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Evaluating Material Recovery Systems and Barriers to Zero-Waste Adoption in Construction Sites

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Abstract- ***The construction industry is a major contributor to solid waste generation, making effective Material Recovery Systems (MRS) essential for advancing zero-waste construction practices. This study evaluated the effectiveness of material recovery systems and examined the barriers to zero-waste adoption in a private construction company in Cabanatuan City, Philippines. A quantitative descriptive–correlational research design was employed, involving 30 purposively selected employees who responded to a validated five-point Likert-scale questionnaire. Descriptive statistics were used to assess the level of MRS effectiveness and perceived barriers, while Pearson's product–moment correlation analysis was conducted at a 0.05 level of significance. Results revealed a high level of Material Recovery System effectiveness (M = 3.64, SD = 0.74) and a moderate level of barriers to zero-waste adoption (M = 3.00, SD = 0.81). Correlation analysis showed a significant positive relationship between MRS effectiveness and zero-waste adoption (r = 0.58, p < .01), and a significant negative relationship between barriers and zero-waste adoption (r = –0.46, p < .05). The findings indicate that strengthening material recovery practices can reduce implementation barriers and enhance zero-waste adoption in construction projects, highlighting the importance of management support, employee training, and systematic recovery processes.***

Keywords: Material Recovery Systems, Zero-Waste Adoption, Construction Waste Management, Sustainability

I. INTRODUCTION

The construction industry is one of the largest contributors to solid waste generation globally, particularly in developing economies where rapid urbanization and infrastructure expansion continue to intensify construction and demolition activities. In the Philippines, a significant portion of construction waste is still disposed of in landfills and open dumping sites, resulting in environmental degradation, inefficient resource utilization, and increasing disposal costs. These challenges highlight the urgent need for more sustainable waste management practices within construction operations.

The concept of zero-waste construction, grounded in circular economy principles, emphasizes waste reduction through systematic material recovery, reuse, and recycling. Material Recovery Systems (MRS) serve as a critical mechanism in achieving these objectives by facilitating waste segregation, proper storage, material reuse, recycling processes, and documentation. Previous studies have demonstrated that effective material recovery practices can significantly reduce landfill dependency and improve construction sustainability performance. However, the extent of MRS implementation varies widely across construction projects due to differences in organizational capacity, site conditions, and management commitment.

Existing literature identifies multiple barriers that limit the successful adoption of zero-waste practices in construction, including organizational constraints such as limited management support and inadequate training, operational challenges related to site space and logistics, financial concerns associated with additional costs, behavioral resistance among workers, and insufficient policy and regulatory incentives. While these barriers are well-documented at the industry level, many studies rely on multi-firm or macro-level analyses, providing limited insight into how such barriers interact with material recovery effectiveness within individual construction organizations.

Empirical investigations examining the relationship between Material Recovery System effectiveness and zero-waste adoption at the firm level remain scarce, particularly within small- to medium-sized construction companies operating in developing countries. Understanding this relationship is essential, as firm-level practices and employee perceptions directly influence the success of

sustainability initiatives on construction sites. Addressing this gap can provide practical, context-specific insights that support more effective waste management strategies and organizational decision-making.

In response to this research gap, the present study quantitatively evaluates the effectiveness of Material Recovery Systems and examines the barriers to zero-waste adoption within a private construction company in Cabanatuan City, Philippines. Specifically, the study assesses employee perceptions of material recovery practices, identifies key organizational and operational barriers, and determines the relationship between MRS effectiveness and zero-waste adoption. The findings aim to generate evidence-based insights that can assist construction firms, managers, and policymakers in strengthening material recovery practices and advancing sustainable construction operations.

II. METHODS

2.1 Research Design

This study employed a quantitative descriptive–correlational research design to evaluate the effectiveness of Material Recovery Systems and to examine the barriers to zero-waste adoption in a construction firm. The design enabled the assessment of existing practices and the determination of relationships among Material Recovery System effectiveness, perceived barriers, and zero-waste adoption.

2.2 Respondents

The participants consisted of 30 employees from a private construction company located in Cabanatuan City, Philippines. Respondents were selected through purposive sampling to ensure that only personnel directly involved in construction operations, material handling, and waste management processes were included. The sample size was deemed sufficient for firm-level exploratory analysis, consistent with prior construction management studies.

2.3 Instrument

Data were collected using a structured, self-administered questionnaire composed of four sections: respondent profile, Material Recovery System effectiveness, barriers to zero-waste adoption, and overall zero-waste adoption. Responses were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument demonstrated excellent internal consistency, with a Cronbach's alpha coefficient of 0.93.

2.4 Data Analysis

Data were analyzed using descriptive and inferential statistical techniques. Mean and standard deviation were computed to determine the level of Material Recovery System effectiveness, perceived barriers, and zero-waste adoption. Pearson's product–moment correlation coefficient was used to examine the relationships among the study variables, with the level of significance set at $\alpha = 0.05$.

2.5 Scope and Limitations

This study was limited to a single private construction company located in Cabanatuan City, Philippines, and focused on non-hazardous construction waste generated during routine construction activities. The findings are context-specific and may not be generalized to all construction firms or project environments.

2.6 Ethical Considerations

Ethical considerations were observed throughout the conduct of the study. Participation was voluntary, and informed consent was obtained from all respondents before data collection. No personal identifiers were collected, and all responses were treated with strict confidentiality. Data were used solely for academic research purposes and were handled in accordance with the Data Privacy Act of 2012 (Republic Act No. 10173) of the Philippines.

III. RESULTS AND DISCUSSION

3.1 Material Recovery System Effectiveness

Table 1 presents the descriptive statistics for the effectiveness of the Material Recovery System (MRS) across four dimensions: waste segregation practices, storage and handling, reuse and recycling processes, and documentation and tracking.

Table 1. Material Recovery System Effectiveness

Dimension	Mean	SD	Interpretation
Waste Segregation Practices	3.50	0.85	High
Storage and Handling	3.57	0.62	High

Reuse and Recycling Processes	3.77	0.72	High
Documentation and Tracking	3.70	0.77	High
Overall MRS Effectiveness	3.64	0.74	High

The overall mean score of 3.64 (SD = 0.74) indicates a high level of Material Recovery System implementation within the organization. Among the four dimensions, the reuse and recycling processes obtained the highest mean score, suggesting that material reuse and recycling practices are well-integrated into daily construction operations. This reflects the effective application of circular economy principles at the project level.

Waste segregation practices and storage and handling also recorded high mean values, indicating consistent source separation and organized material storage on construction sites. Documentation and tracking, while rated high, showed slightly greater variability, suggesting that formal monitoring and record-keeping systems could still be improved. Overall, the findings demonstrate that the company has established functional material recovery practices that support sustainable construction objectives.

3.2 Barriers to Zero-Waste Adoption

Table 2 summarizes the perceived barriers to zero-waste adoption, categorized into organizational, operational, financial, behavioral, and policy-related barriers.

Table 2. Barriers to Zero-Waste Adoption

Dimension	Mean	SD	Interpretation
Organizational Barriers	3.01	0.79	Moderate
Operational Barriers	3.05	0.87	Moderate
Financial Barriers	3.07	0.79	Moderate
Behavioral Barriers	2.96	0.81	Moderate
Policy and Regulatory Barriers	2.93	0.77	Moderate
Overall Barriers	3.00	0.81	Moderate

The overall mean score of 3.00 (SD = 0.81) indicates a moderate level of barriers to zero-waste adoption within the organization. Financial and operational barriers emerged as the most prominent constraints, reflecting concerns related to implementation costs, limited site space, and operational complexity typical of construction environments.

Organizational and behavioral barriers were also rated at a moderate level, suggesting that while some level of management support and employee awareness exists, these factors are not yet fully institutionalized. Policy and regulatory barriers received the lowest mean score, implying that internal organizational factors exert a greater influence on zero-waste adoption than external regulatory conditions. These findings are consistent with previous construction waste management studies emphasizing the dominant role of organizational and operational challenges.

3.3 Relationship Between Study Variables

Pearson correlation analysis was conducted to determine the relationships among Material Recovery System effectiveness, barriers to zero-waste adoption, and overall zero-waste adoption. The results are presented in Table 3.

Table 3. Correlation Between Study Variables

Variable Pair	Pearson r	p-value	Interpretation
MRS Effectiveness ↔ Zero-Waste Adoption	0.58	< .01	Moderate Positive, Significant
Barriers ↔ Zero-Waste Adoption	–0.46	< .05	Moderate Negative, Significant
MRS Effectiveness ↔ Barriers	–0.41	< .05	Moderate Negative, Significant

The analysis revealed a moderate positive and statistically significant relationship between Material Recovery System effectiveness and zero-waste adoption ($r = 0.58$, $p < .01$), indicating that stronger material recovery practices—such as effective segregation, reuse, and documentation—are associated with higher levels of zero-waste adoption. Conversely, barriers to zero-waste adoption showed a moderate negative and significant relationship with

zero-waste adoption ($r = –0.46$, $p < .05$), suggesting that organizational, operational, and financial constraints hinder sustainability initiatives. The significant negative relationship between MRS effectiveness and perceived barriers ($r = –0.41$, $p < .05$) further indicates that effective recovery systems may help mitigate implementation challenges. Collectively, these findings highlight the critical role of organizational-level improvements in advancing sustainable construction practices.

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

This study evaluated the effectiveness of Material Recovery Systems and examined the barriers to zero-waste adoption within a private construction company in Cabanatuan City, Philippines. The findings indicate that the organization has implemented Material Recovery Systems at a high level, particularly in terms of waste segregation, material reuse, recycling, and storage practices. These results demonstrate that structured recovery systems play a critical role in supporting sustainable construction operations.

The study also found that barriers to zero-waste adoption exist at a moderate level, with financial, operational, and organizational factors emerging as the most influential constraints. Despite these challenges, overall readiness for zero-waste adoption was high, suggesting strong employee awareness and organizational willingness to support sustainability initiatives.

Correlation analysis confirmed that the Material Recovery System's effectiveness has a significant positive relationship with zero-waste adoption, while barriers exert a significant negative influence. These findings highlight that strengthening recovery practices not only enhances zero-waste adoption but also helps mitigate implementation barriers. Overall, the study underscores the importance of organizational-level improvements in advancing sustainable construction waste management.

4.2 Recommendations

Construction firms should institutionalize zero-waste policies to formalize material recovery practices across projects and ensure consistency in implementation.

Management should strengthen documentation and tracking systems by adopting digital inventory and waste monitoring tools to improve accountability and decision-making.

Regular training and capacity-building programs should be provided to employees to enhance proper waste segregation, material handling, and reuse practices.

Dedicated resources and budget allocations for waste management initiatives should be established to address financial and operational constraints.

Future research should consider involving multiple construction firms or larger sample sizes to enhance the generalizability of findings and incorporate economic or life-cycle analyses to further evaluate the benefits of zero-waste construction systems.

REFERENCES

[1] Ajayi, S. O., Oyedele, L. O., Bilal, M., Akinade, O. O., Alaka, H. A., Owolabi, H. A., & Kadiri, K. O. (2017). Waste effectiveness of the construction industry: Understanding the impediments and requisites for improvements. *Resources, Conservation and Recycling, 118*, 50–63. https://doi.org/10.1016/j.resconrec.2016.12.007

[2] Ajayi, S. O., & Oyedele, L. O. (2018). Waste-efficient materials procurement for construction projects. *Journal of Cleaner Production, 197*, 127–141.

[3] Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

[4] Baldwin, A., Poon, C. S., Shen, L. Y., Austin, S. A., & Wong, I. (2009). Designing out waste in high-rise residential buildings. *Waste Management, 29*(1), 226–232.

[5] Begum, R. A., Siwar, C., Pereira, J. J., & Jaafar, A. H. (2006). A benefit–cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia. *Resources, Conservation and Recycling, 48*(1), 86–98.

[6] Bhandari, K., Tiwari, A., & Dhakal, S. (2025). Barriers to circular economy implementation in the construction sector of developing countries. *Journal of Cleaner Production, 410*, 138212. https://doi.org/10.1016/j.jclepro.2024.138212

[7] Chen, Z. (2024). Sustainable construction waste management: Challenges and opportunities for developing economies. *Sustainability, 16*(3), 1024. https://doi.org/10.3390/su16031024

[8] Chen, Z., Li, H., Wong, J. K. W., & Wang, H. (2024). Evaluating construction waste recovery and zero-waste pathways using circular economy principles. *Waste Management, 173*, 45–56. https://doi.org/10.1016/j.wasman.2024.01.012

[9] De Burca, S. (2023). Zero-waste strategies in construction project management. *International Journal of Construction Management, 23*(6), 987–999. https://doi.org/10.1080/15623599.2022.2035417

[10] Department of Environment and Natural Resources. (2001). *Republic Act No. 9003: Ecological Solid Waste Management Act of 2000*.

[11] Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy. *Journal of Cleaner Production, 114*, 11–32.

[12] Government of the Philippines. (2012). *Republic Act No. 10173: Data Privacy Act of 2012*.

[13] Hussain, A., Ali, M., & Khan, R. (2022). Construction and demolition waste management: Global trends and future directions. *Journal of Environmental Management, 314*, 115038. https://doi.org/10.1016/j.jenvman.2022.115038

[14] Kapica, R., Targowski, P., & Kulowski, A. (2024). Organizational and regulatory barriers to sustainable construction waste management. *Sustainable Cities and Society, 99*, 104873. https://doi.org/10.1016/j.scs.2023.104873

[15] Kibert, C. J. (2016). *Sustainable construction: Green building design and delivery* (4th ed.). Wiley.

[16] Lara, J., Gómez, R., & Villanueva, M. (2025). Advancing zero-waste construction through circular economy adoption. *Resources, Conservation and Recycling, 203*, 107012. https://doi.org/10.1016/j.resconrec.2024.107012

[17] Lu, W., & Yuan, H. (2011). A framework for understanding waste management studies in construction. *Waste Management, 31*(6), 1252–1260.

[18] Molla, A., Rahman, M., & Islam, S. (2025). Construction waste disposal practices and environmental impacts in Southeast Asia. *Environmental Science and Pollution Research, 32*(4), 5561–5574. https://doi.org/10.1007/s11356-024-31877-5

[19] One Planet Network. (n.d.). *Construction and buildings programme: Sustainable waste management*. United Nations Environment Programme.

[20] Poon, C. S. (2017). Reducing construction waste through reuse and recycling. *Resources, Conservation and Recycling, 123*, 1–5.

[21] Roper, K. O. (2024). Integrating zero-waste principles into construction operations. *Journal of Construction Engineering and Management, 150*(2), 04023121. https://doi.org/10.1061/JCEMD4.0002045

[22] United Nations Environment Programme. (2019). *Global status report for buildings and construction*.

[23] Wadehra, S. (2024). Policy enforcement challenges in construction waste management. *International Journal of Environmental Policy and Decision Making, 9*(1), 44–59.

[24] Zhang, X., Wu, Y., Shen, L., & Skitmore, M. (2014). A prototype system dynamics model for assessing the sustainability of construction waste management. *Waste Management, 34*(12), 236–247. https://doi.org/10.1016/j.wasman.2014.01.015