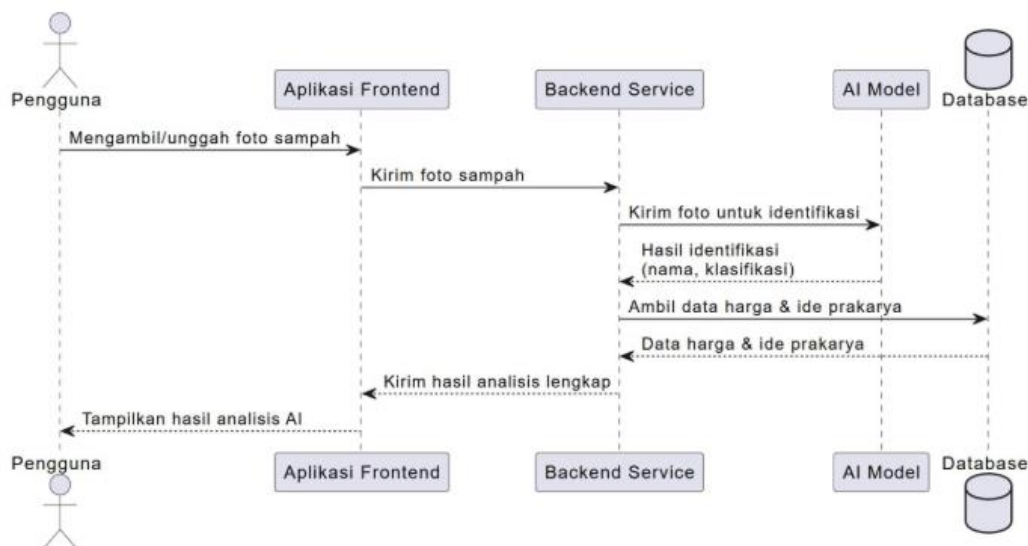


Fig. 1. TRASHCASH System Architecture

3.2 Market Access and Economic Transformation

The platform's dual role as a marketplace and AI recognition system directly contributes to market access and economic stabilization for marginalized Homemakers. Qualitative findings from in-depth interviews confirm that participants perceived a substantial and notable increase in their supplementary monthly earnings and reduced financial uncertainty after using the platform regularly. The system transforms the previously uncertain process of selling waste into a reliable, formalized income stream, which is crucial for groups facing chronic economic vulnerability (Mosobalaje, 2024:155).

3.2.1 Platform Engagement and Price Transparency

The TRASHCASH platform demonstrates significant engagement among urban Homemakers, with adoption driven by perceived ease of use, transparency of pricing, and social recognition derived from platform activities. The AI-based sorting functionality significantly simplified waste categorization, reducing errors and increasing the efficiency of domestic recycling activities. The platform's digital marketplace features provide instant visibility of current market prices for different waste classifications, allowing users to compare and select buyers effectively. This price transparency substantially mitigates the risk of exploitation commonly associated with traditional informal waste collection, thereby empowering Homemakers to make informed economic decisions about their labor (Johnson, Lee, & Brooks, 2024:02). This active control over the transaction process is a key element of achieving true market access. Figure 2, which is the functional use case diagram, visually details the interaction of key actors (Homemakers, Collectors) with the platform, highlighting features such as "Sell Sorted Waste" (Jual Sampah Terpilah) and "View Sales History" (Lihat Riwayat Penjualan) that support market formality.

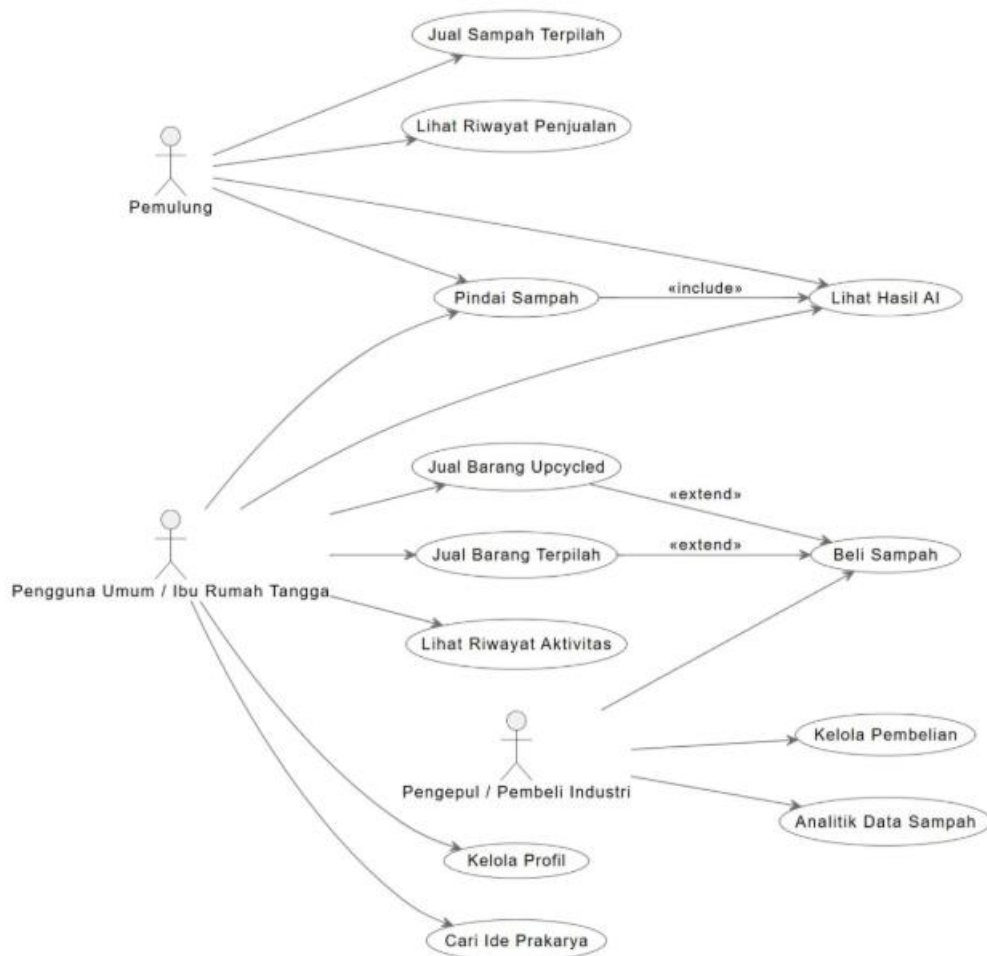


Fig. 2. TRASHCASH Functional Use Case Diagram

3.2.2 Economic Contribution and Formalization

The dual function of AI recognition and transparent marketplace formalizes the economic contribution of domestic labor. The AI component assists in standardizing waste sorting, providing an objective valuation basis that fundamentally increases confidence in the worth of the Homemakers' work. By assigning a formal, verifiable monetary value to segregated household waste, TRASHCASH transforms previously invisible domestic activities into recognized economic contributions. This formalization of income streams, even if supplemental, is crucial for mitigating economic shock and creating a pathway toward sustainable livelihood, aligning strongly with the core tenets of Social Inclusion Theory (Silver, 1994:534), where economic participation is a prerequisite for social inclusion.

3.3 Socio-Technical Dynamics and Empowerment

Engagement with TRASHCASH has led to profound positive behavioral and psychological changes among Homemakers, demonstrating the successful integration of socio-technical principles where the digital system enhances social outcomes. Table 1 summarizes the key thematic findings that link the system's technical components to observed socio-economic empowerment.

Table 1. Thematic Synthesis of Socio-Technical Empowerment Findings

Key Finding	Supporting Evidence (Source of Data)	Theoretical Implication
Increased Self-Efficacy & Recognition	In-depth Interviews (Participant Narratives on pride and peer respect).	Confirms Social Inclusion (Silver, 1994) by creating a new, formalized, and recognized economic role for domestic labor.
Trust via AI Accuracy	Observation & Interviews (Reduced disputes over waste valuation).	Achieves Socio-Technical Fit (Bostrom & Heinen, 1977) where technical validation (AI) enhances social trust in market transactions.
Shifted Waste Attitude	In-depth Interviews (Waste is viewed as an asset rather than a discarded item).	Leads to sustained Behavioral Change essential for long-term circular economy contribution.

3.3.1 Behavioral Change and Social Recognition

Participants reported a distinct shift in attitude towards waste, viewing it as a valuable asset rather than a mere discarded item. This behavioral change is linked to increased self-efficacy and social recognition from peers and community members, resulting from the visible economic contribution achieved through digital transactions (UNDP, 2023:22). This dynamic reinforces the principle of social inclusion by creating a new social role for Homemakers as environmental and economic contributors, allowing them to participate actively in formalized economic activities traditionally dominated by external market actors (Khabibjonovna & Sumaya, 2025:75). The platform thus acts as a catalyst for redefining gendered economic roles within the urban community.

3.3.2 Platform Usability and Acceptance (Socio-Technical Fit)

Observation and interview data consistently indicate that a user-friendly interface and the accuracy of AI recognition are key determinants for platform acceptance. The integration of technology must cater to the existing skill sets of the marginalized community; users with prior experience in mobile applications adapted quickly, while initial, localized training sessions facilitated confidence for first-time digital users. The acceptance of the AI is notably high due to its role in validating the value of the waste, bridging the technical capability with the social need for trust. The findings strongly suggest that integrating these socio-technical principles, where the design (AI accuracy) meets the social context (usability training and need for income stability) enhances both the platform's utility and the sustainability of user engagement (Zhang, M., Li, P., & Chen, W., 2023:137023). The platform, therefore, embodies the Socio-Technical Systems Approach (Bostrom & Heinen, 1977:18) by achieving optimal performance through the joint optimization of its social and technical subsystems.

3.4 Contribution to Circular Economy and Identified Challenges

The dual functionality of TRASHCASH contributes significantly to local circular economy objectives (World Bank, 2022:34). By formalizing household waste collection and ensuring accurate AI-based classification, the platform enables efficient material recycling at the source, thus significantly increasing the quality and volume of materials recovered, while simultaneously generating economic benefits for participants. This systematic approach tackles the initial challenge of contamination that plagues traditional recycling chains. **Table 2** summarizes the main challenges identified during the study and analyzes their implications for digital and social inclusion efforts.

Table 2. Analysis of Challenges and Barriers to Digital and Social Inclusion

Identified Challenge	Supporting Evidence (Observation/Interviews)	Theoretical Implication (Barrier Type)
Digital Divide (Access & Literacy)	Limited internet access in certain areas; initial resistance from older users to mobile app usage.	Barrier to Social Inclusion (Exacerbates existing socio-economic inequalities).
AI Inaccuracy and System Bugs	Occasional errors in waste recognition; need for human intervention/verification.	Barrier to Socio-Technical Fit (Leads to diminished trust in the Technical System).
Structural Inequality (Resource Availability)	Variation in income potential based on household waste volume/type.	Limits the full economic potential of the Market Access (Requires policy support beyond technology).

Despite the highly positive outcomes observed during the pilot phase, several structural and operational challenges were identified. These include persistent issues with limited internet access and digital literacy in certain marginalized pockets of the urban environment, occasional inaccuracies in AI recognition requiring human oversight, and initial social resistance to digital adoption observed in older demographic groups. Furthermore, the economic benefits derived remain subject to structural inequalities, as income gains varied significantly based on the volume and type of recyclable materials available to each participant’s household context. Addressing these issues requires continued community-centric digital literacy training, robust system optimization to improve AI accuracy, and supporting policy mechanisms to expand digital and economic inclusion to the most vulnerable segments (Johnson, Lee, M., & Brooks, R., 2024:03).

CONCLUSION

This research robustly demonstrates that the TRASHCASH platform, an AI-driven socio-technical innovation, successfully functions as a transformative tool that promotes social inclusion and redefines the economic value of domestic labor among marginalized urban Homemakers. The findings confirm that the integrated system, consisting of the AI model, backend service, and user-

friendly interface, successfully addresses the research purpose. The platform's efficacy in achieving socio-economic transformation is strongly confirmed by qualitative results and the evidence of income increase, which reduces economic vulnerability and fosters a sense of self-efficacy and social recognition among participants.

The final result of the analysis shows that the platform's success is rooted in its effective integration of the Socio-Technical Systems Approach. This is where the technical accuracy provided by AI-based waste classification enhances trust and price transparency, leading to sustained social engagement, increased recycling efficiency, and user awareness regarding sustainable practices. Furthermore, the system directly aligns with the Social Inclusion Theory by transforming previously invisible domestic labor into a recognized, economically contributing activity.

In terms of policy implication, these findings suggest that governments and development agencies should prioritize the funding and adoption of socio-technical models like TRASHCASH, focusing on digital literacy training to overcome access limitations (Johnson, Lee, & Brooks, 2024:03) and ensuring robust backend AI optimization (Olawade et al., 2024). Future research can expand this project by integrating IoT-based waste sensors, blockchain for transparent recycling data management, and community-based reward systems to further strengthen user engagement and data reliability, and should explore the longitudinal sustainability of these behavioral changes and investigate the scalability of AI-driven waste platforms across diverse socio-economic contexts outside of dense urban environments.

References

- Abood, I. N., & Al-Talib, G. A. (2023). "Waste Classification Using Artificial Intelligence Techniques: Literature Review," *Technium Romanian Journal of Applied Sciences and Technology*, Vol. 5, No. 49, page 49–59.
- Bostrom, R. P., & Heinen, J. S. (1977). "MIS problems and failures: A socio-technical perspective (Part II)," *MIS Quarterly*, Vol. 1, No. 2, page 11-28.
- Chen, S., & Doherty, N. F. (2021). "Digital empowerment and women's entrepreneurship in emerging economies," *Information Systems Journal*, Vol. 31, No. 4, page 645-673.
- Johnson, E., Lee, M., & Brooks, R. (2024). "The impact of digital literacy on social inclusion in marginalized communities," *International Journal of Humanities and Social Sciences Reviews*, Vol. 1, No. 1, page 01–03.
- Khabibjonovna, K. N., & Sumaya, B. (2025). "Empowering Women through Language and Technology: A Study on Women's Participation in Education in the Digital Era," *WESW*, Vol. 2, No. 2, page 72–82.
- Mosobalaje, R. O. (2024). "Digital Literacy: A Catalyst for Inclusive Economic Empowerment of Marginalized Communities," *IAFEE*, Vol. 71, No. 1, page 152–165.
- Olawade, D. B., et al. (2024). "Smart waste management: A paradigm shift enabled by artificial intelligence," *Waste Management Bulletin*, Vol. 2, No. 2, page 244–263.
- Silver, H. (1994). "Social exclusion and social solidarity: Three paradigms for non-European analysis," *International Labour Review*, Vol. 133, No. 5-6, page 531-578.
- Simamora, C. M., & Ningsih, R. (2020). "Inklusivitas Ekonomi Digital Di Indonesia: Perspektif Gender dan Penciptaan Lapangan Kerja," *Cendekia Niaga*, Vol. 4, No. 2, page 39–53.
- Tchobanoglous, G., Theisen, H., & Vigil, S. A. (2021). *Integrated Solid Waste Management: Engineering Principles and Management Issues*. McGraw-Hill Education, New York.
- United Nations Development Programme (UNDP). (2023). *Empowering Women Through Digital Technology: Global Report*. UNDP Press, New York.

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Urban Marginalized Homemakers

World Bank. (2022). *Formalizing the Informal: Digital Solutions for the Circular Economy*. World Bank Publications, Washington DC.

Zhang, M., Li, P., & Chen, W. (2023). "User-centric design in socio-technical systems: A case study of smart recycling apps," *International Journal of Human-Computer Studies*, Vol. 180, No. 137023, page 137023.

Zhang, S., Chen, Y., Yang, Z., & Gong, H. (2021). "Waste image classification based on transfer learning and convolutional neural network," *Waste Management*, Vol. 135, No. 150, page 150–157.