

The Nexus Between Green Solid Waste Management and Sustainable Development in Sanitation Companies in Hargeisa City, Somaliland

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Abstract

This study examined the nexus between green solid waste management and sustainable development among sanitation companies in Hargeisa, Somaliland. This study was anchored on the evolving theory of waste management and employed an explanatory research design. The study targeted 506 employees of sanitation firms working in street cleaning, waste collection, and waste disposal. Stratified and simple random sampling techniques were used to draw a sample of 218 employees. A conceptual model comprising four latent variables was tested using Covariance-based Structural Equation Modeling (CB-SEM). The results indicate that the three green practices of recycling ($b=.413$, $p<.05$) and reducing ($b=.300$, $p<.05$) are positive and significant predictors of sanitation companies in Hargeisa City. However, reuse ($b = 0.180$, $p > .05$) does not significantly predict the firms' sustainability. These findings imply that sanitation companies in the city can protect the environment and human health by leveraging green waste management practices. Future studies should broaden the scope to include households, as they contribute significantly to waste generation and should be sensitive to green waste management practices.

Keywords: Green solid waste management, sanitation, sustainable development, Somaliland

Introduction

Greenhouse gas emissions caused by human activity are driving the planet toward the precipice of the sixth mass extinction (Torres-Romero et al., 2020). This drive has significantly altered habitats, leaving the species that inhabit them devastated (Akani et al., 2022). Faced with this challenge, the United Nations (UN) member states assembled to combine efforts to protect the planet's natural resources. Therefore in 2015, UN member states held a sustainable development summit themed 'Transforming our World', which adopted the 2030 Agenda for Sustainable Development (Tsalis et al., 2020). Through the agenda, the member states resolved to end poverty and hunger, build peace, increase equity and inclusion within and among member states, and provide lasting protection of

the planet. Sustainable development focuses on providing for the needs of the present generation without compromising those of future generations (Beckerman, 2017). Therefore, in seeking to adopt a common front to protect the planet's natural resources, UN member states sought to promote economic and social development without degrading or polluting the environment (Holmberg & Sandbrook, 2019). Implementing sustainable development can be a daunting experience for sanitation firms, probably because of the increasing amount of solid waste globally. According to the Resource Conservation and Recovery Act (RCRA), enacted in 1976 (Lehman, 2020), solid waste is related to discarded materials that arise from human activities. They include garbage or refuse, sludge from water supply plants, water treatment

plants, air pollution control facilities, and other discarded materials such as plastic. Several types of solid waste have been identified in the existing literature, including municipal solid waste, which is non-hazardous and is collected in cities, towns, or villages (Ding et al., 2021). Other types of waste include hazardous waste, such as toxins, reactives, ignitables, corrosives, and infections that can harm the environment and humans (Asante-Duah, 2021); industrial waste arising from material processing (Gaur et al., 2020); agricultural waste generated from agro-based industries, crops, and livestock (Nguyen et al., 2019); and biomedical waste generated during the production and testing of biological components and in medical operations (Ilyas et al., 2020).

Concerns have arisen that the increasing global human population has occasioned the generation of large volumes of these solid wastes, negatively impacting air, water, and land (Prajapati et al., 2021). According to the United Nations (UN), humans are responsible for nearly 11.2 billion tonnes of solid waste generated worldwide (Nandi et al., 2022). The World Bank projects an annual solid waste generation of approximately 3.8 billion tonnes by 2050 (Maalouf & Mavropoulos, 2022).

The increasing population is also a feature in Somaliland's urban cities, which are being reconstructed and rebuilt. One of the cities experiencing this population growth is Hargeisa, which reportedly has a population of 650,000 and generates 223 tons of waste per day, equivalent to 0.35 kg/d per capita (Abi, 2020). However, Hargeisa has only four dumping sites for managing garbage and five companies (Keeps, Alims, Tawfiq, Tabson, and Horsed) for waste management (Mohamed Jama, 2018). The consequence of the limited number of waste management companies and dumping sites is that Hargeisa lacks an organized, centralized system to facilitate proper waste management (Abi, 2020; Omer, 2021). Solid waste collection is a key challenge facing Hargeisa (Abi, 2020). It is argued that despite the local government of Hargeisa having agreed with private companies

to collect solid waste, adequate administration and involvement of the local government for better management are lacking. Consequently, improper waste management has persisted, resulting in serious environmental degradation and pollution, posing inefficient resource use and health risks.

The study involved sanitation companies in Hargeisa. The city is situated in the valley of the Galgodon highlands in northwestern Somalia and is the capital of the self-declared autonomous state of the Republic of Somaliland. Hargeisa's waste management challenges provide a compelling and valuable case study for exploring the GSWM-SD nexus.

As the capital of Somaliland, Hargeisa is experiencing exponential population growth and urbanization, resulting in a serious and escalating solid-waste management crisis. This creates an urgent scenario for studying the implementation and impact of green practices. Hargeisa is also facing solid waste management challenges due to post-war reconstruction efforts. The city has five sanitation firms: KEEPs, Towfiq, Tabson, Horseed, and Almis. The firms were appropriate for exploring the relationship between green solid waste management and the sustainability of the sanitation firms.

Green practices such as recycling, waste reduction, reuse, garbage disposal units, composting, and hazardous waste sites have been associated with sustainable waste management in diverse contexts (Agyeiwaah, 2020; Bartolacci et al., 2018; Guo et al., 2019; Vanapalli et al., 2021). The question then is whether the local authorities in Hargeisa recognize the utility of green solid waste management practices to encourage private companies to adapt to waste management. This study sought to establish the nexus between green solid waste management and sustainable development in sanitation companies in the city. The specific hypotheses of this study were as follows:

1. **H_{a1}**: Recycling as a green solid waste management practice has a significant

influence on sustainable development in sanitation companies in Hargeisa city.

2. **H_{a2}**: Reuse as a green solid waste management practice has a significant effect on the sustainable development of sanitation companies in Hargeisa city.
3. **H_{a3}**: Reduce as a green solid waste management practice has a significant effect on the sustainable development of sanitation companies in Hargeisa city.

Literature Review

Waste Recycling and Sustainable Development

Waste recycling can be defined as the process of recovering energy and materials from waste management streams and reintegrating them into the production cycle. (Rizos & Bryhn, 2022). Sustainable development is an integrated policy and theoretical framework that seeks to harmonize three distinct pillars: social equity, economic viability, and environmental sustainability. (Sachs, J. D., et al. 2021).

Recycling is a critical component of modern waste reduction. It advances environmental sustainability by converting waste material into new objects and redirecting them into the economic system (Geissdoerfer et al., 2017). Several scholars have empirically demonstrated the contribution of recycling to sustainable development in diverse study contexts. For instance, Krauklis et al. (2021) considered events such as the banning of composite landfills in Germany, the decommissioning of composite wind turbines, and the increase in composites due to the mass production of cars to explore composite material recycling technology. They were buoyed by the desire to benefit society by providing guidelines for sustainable industrial development. They aimed to justify recycling by developing fiber-reinforced-material recycling. However, their study focused on end-of-life (EOL) waste, which may be addressed differently from solid waste, necessitating this study on solid waste in a developing nation. Research has shown that improper waste transportation and disposal in Hargeisa is directly correlated

with epidemics of malaria, cholera, and respiratory diseases (Omer, 2021). Sustainable development frameworks prioritize the “planet earth” ensuring that sanitation companies move towards controlled disposal to protect water bodies and air quality.

Cerqueira et al. (2021) assessed the interconnections between recycling, renewable energy, and sustainable development in OECD countries. They employed a panel data approach spanning 2000-2016. They determined that recycling and renewable energy facilitate a circular process that ensures self-sustained development while protecting the environment. Given that Somaliland is in the process of restructuring and rebuilding, a longitudinal waste management study may not have been feasible. Therefore, the ordinary least squares (OLS) model is the most suitable for investigating the benefits of recycling for sustainable development. This study employed the OLS regression approach to determine the nexus between green solid waste management and sustainable development among sanitation companies in Hargeisa.

Su et al. (2020) focused on construction and demolition waste to explore the potential of recycling to promote sustainable development in China. Using numerical simulation, they determined six stable evolutionary strategies that recognized recycled products from recycling plants as favorable options among contractors. However, they also determined that recycling plants depend on violation penalties, production costs, reputation benefits, product prices, and resource taxes. The presumption made by Su et al. (2020) presumed that recycling is not a cheap option. With this presumption, the viability of sanitation firms in Hargeisa for recycling waste for sustainable development comes under scrutiny.

Abdallah et al. (2021) built on the rising awareness of scrap management options due to the increasing use of glass fibres and carbon to explore the pyrolysis option. Considering that pyrolysis is a promising and realistic approach, they determined that pyrolysis, unlike gasifi-

cation, incineration, and mechanical separation, belongs to the total fiber recovery technology sensitive to climate change and circular economies. However, it remains unclear whether such technology can be employed to reconstruct cities such as Hargeisa. Therefore, this study probed the recycling practices employed and their impact on sustainable development in sanitary firms.

Lamba et al. (2021) took cognizance of the exponential rise in plastic production that has led to a surge in plastic waste to explore the recycling of plastic waste towards sustainable development. Using a review of the existing literature, they concluded that recycling could tackle the surge in plastic waste in the ecosystem. We contend that sanitary firms in Hargeisa can leverage recycling to tackle the surge in solid waste. This is more so, given that recycling has also been used to address construction and demolition waste (Alshyab, 2021), waste tires (Formela, 2021), and organic waste for a carbon smart circular economy (Awasthi et al., 2022).

Waste Reusing and Sustainable Development

Waste reuse refers to the action of minimizing the toxicity and quantity of materials before they enter the waste management stream. It involves changing the design, manufacturing, and consumption patterns to ensure that fewer resources are used and less waste is generated in the first place. (Tunn, V. S., et al. 2021)

The concept of adaptive reuse is featured substantially in the empirical literature. De Medici et al. (2019) explored cultural heritage as adaptive reuse by comparing two Italian case studies, the Basilica of St. Peter the Apostle and the Ancient Market in Siracusa. The results indicated that most participants reported an improvement in the state of buildings and urban spaces in the 20 years that the two adaptive reuse interventions had been in place. Although they were located in Ortigia, they differed in their impact.

Vardopoulos (2019) focused on the value-adding parameters of adaptive reuse projects. In

particular, this study identified the factors influencing the sustainable development and adaptive reuse of urban industrial buildings. The study determined that cultural heritage protection, alongside land conservation, involvement empowerment, and community action, were significant factors in adaptive reuse and sustainable development. However, by focusing on the adaptive reuse of industrial buildings, Vardopoulos (2019) did not indicate how reuse could be applied to managing solid waste and its subsequent impact on sustainable development. Wang et al. (2018) investigated the impact of waste reuse on municipal solid waste sustainability in China. Using the extended energy assessment method, they determined that the reuse of bottom ash enhanced the sustainability. With this finding, Wang et al. (2018) contributed to solutions for addressing solid waste. However, the Chinese context is more advanced than developing nations such as Somaliland, and what works in China is not guaranteed to work in Somaliland. Therefore, this study sought to examine whether reuse could be implemented in Hargeisa.

Wang et al. (2021) analyzed the effects of waste slag reuse on sustainability in the lead industry. They were motivated by the knowledge that processing lead-acid battery waste is a major contributor to environmental pollution due to the waste slag produced. They used an emergy-based approach and determined that, despite increasing disposal costs, waste slag reuse could improve sustainability through enhanced environmental performance in treating lead-acid batteries. It should be noted that lead-acid batteries are part of the solid waste in Hargeisa.

Waste Reducing and Sustainable Development

Waste reuse is the reusing of items for their own purpose but not changing them physically through industrial processing. Reuse is different from recycling (which splits materials into the components), because reuse retains the entity's "embodied energy" and structural integrity (Morsetto, 2023). Reframing the nexus between resource efficiency and the

3Rs as antecedents of planetary boundaries concerning sustainable development, Khajuria (2020) found direct evidence of the reduced impact of production patterns of resources and unsustainable consumption on sustainable resource management. This result emphasizes the significance of the role of reduction in the 3Rs in sustainable development, as Khajuria demonstrated. Ministry of Planning and National Development (2023) gives specific emphasizes urban resilience and green growth. World Bank (2024) reports indicate that public-private partnerships (PPPs) in Hargeisa's sanitation sector must pursue environmental goals to qualify for international capital and government support. Therefore, the intersection of sustainable development and green solid waste management demonstrates the strategic convergence between corporate purpose and national development priorities.

Thamagasorn and Pharino (2019) focused on food waste and examined the impact of waste reduction as a 3R component of sustainability. They were motivated by the understanding that providing food to airline passengers constituted an unsustainable consumption and production pattern that posed a serious sustainability issue. A case study of halal food producers established that total waste represented 40-50 percent of the total food waste. They recommended prioritizing the reduction of seafood waste, noting that reducing waste will significantly impact cost-saving potential.

Palmeira and Musso (2017) emphasized the reduction element of the 3Rs by analyzing the 3Rs of sustainability and consumer behavior. They used a multi-method study that targeted Europe and Brazil to show that recycling was often given priority at the expense of reduction and reuse, leading to a weaker impact on consumer behavior. They regretted that despite focusing on reducing packaging and carbon footprints, people were not conscious of approaches to preserve ecosystems.

Gorman (2020) used the Horseshoe crab context to explore the potential of the 3Rs in

sustainability. Building on in-depth interview findings regarding the increasing use of the 3Rs in sustainability, Gorman demonstrated, albeit not categorically, that the 3Rs are important drivers of change and allow the use of sustainable methods. Although there is a shortage of studies on the 3Rs, particularly the reduce component, focusing on Hargeisa, empirical evidence shows the utility of 'reduce' in sustainable development.

Theoretical Framework: Circular Economy Theory (CET)

The economic paradigm underpinning this research is the Circular Economy Theory, which provides a pathway for restorative and regenerative alternatives to the linear economic model of linear disposal ("take-make-dispose"). As noted by Geissdoerfer et al. (2017), CET is a system that seeks to minimize resource input, waste, emissions, and energy leakage by slowing down, closing, and narrowing material and energy loops; it provides low-cost efficiency.

The 3Rs in the Hierarchy of Circularity of Waste

In CET, the movement toward environmental sustainability takes three forms in their operation: recycling, reduction, and reuse. This hierarchy does not just show a listing of alternative strategies but also a prioritized resource allocation strategy:

- i. Reduce (inner loop): This is the most virtuous circle. It is about "narrowing" the loop by looking into waste at the source. This is, in relation to sanitation companies, about unsustainable consumption, so materials are less packaging heavy.
- ii. Reuse (The Middle Loop): CET asserts that reuse is much more sustainable than recycling because reuse is not an energy-burdening process of disintegrating a product and preserving its value. It is about "slowing" the loop by extending the life cycle of such goods.
- iii. Recycle (the outer loop): To close the loop, recycling is imperative; however,

recycling is seen as a final line of business as it requires the necessary energy to convert waste into other useful materials.

CET and Sustainable Development.

For emerging economies' sanitation companies in Hargeisa, CET opens up an avenue for sustainable development by cutting off the chain between economic development and resource use. Circular initiatives may help firms reduce operating costs (through waste minimization), create additional sources of income (by utilizing recycled materials), and avoid environmental degradation (Kirchherr et al., 2017). CET is often used in local markets but can be successfully adapted to local infrastructure and technological innovations. Although theoretical models, such as the Butterfly Diagram, claim that Reuse is better than Recycling, their application in emerging urban centres may suggest that organized recycling systems are much more cost-effective than informal re-use practices.

Methodology

This study leaned towards the post-positivist research philosophy that advocates for quantitative methods. The research design was descriptive-correlational relationships between green practices and sustainability in sanitation companies. The study targeted employees of sanitation companies working in street cleaning, waste collection, and disposal. These employees were better positioned to answer the questionnaire items. The employees included managers, technical supervisors, and heads of operations of every registered formal and semi-formal sanitation company operating in Hargeisa city. The inclusion criteria were applied to companies involved in the collection, transportation, and/or disposal of solid waste. They provided insider perspectives on GSWM practices, challenges, and internal outcomes. These sections play a significant role in solid waste management and may contribute to environmental pollution, making them ideal for this study. A reconnaissance study in the city revealed five sanitation companies with a total of 506 employees in the targeted sections.

Stratified and simple random approaches were used to sample 218 employees proportionately from the three sections using the Krejcie and Morgan table. An employee questionnaire containing five sections was used: waste collection practices, for example, type of waste handled and collection method; waste segregation, for example, organic, recyclable, hazardous, and medical waste; transportation, for example, vehicle suitability, loading and unloading practices; treatment and disposal practices, for example, composting practices, landfills, waste recovery; environmental protection and hygiene, for example, cleaning equipment and prevention of pollution. The sections were appropriate for collecting data because of their known versatility, flexibility, and cost-effectiveness (Boparai et al., 2018).

This study utilized a quantitative research method to test the hypothesized link between green solid waste management (GSWM) practices and sustainable development outcomes at sanitation companies in Hargeisa. A quantitative approach was considered to be the most suitable for three main reasons. First, validated multi-item scales enable the measurement of latent constructs and can measure the extent of the expected change, such as organizational commitment to GSWM, perceived institutional pressures, and multi-dimensional sustainable development benefits (economic, social, and environmental). Second, it allows for generalizations to be made from a representative sample of enterprises and stakeholders to provide a fairly broad map of the nexus across these companies and urban areas of the city's sanitation sector (a fundamental tool to inform policy). Third, the approach allows for advanced multivariate statistics, especially Covariance-Based Structural Equation Modeling (CB-SEM), to be conducted to assess a complicated theoretical model with simultaneous analysis of multiple dependent and independent variables, which controls for measurement error. Because the study is designed to examine the GSWM-sustainable development nexus and test and validate this theoretical model, a quantitative approach

is necessary to bring the rigor and objectivity inherent in hypothesis testing.

Data Analysis

Data were analyzed using the Analysis of Moment Structures (AMOS) software. The analysis was based on covariance-based structural equation modeling (CB-SEM). The latent variables were reflective and were deemed to cause their respective indicators. The measurement and structural models were validated for confirmatory one-dimensionality, convergent validity, discriminant validity and model fit. Analysis of Moment Structures (AMOS) software for Covariance-Based Structural Equation Modeling (CB-SEM) was meticulously justified because the central hypothesized nexus includes a number of latent constructs, for example, Green Processing, Stakeholder Engagement, Economic Sustainability, and Environmental Sustainability) that cannot be measured directly but are inferred from different observed (indicator) survey items. AMOS, based on CB-SEM, is explicitly designed to manage such complexity, allowing for the simultaneous estimation of the measurement model to assess how well the observed variables load onto their respective latent constructs (confirmatory factor analysis) to ensure construct validity and reliability. It also tests all hypothesized causal relationships between the latent constructs simultaneously to provide a holistic picture of the nexus.

Content validity was established using an expert review panel, and face validity was verified through a pilot study conducted in Hargeisa. Reliability was measured using Cronbach's alpha, with all constructs exceeding the recommended threshold of 0.70 (Cohen et al., 2018). Moreover, considering the local context, a back-translation method (English-Somali-English) was used (Omer, 2021) to maintain the conceptual integrity of the research instruments.

The study adhered to established ethical standards, including informed consent, confidentiality, and responsible data management. Ethical sensitivity was maintained throughout the research process to ensure the rights and welfare of the participants and the integrity of the research findings.

Research Results

The descriptive analysis of the study variables revealed that sanitation firms in Hargeisa City were committed to green practices in waste management, achieving the desired effects on the sustainable development of the companies. For instance, companies were committed to recycling waste, as demonstrated by their agreements and strong agreements with the three activities that the companies encourage (Table 1). Similar results were reported for reusing and reducing. The descriptives also yielded higher proportions of agreements and strong agreements with efforts towards sustainable development.

Table 1: *The distribution of practices in sanitation companies in Hargeisa*

	Strongly Disagree	Disagree	Moderately Agree	Agree	Strongly Agree
Waste Recycling					
1. Collecting and processing waste	2.1%	5.2%	12.0%	48.7%	31.9%
2. Manufacturing with recyclable content	1.6%	7.9%	16.8%	45.5%	28.3%
3. Purchasing recycled products	0.5%	1.6%	13.6%	46.6%	37.7%
Waste Reusing					
1. Use of reusable bags	0.5%	4.7%	30.4%	38.2%	26.2%
2. Reuse of home items	0.0%	2.6%	28.3%	45.5%	23.6%
Waste Reducing					
1. Prioritizing needs	0.0%	1.6%	27.2%	42.9%	28.3%
2. Bulk purchases	0.0%	4.2%	24.1%	39.3%	32.5%
3. Minimizing packaging	1.6%	8.4%	24.6%	39.8%	25.7%
Sustainability					
1. Disaster risk reduction	0.5%	0.5%	17.8%	49.2%	31.9%
3.Sustainable management	0.5%	3.7%	17.3%	45.5%	33.0%

The distribution of practices in sanitation companies in Hargeisa is presented in Table 1 using frequencies and percentages. Since Likert-scale data are ordinal, frequency reporting eliminates the potential bias of mean scores and indicates the level of consensus in green waste practices. This approach is also generally utilized in waste management analysis (Omer, 2021) and is aligned with current methods for study outcome analysis, establishing descriptive baselines as an adequate prerequisite for inferential analyses. The respondents in Table 1 all had a strong awareness of and involvement in “Green” behavior.

- **Waste Recycling:** This dimension also had the best positive response to “collecting and processing waste” (strongly agreed by more than 80% of the respondents). Hargeisa seems to have a recycling system as its main source of waste management.
- **Waste Reducing:** There was a marked >70% agreement with “minimizing packaging” and “bulk purchases,” indicating that prevention measures are being included in the hierarchy of waste management.

- **Reuse of Waste:** Recycling was less effective as home products were re-used less (approx. 64%) than when recycled. This is a sign that recycling is official, but reuse is more personal or informal.
- **Sustainability:** Given the high agreement in the areas of “sustainable management” (78.5%) and “disaster risk reduction” (71.1%), there seems to be a higher-level correlation between waste management and environmental resilience.

The sample correlations in Table 2 between the construct indicators confirm that there was no issue of multicollinearity in the exogenous latent variables. All the correlation coefficients were below 0.7.

Table 2: Sample Correlations (Group number 1)

	DRR	SPC	BP	MP	PN	OTR	DP	M	PRP	CP
DRR	1.000									
SPC	.682	1.000								
BP	.370	.331	1.000							
MP	.382	.336	.524	1.000						
PN	.426	.459	.490	.325	1.000					
OTR	.258	.357	.263	.154	.320	1.000				
DP	.263	.308	.297	.360	.277	.403	1.000			
M	.305	.320	.174	.380	.265	.241	.228	1.000		
PRP	.504	.440	.408	.378	.346	.245	.338	.479	1.000	
CP	.349	.348	.254	.403	.372	.240	.319	.553	.448	1.000

Condition number = 14.385

Eigen values

4.220 1.074 .965 .927 .693 .568 .536 .411 .313 .293

Confirmatory unidimensionality was confirmed using factor loadings above 0.5. Similarly, convergent validity was justified by an average variance extracted (AVE) above

0.5, and standard loadings greater than 0.6. The final structural model presented in Figure 1 was validated by default fit indices higher than the recommended ones (Table 3)

Figure 1: Structural Model

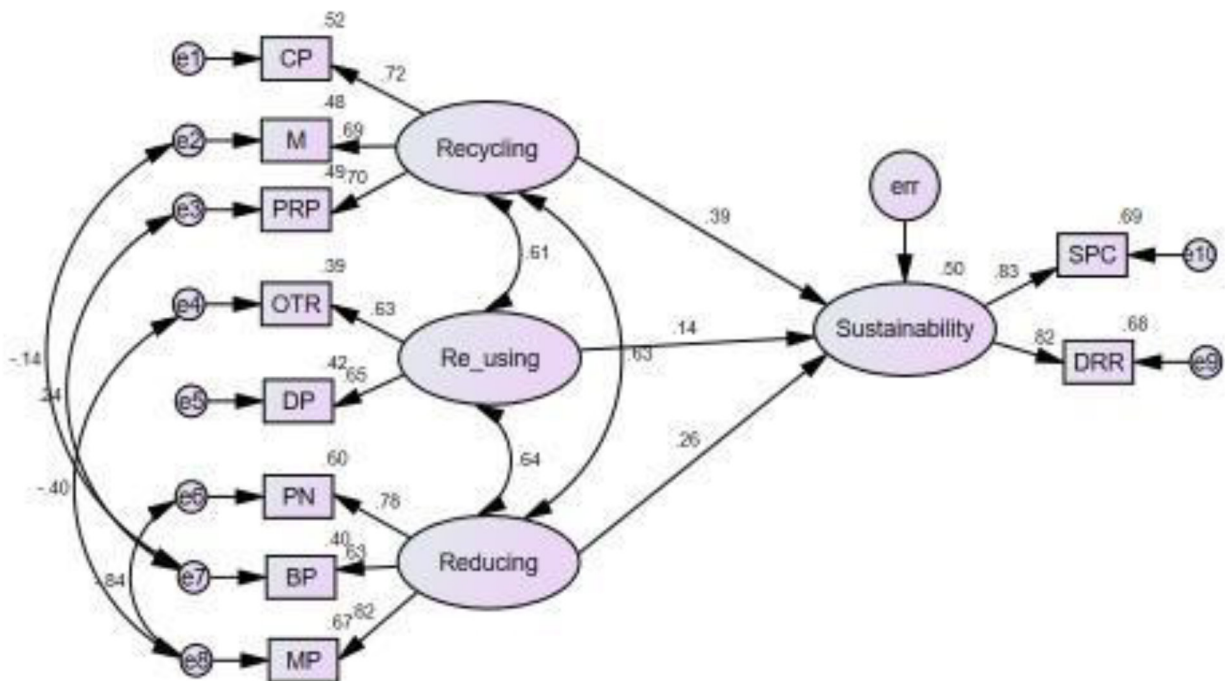


Table 3: Model Validation

Fit indices	Recommended value	Test value
χ^2/df	>5.0	1.376
GFI	>.90	0.966
AGFI	>.90	.0925
NFI	>.90	0.947
RFI	>.90	0.905
IFI	>.90	0.985
CFI	>.90	0.985
TLI	>.90	0.972
RMSEA	<.05	0.44

According to the results in Table 3, before testing the hypotheses, the structural model’s integrity was verified using several fit indices.

- The χ^2/df (CMIN/DF) value of 1.376 is well below the threshold of 3.0, indicating an excellent fit.
- The CFI (.985), GFI (.966), and TLI (.972) values were all significantly above the recommended 0.90 threshold, suggesting that the model accurately represented the observed data.
- The RMSEA value of 0.044 is below the 0.08 limit, indicating a low residual error.
- These indices collectively confirm that the proposed model is robust and provides a statistically sound basis for testing the nexus between waste management and sustainability.

Table 4: Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Sustainability	<---	Recycling	.413	.135	3.061	.002	significant
Sustainability	<---	Reducing	.300	.147	2.038	.042	significant
Sustainability	<---	Reusing	.180	.185	.975	.329	Not significant

Table 4 presents the path coefficients and significance levels for the impact of the “3Rs” on sustainability.

1. Recycling leading to sustainability ($\beta = .413, p = .002$): Recycling emerged as the strongest and most significant predictor of sustainable development. For every unit increase in recycling efforts, sustainability increases by 0.413 units. This confirms that for sanitation companies in Hargeisa, investing in the recycling process is the most effective path to achieving long-term environmental goals.
2. Reducing leading to sustainability ($\beta = .300, p = .042$): Waste reduction also has a statistically significant positive impact. This highlights that reducing waste at the source (e.g., through better packaging or bulk purchasing) is a viable strategy for enhancing the sustainability of the city’s waste management system.
3. Reusing leading to Sustainability ($\beta = .180, p = .329$): Surprisingly, the path from Reusing to Sustainability was not statistically significant. This suggests

that while respondents personally agree with reusing items (as shown in Table 1), these activities currently lack the scale or formal integration within Hargeisa's sanitation companies to significantly move the pointer on institutional sustainability.

Discussions

The study revealed that the nexus between green solid waste management and the sustainable development of sanitation companies in Hargeisa was causal, involving recycling, reusing, and reducing waste. The study provides evidence that the links between the sustainable development of sanitation companies and green solid waste management in Hargeisa are direct, including recycling, reusing, and reducing waste. From the perspective of Circular Economy theory, these results offer a complex account of how closed-loop systems work in developing cities. CET posits that resources should be maintained for as long as possible, extracting the maximum value before recovery and regeneration (Geissdoerfer et al., 2017). The ultimate impact of recycling and reducing aligns perfectly with CET's "tightening the loop" and "designing out waste." By prioritizing needs and bulk purchases (Reduction) while returning goods to the economic system (Recycling), sanitation companies in Hargeisa have practically implemented the restorative elements of CET. Surprisingly, reusing was an insignificant predictor ($\beta = .180$, $p = .329$), which was unexpected for two reasons: the perception–practice gap, as shown in Table 1, which indicates that most respondents believed that reusing home items and bags is significant. However, our results contradict this theoretical hierarchy, indicating that recycling (the outer loop) is significantly more effective in Hargeisa. This suggests that recycling is more institutionalized and profitable in Somaliland's current economy, whereas reuse appears to be an informal, low-impact practice that has yet to gain formal traction as a part of public sanitation firm sustainability metrics.

The results show that recycling positively and significantly impacts sustainable development, reflecting the recognition of recycling as a modern waste management practice that redirects materials into the economic system (Geissdoerfer et al., 2017). Indeed, research shows that recycling facilitates a circular economy that relies on self-sustained development (Cerqueira et al., 2021). Although recycling technologies such as pyrolysis (Abdallah et al., 2021) can be expensive, water collection and processing, manufacturing materials with recyclable content, and purchasing recycled products, as determined in this study, offer viable and cheaper options for recycling.

This study determined that reducing waste and unsustainable consumption had a positive and significant effect on the sustainability of sanitation firms in Hargeisa. This finding underscores the need, as noted by other scholars, to adopt sustainable consumption and production patterns (Khajuria, 2020; Thamagasorn & Pharino, 2019). Reduction is often overlooked in favor of recycling. Therefore, this finding demonstrates that sanitation companies in Hargeisa recognize the need to reduce waste by emphasizing prioritization when purchasing, reducing the number of packaged goods, and making bulk purchases. Thus, the emerging focus on reducing packaging and the city's carbon footprint is feasible (Palmeira & Musso, 2017).

The finding that reusing was not a significant predictor of sustainability in sanitation companies in Hargeisa was rather surprising but confirmed the interest in recycling at the expense of the other two practices. Moreover, given that the practice of reusing requires that an object be used without treatment (Pagliaro & Meneguzzo, 2019), perhaps most of the solid waste in the city cannot be reused. Evidence shows that materials such as paper cups, cartons, toothpaste tubes, and fiberglass are difficult to reuse, whereas plastic and glass are inherently hard to recycle (Bridgens et al., 2018). Moreover, industrial acids such as formic, oxalic, and hydrochloric acids are challenging to reuse (Keskinen et al., 2018).

This finding is surprising because materials commonly perceived as recyclable or usable, such as packaging that uses paper, glass, and plastic, have been shown to exhibit significant challenges when it comes to recycling and reuse. Therefore, this contradicts the prevailing sustainability assumptions and policy briefs.

Conclusion and Recommendations

The study concludes that sanitation companies in Hargeisa City can significantly improve their sustainable development by fully embracing the Circular Economy Theory. Although 3R practices are currently in use, their impact is lopsided. Currently, recycling and reducing are the primary engines of sustainability, whereas reusing remains a peripheral activity. Sanitation companies in Hargeisa City can improve their waste management by recognizing the potential inherent in green solid waste management. Leveraging the 3R practices of waste recycling, waste reduction, and waste reusing is likely to enhance sustainable development in these companies. Although waste reuse had a non-significant effect on sustainable development, its importance cannot be ignored, especially when the local government in Hargeisa limits expenditure to meet budgetary requirements. From a practical perspective, green practices allow garbage collection companies to redeem themselves from accusations of dumping waste in the suburbs and choose to recycle, reduce, and reuse waste.

Meanwhile, with the lack of a comprehensive waste management system emerging among the challenges experienced in urban centers in Somaliland, City governments, which have been the focus of criticism for their inability to regulate waste management, have a framework upon which to base policy formulation that can entrench the ideals of recycling, reducing, and reusing waste among households in the Cities in Somaliland.

Recommendations

1. Prioritize practical actions that strengthen the 'bottom-up,' people-centered aspects

of solid waste management as opposed to the 'top down' approach that often focuses on (large scale) infrastructure.

2. A clear pathway targeting communication campaigns should be developed to ensure easy access to information that encourages reuse, reduces consumption, and recycling, aimed at minimizing waste generation in cities.
3. Implementation of policies that are geared towards green waste management practices. This is critical for reducing the quantity of solid materials that enter the waste stream.
4. Future studies should broaden the scope to include households, as they contribute significantly to waste generation and should be sensitive to green waste management practices.

Limitations of the Study

Despite the insights provided, this study focused exclusively on Hargeisa, Somaliland. While it provides insights for developing urban cities, the findings may not be fully generalizable to more industrialized and urbanized regions or rural areas with different waste compositions.

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Conflicts of Interest

None

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