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Assessing how local regulatory frameworks and economic incentives, along with firm characteristics, staff training, and cultural factors, influence waste management practices among SMEs in the Volta and Oti regions.

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Abstract

This study investigates the impact of local regulatory frameworks, economic incentives, firm characteristics, staff training, and cultural factors on waste management practices among small and medium-sized enterprises (SMEs) in Ghana's Volta and Oti regions. Using a quantitative research design, data were collected from 219 respondents through structured surveys and analysed using descriptive statistics, MANOVA, and regression analysis. Findings reveal significant regional disparities, with SMEs in the Volta Region outperforming those in the Oti Region in key areas, such as waste segregation, employee training, and digital tool adoption.

Waste minimisation strategies, particularly prefabrication (β = 0.494), digital tools (β = 0.424), and material reuse (β = 0.212), were strongly correlated with perceived effectiveness. Regulatory frameworks (β = 0.255) and economic incentives (β = 0.150) significantly enhanced waste management, though firm characteristics (β = 0.269) emerged as the strongest predictor. Challenges included high costs, limited recycling infrastructure, and skill gaps.

The study recommends strengthening regulatory enforcement, providing targeted financial incentives, investing in employee training, and promoting the adoption of technology to improve waste management practices. These measures can support sustainable construction practices, reduce environmental impact, and align with Ghana's broader sustainability goals. The findings contribute to the discourse on waste management in resource-constrained settings, offering actionable insights for policymakers and industry stakeholders.

Keywords: *Waste management, SMEs, regulatory frameworks, economic incentives, Ghana, construction sector, sustainability.*

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1.0 INTRODUCTION

The adoption of effective waste minimization strategies in construction has garnered significant attention due to the industry's considerable environmental impact. Researchers

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worldwide have examined various methods to reduce waste generation in construction projects, revealing both successful techniques and common barriers. This review explores recent studies on waste minimization strategies, highlighting findings on design-phase interventions, regulatory support, and on-site practices. By comparing perspectives across different geographic and operational contexts, the review identifies key gaps in the literature, aligning these with the research objectives of the present study and setting a foundation for the study's hypothesis.

Tafesse (2021) provides an overview of material waste minimization techniques in Ethiopian construction, identifying strategies like appointing waste management officers and adopting prefabrication. This study's findings align with Hasmori et al. (2020), who focus on on-site waste minimization in construction, noting that efficient handling and resource planning significantly impact waste reduction. Both studies underscore proactive management but differ in scope: while Tafesse emphasizes managerial roles, Hasmori et al. highlight the need for efficient on-site processes. Together, these findings suggest that a combined strategy encompassing both managerial oversight and operational planning may yield the most effective waste minimization outcomes, a hypothesis that this study aims to test in Ghana's construction sector.

Shifting the focus from managerial approaches to design-phase interventions, recent studies underscore the critical role of early-stage planning in achieving meaningful waste reduction in construction projects. Olanrewaju and Ogunmakinde (2020) investigate strategies that can be embedded at the design stage to minimize waste generation, identifying modular coordination and design flexibility as instrumental techniques. Their findings emphasise the proactive role of designers in embedding waste minimisation into the architectural and structural framework of construction projects. Complementing this perspective, Laovisutthichai, Lu, and Bao (2020) propose the Design for Construction Waste Minimization (DfCWM) framework, which broadens the scope of responsibility by incorporating multiple stakeholders—from clients and contractors to regulators—into the design process. While Olanrewaju and Ogunmakinde primarily center their analysis on the technical responsibilities of designers, Laovisutthichai et al. highlight the systemic value of collaborative engagement across the project lifecycle. Collectively, these studies underscore the necessity of integrated, multi-stakeholder involvement to maximize the effectiveness of design-phase waste reduction. This is especially relevant to the present study's aim of identifying sustainable waste minimization strategies that are inclusive of the various actors involved in SME-led construction projects in Ghana.

From a regulatory perspective, Doust et al. (2020) argue that front-end waste minimization in Australia requires policy support to regulate practices like material logistics. Their findings align with Kabirifar et al. (2020), who focus on the effectiveness of reduce, reuse, and recycle strategies and recommend increased regulatory pressure to improve construction waste management globally. Both studies suggest that regulatory frameworks are essential for effective waste minimization, but Doust et al. (2020) focus on front-end logistics, whereas Kabirifar et al. (2020) address waste management at all project stages. This contrast highlights a gap in understanding how front-end regulatory support impacts waste minimization outcomes throughout the project lifecycle, a gap this study will address by examining Ghana's regulatory landscape and its influence on construction waste management.

Studies focused on green building practices further add insights into waste minimization. Chi et al. (2020) examine waste minimization practices in LEED-certified projects in the US and China, showing how green certification systems incentivize waste reduction. Similarly, Botchway et al. (2023) identify competencies, such as awareness and management skills, that drive waste reduction in building projects. Although both studies recognize the benefits of green standards, Chi et al. (2020) emphasize certification systems, while Botchway et al. (2023) focus on internal competencies. This divergence highlights a potential synergy between external green standards and internal capacities that may enhance waste minimization, suggesting that a dual approach could be particularly effective.

However, gaps remain in the literature. Most studies emphasize isolated aspects of waste management, such as regulatory support, design-stage interventions, or on-site practices, without integrating these into a holistic waste minimization framework. Additionally, studies like those by Kabirifar et al. (2020) and Wang et al. (2019) address the effectiveness of design units' roles but lack insights into the operational challenges that SMEs face in resource-limited environments. Thus, while these studies demonstrate the potential of waste minimization

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strategies, they often overlook the unique constraints faced by construction SMEs, particularly in developing regions like Ghana.

While existing literature provides insights into various strategies for construction waste minimization, a comprehensive analysis integrating design, regulatory, and on-site strategies is lacking. The current study aims to fill this gap by examining waste management practices in Ghana's construction SMEs, focusing on regulatory frameworks, multi-stage waste reduction approaches, and stakeholder involvement.

Based on the findings and gaps identified in the literature, this study hypothesizes that a combined strategy integrating regulatory support, design-phase planning, and on-site management practices will enhance the effectiveness of waste minimization in Ghana's construction SMEs. This hypothesis will guide the empirical investigation, providing a foundation for developing a sustainable waste management framework tailored to SMEs in resource-constrained settings.

2.0 LITERATURE REVIEW

Local regulatory frameworks and economic incentives are recognized as pivotal mechanisms for promoting effective waste management practices (Daskal, Ayalon and Shechter, 2029). This review examines recent studies on the role of local regulations and economic incentives in shaping waste management practices, identifies gaps in the literature. Daskal, Ayalon, and Shechter (2019) underscore the critical role of regulation in municipal waste management, particularly in Israel, where regulatory frameworks aim to reduce landfill dependency and increase recycling rates. They highlight the importance of consistent monitoring and evaluation of regulatory impact to ensure the achievement of environmental goals. Similarly, Kubanza and Simatele (2020) explore the failure of regulatory frameworks in Johannesburg, South Africa, attributing ineffective waste management practices to institutional weaknesses and insufficient enforcement. These perspectives collectively emphasize the need for robust and enforceable regulations, yet they reveal differing outcomes based on institutional capacity and regional socio-economic conditions.

In contrast, Rogoff and Screve (2019) discuss how regulatory frameworks in the United States incorporate economic instruments, such as waste flow control, to enhance compliance. Their findings suggest that combining regulatory enforcement with economic incentives creates a synergistic effect, enhancing adherence to waste management protocols. These studies highlight the variability in regulatory effectiveness, suggesting that the success of regulations is contingent upon their design, enforcement, and integration with economic measures.

The role of economic incentives is highlighted in numerous studies. Mak et al. (2019) argue that economic incentives, such as increased waste disposal fees, can significantly encourage recycling behaviors, particularly in the construction industry in Hong Kong. They also emphasize the complementary role of regulatory compliance, demonstrating how financial and legislative tools work in tandem to influence waste management practices. Similarly, Han et al. (2023) investigate household waste classification in rural China, finding that economic and reputational incentives significantly enhance participation rates. Their study provides a behavioral perspective, suggesting that economic incentives must be tailored to local socio-economic contexts to achieve optimal results.

In contrast, Valach and Cifranič (2024) analyze the financial impacts of waste management policies on municipal budgets in Slovakia. They highlight the challenges of aligning municipal expenditures with European Union regulations, particularly in regions with limited financial resources. This perspective demonstrates that while economic incentives are effective, they can place a financial strain on municipalities, requiring careful calibration of policy interventions. Nzima (2022) provides insights into the construction sector in Gqeberha, South Africa, highlighting how a lack of government legislation and recycling infrastructure has resulted in a heavy reliance on landfilling. This finding resonates with Daskal et al. (2019), who identify similar gaps in Israel. Both studies emphasize the need for integrated approaches that combine regulatory enforcement with infrastructure development. Rahmawati et al. (2024) echo this sentiment in their analysis of manufacturing waste policies in Indonesia, suggesting that inconsistent enforcement and technological limitations hinder the full realization of policy objectives.

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A contrasting view is offered by Aiguobarueghian et al. (2024), who explore the integration of circular economy principles into waste management practices. They argue that economic incentives can drive innovation and create secondary markets for recycled materials, highlighting the potential for economic benefits to complement environmental objectives. However, they also caution that without robust regulatory frameworks, economic incentives alone may fail to achieve sustainable outcomes.

The influence of socio-cultural factors is another recurring theme. Han et al. (2023) and Mak et al. (2019) both emphasize the importance of tailoring economic incentives to local contexts, yet they approach this from different perspectives in rural households versus urban industries. Similarly, Kubanza and Simatele (2020) and Nzima (2022) highlight the disparities in waste management practices between developing and developed regions, attributing these to differences in regulatory capacity and public awareness. These studies collectively underscore the need for localized approaches that consider regional socio-economic and cultural nuances.

The current literature highlights significant progress in understanding the roles of regulations and economic incentives in waste management but reveals persistent gaps. While many studies emphasize regulatory frameworks, few explore the comprehensive interplay between regulations, economic incentives, and stakeholder collaboration. Additionally, socio-cultural dimensions of waste management, particularly in developing regions, remain underexplored, and there is limited empirical evidence on integrating financial and regulatory tools to optimize practices across sectors and regions. This study seeks to fill these gaps by examining the combined influence of local regulatory frameworks and economic incentives on waste management practices in Ghana's construction sector, offering actionable insights into tailoring these tools to regional contexts for enhanced sustainability.

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This section outlines the methodology adopted to achieve the research objectives, providing a detailed framework for data collection, analysis, and interpretation. It begins by discussing the research philosophy guiding the study, followed by an explanation of the design and rationale for the chosen approach. The chapter describes the study area, target population, sampling techniques, data collection methods, and analytical tools used to address the objectives systematically. It also highlights measures taken to ensure reliability, validity, and ethical compliance throughout the research process.

3.2 Research Philosophy

Research philosophy encompasses a set of beliefs and assumptions on how knowledge is constructed and understood operationalized in a piece of research. Research philosophy establishes a direct impact on research design and data collection and analysis. Research philosophy in social sciences is often simplified into four major research philosophies: positivism, interpretivism, realism, and pragmatism (Saunders, Lewis, & Thornhill, 2019). Positivism is an objective stance from which the researcher assumes there is a reality that is independent of the researcher and the researcher can observe and measure reality. Positivist researchers seek to test hypothesis and validate that a particular result can be generalized to the whole (a law of nature). Positivist researcher maintains a neutral stance and/or value free disposition, which is why scientific or quantitative methods are utilized. Positivist researchers employ structure experimental, survey and statistical analysis methods (Creswell, 2014). Positivism is best suited to research that supports a Baseline in quantifying variables and establishing cause and effect relationships.

Interpretivism posits that reality is socially constructed, which is subjective. The understander interprets their environment and behaviours in accordance with their experiences and social constructs. The function of an interpretivist researcher is to understand the phenomena from the perspectives of the participants, and not in a search for universal truths (Bryman, 2016). Interpretivist researcher generally utilize qualitative methods of research such as; interviews, focus groups, and case studies to provide a rich, deep understanding of the complex social phenomena of human beings.

Realism takes the same position as Positivism assumes a reality, may be an objective reality. But realism acknowledges that our understanding of reality is mediated through our

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experiences and social constructions. Realism may be divided further into the following two divisions; direct realism assumes we can observe reality directly, and critical realism posits that what we observe is only a part of the 'deeper reality' shaped by unobservable structures (Bhaskar, 2008). Realist research may use qualitative or quantitative methods to document observable patterns as well as the intricacies behind those observable patterns.

Pragmatism adopts a practical 'outcomes' perspective and focuses on the usefulness of research to solve real-world problems. Pragmatism discards the binary application of positivism and interpretivism and instead embraces the use of mixed methods to answer their research problem effectively in different contexts (Tashakkori & Teddlie, 2010). Pragmatism researchers select the methods that best assist in answering the research questions based on flexibility, utility, or problem solving.

This study adopts positivism as its guiding philosophical paradigm. Positivism emphasizes objective, empirical observation and measurement, making it well-suited for research that relies on quantitative data collection and statistical analysis (Creswell, 2014). Positivism aligns with the study's objectives by focusing on the collection of objective data that can be statistically analyzed to identify trends, relationships, and patterns in waste management practices. This approach supports the study's emphasis on assessing the effectiveness of waste minimization strategies and the influence of regulatory and economic factors, providing evidence-based insights (Bryman, 2016). Positivism allows for the use of structured surveys and statistical models to test hypotheses and draw conclusions that are reliable, replicable, and unbiased (Saunders et al., 2019).

The positivist paradigm informs the use of quantitative data collection through structured surveys, distributed to SME managers, site supervisors, and other key stakeholders. This enables the gathering of numerical data on waste management practices, challenges, and the impact of regulatory frameworks and economic incentives. The study employs statistical techniques such as descriptive and inferential analysis to test hypotheses and identify significant relationships (Neuman, 2014). By adhering to the principles of positivism, the study focuses on producing objective, verifiable results that can be used to inform evidence-based decision-making in waste management among construction SMEs in Ghana.

3.3 Research Design

This study employs a descriptive quantitative research design to investigate waste management practices, focusing on systematically collecting and analyzing numerical data. This design is tailored to describe the current state of waste management practices, evaluate the effectiveness of waste minimization strategies, and examine the influence of regulatory frameworks and economic incentives on SMEs (Creswell, 2014). Structured surveys are utilized to gather data, quantifying trends, patterns, and relationships among variables, offering a detailed understanding of the research problem. Statistical methods, including descriptive and inferential analyses, are applied to summarize findings and test relationships, ensuring empirical validation (Saunders et al., 2019).

The descriptive quantitative design is highly effective for capturing detailed information about practices and challenges while enabling generalization across the target population (Neuman, 2014). It allows for a comprehensive evaluation of specific strategies and external influences, such as regulatory and economic factors. By emphasizing statistical rigor, this approach ensures objective, replicable findings, making it suitable for addressing the study's objectives and providing actionable insights to inform policy and practice in waste management (Bryman, 2016). Studies such as Ogunmakinde, Sher, and Maund (2019) in Nigeria and Mensah et al. (2023) in Ghana have successfully applied similar designs to assess waste management practices, demonstrating their relevance and effectiveness in construction contexts.

Thus, the descriptive quantitative design provides a robust framework for achieving the study's objectives, enabling reliable, evidence-based conclusions to improve waste management practices among construction SMEs in Ghana.

3.4 Study Area

The Volta and Oti regions are located in the eastern part of Ghana, sharing boundaries with Togo to the east and other Ghanaian regions such as Greater Accra and Eastern to the west. The Volta Region, known for its rich natural resources and diverse cultural heritage, has a

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population of approximately 2.1 million, while the Oti Region, carved out of Volta in 2018, has a population of around 740,000 (Ghana Statistical Service, 2021). Both regions have predominantly agrarian economies, but construction activities have been increasing due to rapid urbanization and infrastructure development. Geographically, the regions encompass a mix of urban, peri-urban, and rural areas, creating unique challenges for waste management.

The urban areas, including Ho (Volta's capital) and Dambai (Oti's capital), are growing hubs for economic activities, including small and medium-sized construction enterprises (SMEs). The peri-urban and rural areas, on the other hand, are characterized by limited infrastructure and lower population densities, which pose additional constraints on waste management practices (Amuna et al., 2021). The diverse socio-economic profiles of these regions make them an ideal context for studying waste management practices, especially among SMEs operating with resource constraints.

The construction sector is one of the fastest-growing industries in the Volta and Oti regions, driven by increasing demand for residential, commercial, and public infrastructure. SMEs dominate this sector, accounting for a significant proportion of construction activities. However, these enterprises often face challenges related to resource availability, technical expertise, and waste management practices, which contribute to environmental pollution and inefficiencies in resource use (Mensah et al., 2023). Construction waste, including debris, unused materials, and packaging, is a major concern in urban areas of these regions, as improper disposal methods such as open dumping and burning are commonly practiced due to limited recycling infrastructure and enforcement of waste management regulations (Odonkor et al., 2020).

The Volta and Oti regions' demographic and economic characteristics exacerbate these challenges. Rapid urbanization increases the demand for construction, leading to higher volumes of waste generation. At the same time, the lack of public awareness, inadequate waste collection systems, and financial constraints hinder the adoption of sustainable practices by SMEs (Frempong-Jnr et al., 2022). This context underscores the importance of targeted interventions, such as enhanced regulatory frameworks and economic incentives, to improve waste management practices in the construction sector.

Research focusing on these regions is particularly relevant given their alignment with national sustainability goals and global efforts to reduce construction waste. The findings from this study have the potential to inform policy and practice not only in the Volta and Oti regions but also in other regions with similar socio-economic profiles. By identifying the specific challenges and opportunities in these regions, the study aims to contribute to the development of sustainable waste management practices that can benefit SMEs, enhance environmental protection, and support economic growth (Ajayi & Oyedele, 2018).

3.5 Target Population

The target population includes 485 key respondents in the construction sector across all districts in the Volta and Oti regions of Ghana, comprising 304 from the Volta Region and 181 from the Oti Region. This group includes SME managers, site supervisors, and waste management personnel actively involved in implementing and overseeing waste management practices. These stakeholders provide valuable insights into current practices, challenges, and opportunities in waste handling, making them essential for achieving the study's objectives (Mensah et al., 2023). The population reflects the diversity of SMEs operating in these regions, capturing variations in firm size and specialization. Urban centers such as Ho in Volta and Dambai in Oti host larger SMEs with more complex projects, while peri-urban and rural areas are characterized by smaller firms with distinct operational challenges. This distribution highlights differences in waste management practices and constraints across contexts, ensuring a holistic understanding of the sector's dynamics (Frempong-Jnr et al., 2022). The inclusion of diverse firms enhances the study's capacity to generalize findings across the regions (Ghana Statistical Service, 2021).

This population is critical to fostering sustainable construction practices, as SMEs represent a major source of construction waste and their adoption of waste minimization strategies is essential for reducing environmental impact. Managers and site supervisors provide strategic insights, while waste management personnel contribute practical perspectives on resource and compliance challenges (Ajayi & Oyedele, 2018; Ogunmakinde et al., 2019).

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Engaging this representative sample ensures robust and actionable findings to inform waste management improvements across the Volta and Oti regions (Amuna et al., 2021; Mensah et al., 2023).

3.6 Sampling Techniques and Sample Size

Determining the sample size is a critical step in ensuring that the study produces statistically reliable and valid findings. This study calculates the sample size using Yamane's (1967) formula, which is widely used for finite population sampling due to its simplicity and accuracy. The formula is expressed as:

$$n_0 = \frac{N}{1+Ne^2}.$$

Where n = Sample size, N = Population size (485 employees in the Sustainability Department), e = Margin of error (typically 5% or 0.05). Given the total population of 151 employees, and using a 5% margin of error, the calculation is as follows:

$$n_0 = \frac{485}{1+485(0.05)^2} = \frac{485}{1+485(0.05^2)} = 219.21 \cong 219.$$

Thus, the required sample size for the study is 219 respondents. To ensure proportional representation of the target population, the sample size is distributed across the Volta and Oti regions in proportion to their respective population sizes. The proportional allocation is calculated as follows: The study employs stratified sampling as the primary sampling technique. Stratified sampling involves dividing the population into subgroups, or strata, that share similar characteristics. For this study, the strata are based on the districts within the Volta and Oti regions, ensuring representation from both urban and rural areas. This technique is particularly appropriate for a study of this nature because it enhances the precision and reliability of the results by ensuring that all subgroups within the population are proportionally represented (Saunders et al., 2019). The estimated sample size for each of the regions is shown below;

Volta Region (304 stakeholders); $n_{volta} = \frac{304}{485} \times 219 = 137$

Oti Region (181 stakeholders); $n_{oti} = \frac{181}{485} \times 219 = 82$

Therefore, the sample consists of 137 respondents from the Volta Region and 82 respondents from the Oti Region. This proportional allocation ensures that the sample accurately reflects the distribution of SMEs across the two regions, maintaining the representativeness of the findings. The use of Yamane's formula to determine the sample size ensures that the study is statistically rigorous while balancing practicality and resource constraints. A sample size of 219 respondents provides sufficient statistical power for meaningful analysis while being manageable within the scope of the study. This ensures that the study achieves its objectives of assessing waste management practices, challenges, and strategies among SMEs in the Volta and Oti regions.

Stratified sampling is well-suited for this study as it allows for a deeper understanding of the diversity in waste management practices among SMEs in both urban and rural districts. Construction SMEs in urban areas, such as Ho and Dambai, may have access to better infrastructure and regulatory oversight compared to those in rural districts, where resource constraints and logistical challenges may hinder effective waste management practices (Frempong-Jnr et al., 2022). Stratifying the sample ensures that these contextual differences are adequately captured in the analysis, making the findings both comprehensive and contextually relevant.

3.7 Research Models for Study Objectives

This section outlines the research models and theoretical frameworks employed to achieve the study's objectives, including examining waste management practices, comparing the effectiveness of waste minimization strategies, identifying key challenges, and assessing the influence of regulatory frameworks and economic incentives. By adopting a purely quantitative approach, the study uses statistical models grounded in Institutional Theory and the Resource-

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Based View (RBV) to provide a structured and comprehensive analysis of both external influences and internal capacities affecting construction SMEs in the Volta and Oti regions.

To analyze waste management practices, descriptive statistical analysis is applied to summarize data collected through structured surveys. Metrics such as frequency distributions, means, and percentages are employed to explore variables such as waste generation rates, disposal methods, and recycling practices. These statistical methods provide insights into existing practices, revealing patterns and trends across SMEs. Guided by Institutional Theory, the analysis examines the extent to which external factors—such as regulatory frameworks, societal expectations, and industry standards—shape these practices (Scott, 2005). This approach facilitates a comprehensive understanding of how SMEs respond to institutional pressures in managing waste.

To compare the effectiveness of waste minimization strategies, inferential statistical methods such as Analysis of Variance (ANOVA) and t-tests are utilized. These models assess differences in waste reduction outcomes among SMEs adopting various strategies, including recycling, reuse, and advanced waste technologies. By identifying statistically significant differences, the study determines which strategies deliver the best results under different conditions. The analysis is grounded in the Resource-Based View (RBV), which links the success of these strategies to internal resources such as technical expertise, managerial capacity, and financial readiness (Barney, 1991). This framework highlights how SMEs' resource capabilities influence the effectiveness of their waste minimization efforts.

The study also addresses the challenges faced by SMEs in implementing waste management practices using frequency distribution analysis to quantify and rank the prevalence of barriers such as financial constraints, inadequate infrastructure, and regulatory compliance difficulties. To provide a more nuanced understanding, Exploratory Factor Analysis (EFA) is employed to group related variables into broader categories of challenges, such as external regulatory barriers and internal resource limitations. Institutional Theory and RBV jointly frame this analysis, with Institutional Theory highlighting challenges posed by external pressures, and RBV focusing on internal organizational constraints (Scott, 2005; Barney, 1991). This dual perspective ensures a balanced exploration of the obstacles SMEs face.

To assess the influence of local regulatory frameworks and economic incentives on waste management practices, Structural Equation Modeling (SEM) is applied. SEM examines direct and indirect relationships between regulatory frameworks, economic incentives, and waste management outcomes. For instance, the model tests whether economic incentives mediate the impact of regulations on improved waste practices. This analysis integrates Institutional Theory to explore external pressures and RBV to evaluate how internal capacities, such as financial resources and management capability, mediate SMEs' responses to these pressures (Scott, 2005; Barney, 1991). SEM provides a comprehensive understanding of the interplay between external and internal factors, allowing for a detailed exploration of how these dynamics shape waste management behavior.

Thus, integrating these models, the study ensures a rigorous methodological approach. Descriptive statistics offer foundational insights into current practices, while inferential techniques like ANOVA and t-tests provide comparative analysis of waste minimization strategies. Frequency distribution and EFA clarify the challenges faced by SMEs, and SEM uncovers the complex relationships between regulatory, economic, and organizational factors.

Grounding this analysis in Institutional Theory and RBV ensures the study captures the interplay between external institutional pressures and internal resource capabilities. Together, these models contribute to actionable recommendations for enhancing waste management practices, addressing sector challenges, and leveraging regulatory and economic incentives to foster sustainability in the construction industry.

3.8 Primary Data Collection

Structured surveys form the core method of data collection. The surveys are designed with closed-ended questions, including Likert-scale items, to capture quantitative data on waste management practices, waste minimization strategies, and challenges faced by SMEs. Key variables measured include waste generation rates, disposal methods, and the perceived impact of regulatory and economic factors. The use of structured surveys ensures uniformity in data collection and enables robust statistical analysis to address the study's objectives (Creswell,

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2014). Surveys are distributed to SME managers, site supervisors, and waste management personnel, ensuring a comprehensive representation of stakeholders.

Field observations complement the survey data by focusing on actual waste management practices at construction sites. Observations are systematically recorded using a predefined checklist that tracks waste handling, segregation, and disposal methods. This method provides an additional layer of verification by documenting real-world practices, ensuring that the survey responses align with on-site behaviors. Observations also capture contextual details, such as the physical setup for waste management and adherence to best practices, which may not be fully captured through surveys (Saunders et al., 2019).

The exclusive reliance on primary data ensures that the study gathers firsthand, reliable, and actionable insights directly from the target population. Surveys provide measurable, standardized data that allow for quantitative analysis of trends, relationships, and differences. Observations enhance the credibility of the findings by validating survey responses through real-world evidence. Together, these methods ensure a comprehensive understanding of waste management practices, challenges, and opportunities among construction SMEs in the Volta and Oti regions.

3.9 Data Collection Instrument

The primary data collection instrument for this study is a survey questionnaire, specifically designed to align with the research objectives and target small and medium-sized construction firms (SMEs) in the Volta and Oti regions of Ghana. The development of the questionnaire is based on a comprehensive review of relevant literature and theoretical foundations, particularly focusing on organizational politics and waste management practices (Ajayi & Oyedele, 2018; Chinda, 2017). The questionnaire is structured into five main sections, each, apart from the first section, targeting a specific aspect of the research, and employs a 5-point Likert scale (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree) for the majority of the items. The Likert scale is widely recognized for its ability to capture nuanced perceptions and attitudes in a structured and measurable way (Likert, 1932; Boone & Boone, 2012).

The first section, Demographics and Background Information, contains 10 items designed to collect data on respondents' roles, regions of operation, firm size, and the types of projects undertaken. Of these, five items use categorical responses to measure nominal variables such as firm size and geographic location, while the remaining five employ the Likert scale to capture ordinal data related to firm policies and practices. This section provides foundational insights into the characteristics of the SMEs surveyed, enabling the analysis of patterns and relationships across firm types (Ajayi & Oyedele, 2018).

The second section, Waste Management Practices, includes 10 items focusing on the specific practices adopted by SMEs for managing construction waste. These items address activities such as waste segregation, the use of designated bins, recycling initiatives, and supplier collaborations to reduce packaging waste. Each item is measured using the Likert scale, allowing respondents to express their level of agreement or disagreement with statements about their firm's waste management efforts. The content of this section reflects best practices in sustainable waste management as identified in the literature (Chinda, 2017; Tam & Tam, 2006).

The third section, Effectiveness of Waste Minimization Strategies, consists of 10 items that examine the strategies employed by SMEs to minimize construction waste. Key focus areas include prefabrication, just-in-time delivery, and the use of digital tools like Building Information Modeling (BIM). This section also assesses perceived benefits such as cost savings, improved project timelines, and enhanced environmental performance. All items in this section use the Likert scale, ensuring consistency in the measurement approach across the questionnaire (Tam & Tam, 2006). This section aligns with the Resource-Based View (RBV) framework by evaluating how internal resources and capabilities influence the effectiveness of these strategies.

The fourth and final section, Challenges in Implementing Waste Management Practices, includes 10 items aimed at identifying the barriers faced by SMEs in adopting effective waste management practices. The challenges explored include limited access to recycling facilities, high costs of waste management, lack of skilled workers, and resistance to change among employees. As in previous sections, the Likert scale is used to capture the intensity of these challenges as perceived by respondents. This section highlights both external and internal constraints, guided by Institutional Theory and RBV (Ajayi & Oyedele, 2018; Chinda, 2017).

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The development of the questionnaire involved several steps to ensure its reliability and validity. A pilot test was conducted with a sample of SME managers and site supervisors to evaluate the clarity, relevance, and comprehensiveness of the items. Feedback from the pilot test informed revisions to enhance the instrument's usability and effectiveness. Reliability was assessed using Cronbach's alpha, with a threshold of 0.7 deemed acceptable for internal consistency (Nunnally & Bernstein, 1994). Construct validity was established by aligning the questions with the theoretical frameworks of Institutional Theory and RBV, ensuring the instrument effectively captured the intended constructs.

The survey questionnaire serves as a robust and comprehensive tool for collecting primary data on waste management practices, the effectiveness of minimization strategies, and the challenges faced by SMEs. Its structured format ensures that the data collected is both standardized and suitable for descriptive and inferential statistical analysis, contributing to actionable insights into waste management practices and outcomes (Boone & Boone, 2012).

3.10 Reliability and Validity

Ensuring the reliability and validity of the data collection instruments is important to the rigor and credibility of this quantitative study. Reliability is the consistency and stability of the measurement instrument, is addressed through pilot testing, test-retest methods, and internal consistency checks (Nunnally & Bernstein, 1994). The survey questionnaire is pilot-tested with a representative sample of SME managers and site supervisors from the Volta and Oti regions to assess the clarity, relevance, and comprehensiveness of the questions. Feedback from the pilot test informs revisions to improve the instrument's usability and ensure consistent measurement of the intended variables (Ajayi & Oyedele, 2018). Additionally, the test-retest method is employed by administering the same questionnaire to the pilot group on two occasions and comparing the results. A high correlation between responses indicates the instrument's stability over time. Internal consistency is further evaluated using Cronbach's alpha, where values above 0.7 confirm that the Likert-scale items within each section reliably measure the same underlying construct (Nunnally & Bernstein, 1994).

Validity is the extent to which the instrument measures what it is intended to measure, is ensured through content, construct, and external validity (Nunnally & Bernstein, 1994). Content validity is achieved by aligning the questionnaire items with the study objectives and reviewing them against existing literature on waste management practices and challenges (Chinda, 2017). Input from subject matter experts, including academics and practitioners, ensures the comprehensiveness and relevance of the items. Construct validity is established by grounding the instrument in theoretical frameworks such as Institutional Theory and the Resource-Based View (RBV). These frameworks guide the development of questions to capture abstract concepts like regulatory influence, organizational resources, and waste minimization strategies (Scott, 2005). Factor analysis is used to confirm the dimensionality and interrelationships of the constructs, further enhancing construct validity. External validity is addressed by employing stratified sampling, ensuring that the sample reflects the diversity of SMEs across urban and rural districts in the Volta and Oti regions. This representativeness strengthens the generalizability of the findings (Saunders et al., 2019).

3.11 Ethical Considerations

Ethical considerations are integral to the credibility and integrity of any research study, particularly when human participants are involved. This study follows strict ethical protocols to ensure that participants' rights, privacy, and well-being are protected throughout the research process. The ethical considerations encompass obtaining approval, securing informed consent, ensuring confidentiality, promoting voluntary participation, and minimizing risks to participants. The study employs a clear and transparent process to obtain informed consent from all participants. Participants are provided with an information sheet explaining the purpose of the study, the nature of their participation, and the potential risks and benefits. The consent process emphasizes that participation is entirely voluntary and that individuals may withdraw at any time without penalty or consequence. Written consent is obtained before participants engage in the survey or observation. The procedure ensures that participants are fully informed about the study, which aligns with international research ethics guidelines such as those outlined in the Declaration of Helsinki (World Medical Association, 2013).

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Maintaining the confidentiality of participants is paramount to protecting their privacy and fostering trust. All data collected, including survey responses and observational notes, are anonymized by removing any personally identifiable information. Data is securely stored in password-protected databases and encrypted files to prevent unauthorized access. Only the principal researcher and authorized personnel have access to the raw data, ensuring compliance with data protection regulations such as the General Data Protection Regulation (GDPR) (European Union, 2016). In reporting findings, aggregated data is presented to prevent identification of individual participants or firms, ensuring that confidentiality is upheld.

The study adheres to the principle of voluntary participation, ensuring that participants are not coerced or pressured to take part. Clear communication is provided to participants about their right to decline or withdraw from the study at any stage without any repercussions. Voluntary participation is a cornerstone of ethical research, as it respects the autonomy of participants and their right to make decisions about their involvement (Saunders et al., 2019).
The study takes proactive steps to minimize potential risks to participants. While the risks associated with participating in surveys and observations are minimal, the study mitigates them by ensuring that questions are non-invasive and focused solely on the research objectives. Participants are assured that their responses will not be used against them in any way, and any discomfort or concerns they may raise during the research process will be addressed promptly. By following these steps, the study upholds the ethical principle of beneficence, which mandates the minimization of harm and the maximization of benefits (Fouka & Mantzorou, 2011).

4.0 DATA ANALYSIS

4.1 Regulatory Frameworks and Incentives

The descriptive statistics for Regulatory Frameworks and Incentives reveal a mean score of 3.982, suggesting a favorable perception of the regulatory environment and the incentives provided to support waste management. The standard deviation (0.557) indicates consistency in responses. The skewness (-0.037) and kurtosis (-0.018) values confirm that the data follows a normal and symmetric distribution. These results align with studies that emphasize the role of strong regulatory frameworks and economic incentives in promoting sustainable waste management practices (Zhang et al., 2017). The descriptive statistics show positive perceptions of the variables under study, with all data distributions being nearly normal. These findings provide a foundation for further inferential analyses to evaluate relationships and differences across the study variables.

Table 4. 1: Descriptive Statistics of the Variables

Variables	Min.	Max.	Mean	Std. Dev.	Skewness	Kurtosis
Waste Management Practices	1.00	5.00	4.012	0.565	-0.042	0.051
Adoption of Waste Minimization Strategies	1.00	5.00	3.875	0.543	-0.065	-0.024
Challenges in Waste Management	1.00	5.00	3.768	0.512	-0.089	0.037
Regulatory Frameworks and Incentives	1.00	5.00	3.982	0.557	-0.037	-0.018

Source: Field Data, November 2024

4.2 Presentation of the Results

The findings are presented systematically in this section, aligned with the study's objectives. Each objective is addressed individually, with results supported by relevant tables and descriptive analyses to provide a clear and comprehensive understanding. This structured approach ensures that the data is effectively communicated and facilitates the interpretation of key insights related to the study's focus.

4.2.1 Examining Waste Management Practices in the Volta and Oti Regions

The first objective of this study was to examine the waste management practices employed by small and medium-sized construction firms in the Volta and Oti regions of Ghana. To achieve this, the study utilized Descriptive Statistics (mean and standard deviation) and Multivariate

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Analysis of Variance (MANOVA) to evaluate differences in waste management practices across the two regions. Table 4.8 presents the comparative analysis of ten key waste management practices across the two regions, while Tables 4.9 to 4.12 provide supporting multivariate test statistics. This approach enables the study not only to describe but also to statistically verify regional differences in waste management practices among SMEs.

The results reveal that firms in the Volta region consistently outperformed those in Oti across all constructs. For example, firms in the Volta region demonstrated a stronger commitment to clear protocols for separating construction waste compared to those in Oti. Volta firms achieved a mean score of 3.991 (SD = 0.593), significantly higher than Oti's 3.621 (SD = 0.548). This suggests that Volta firms have implemented more structured and standardized processes for segregating waste at construction sites, ensuring efficiency and compliance with environmental standards. These protocols are likely indicative of better organizational practices that contribute to more effective waste management systems in Volta. Similarly, the provision of designated waste bins was significantly better in Volta (M = 4.125, SD = 0.539) than in Oti (M = 3.561, SD = 0.530), with a mean difference of +0.564. This reflects superior infrastructure in Volta for segregating waste at the source. The availability of designated waste bins facilitates on-site sorting and recycling of waste materials, reducing improper disposal practices. Firms in Volta likely benefit from better access to waste management facilities, which directly supports higher scores in this construct compared to Oti.

In addition, Volta firms excelled in conducting regular waste audits (M = 3.955, SD = 0.527) compared to Oti (M = 3.530, SD = 0.533), with a mean difference of +0.425. Regular audits play a crucial role in monitoring and evaluating waste management practices, allowing firms to identify inefficiencies and take corrective actions. The higher performance in Volta suggests a stronger emphasis on accountability and continuous improvement in waste management systems. This focus on regular evaluations likely explains why Volta scores higher across other waste management constructs.

Furthermore, waste management during the design phase was more prominent in Volta (M = 4.071, SD = 0.532) than in Oti (M = 3.530, SD = 0.638), with a mean difference of +0.541. Volta firms prioritize integrating waste management principles early in the construction process, enabling them to reduce waste generation at its source. This proactive approach highlights the importance of incorporating sustainability into project planning stages, which contributes to improved overall waste management outcomes.

Moreover, the Volta region demonstrated superior practices in proper storage to minimize waste, with a mean score of 4.000 (SD = 0.502) compared to 3.439 (SD = 0.558) in Oti. The mean difference of +0.561 indicates that Volta firms are more skilled at organizing and storing materials in ways that prevent damage and waste. Effective storage practices not only minimize material losses but also contribute to cost efficiency and streamlined construction operations. On-site sorting of recyclables was another area where Volta outperformed Oti. Volta firms scored 3.929 (SD = 0.515), significantly higher than Oti's 3.394 (SD = 0.492), with a mean difference of +0.535. This suggests that Volta firms have better systems and practices for segregating recyclable materials at construction sites. By reducing the volume of landfill waste and improving recycling rates, Volta demonstrates a more proactive approach to sustainable construction practices.

Collaboration with suppliers to reduce packaging waste also showed significant differences, with Volta scoring 4.000 (SD = 0.569) compared to Oti's 3.546 (SD = 0.637). The mean difference of +0.455 reflects stronger partnerships in Volta, where firms and suppliers likely work together to adopt sustainable packaging solutions. These collaborations are essential for minimizing upstream waste and promoting a more sustainable supply chain, which aligns with Volta's higher overall performance. Similarly, the use of reusable and durable materials was more prevalent in Volta (M = 3.991, SD = 0.622) than in Oti (M = 3.561, SD = 0.611), with a mean difference of +0.431. Volta firms are more likely to adopt materials that can be reused multiple times or that have a longer lifespan, reducing waste generation and material costs. This practice underscores Volta's commitment to sustainability and resource efficiency in construction activities.

Additionally, the adoption of digital tools for waste management was significantly higher in Volta (M = 3.973, SD = 0.592) compared to Oti (M = 3.409, SD = 0.581), with a mean difference of +0.564. This reflects Volta's more advanced integration of technology in managing

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construction waste. Digital tools enable firms to track, analyze, and optimize waste management processes more effectively, resulting in better overall efficiency and compliance with environmental standards.

The largest gap between the two regions was observed in employee training to minimize waste, where Volta scored 4.116 (SD = 0.515) compared to 3.409 (SD = 0.581) in Oti, with a mean difference of +0.707. This highlights Volta's strong emphasis on equipping employees with the necessary knowledge and skills to implement effective waste management practices. Training programs in Volta likely contribute to the region's superior performance across other constructs, as well-trained employees are better positioned to adopt and maintain sustainable practices.

Table 4. 2: Comparative Analysis of Waste Management Practices Employed by SMEs in Volta and Oti Region

Variable	**Volta Mean (SD)**	**Oti Mean (SD)**	**Difference (Volta - Oti)**	**Observations**
Clear protocols for separating construction waste	3.991 (0.593)	3.621 (0.548)	0.37	Volta has better implementation of protocols for separating waste.
Designated waste bins at sites	4.125 (0.539)	3.561 (0.530)	0.564	Volta outperforms Oti significantly in providing designated waste bins.
Regular waste audits conducted	3.955 (0.527)	3.530 (0.533)	0.425	Waste audits are conducted more regularly in Volta.
Waste management considered during design phase	4.071 (0.532)	3.530 (0.638)	0.541	Volta prioritizes waste management during design more effectively.
Proper storage to minimize waste	4.000 (0.502)	3.439 (0.558)	0.561	Volta scores higher in maintaining proper storage for waste minimization.
On-site sorting of recyclables	3.929 (0.515)	3.394 (0.492)	0.535	Volta excels in sorting recyclables on-site.
Collaboration with suppliers to reduce packaging waste	4.000 (0.569)	3.546 (0.637)	0.454	Volta collaborates more with suppliers, reducing packaging waste.
Use of reusable/durable materials	3.991 (0.622)	3.561 (0.611)	0.43	Volta leads in using reusable or durable materials.
Use of digital tools for waste management	3.973 (0.592)	3.409 (0.581)	0.564	Volta demonstrates higher adoption of digital tools for waste management.
Employee training to minimize waste	4.116 (0.515)	3.409 (0.581)	0.707	Employee training programs are significantly stronger in Volta.

Source: Field Data, November 2024

4.2.4 Influence of Local Regulatory Frameworks and Economic Incentives on Waste Management Practices

The fourth objective of the study was to assess the influence of local regulatory frameworks and economic incentives on the waste management practices of small and medium-sized construction firms in the Volta and Oti regions. To achieve this, a multiple regression analysis was conducted, incorporating predictors such as firm characteristics, staff training and

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awareness, and cultural or regional factors. The regression model was statistically significant, with an F-statistic of 138.024 ($p < .001$), indicating that the predictors reliably explained variations in waste management practices. Notably, the model accounted for 80% of the variance in waste management practices ($R^2 = 0.800$), with an adjusted R^2 of 0.795, reflecting the model's strong explanatory power. Additionally, the multiple correlation coefficient ($R = 0.895$) demonstrated a strong relationship between the predictors and the dependent variable, while the low standard error of 0.112 indicated high precision in the model's predictions. This shown in Table 4.19.

The analysis revealed that local regulatory frameworks had a significant positive influence on waste management practices ($\beta = 0.255$, $t = 17.500$, $p < .001$). This suggests that well-defined and enforced local regulations play a critical role in encouraging firms to adopt sustainable waste management strategies. Regulatory oversight provides a structured framework that motivates firms to comply with waste management standards, ultimately improving their practices. In this context, strengthening regulatory mechanisms is essential to enhance compliance and waste management performance.

Similarly, economic incentives were also found to influence waste management practices significantly ($\beta = 0.150$, $t = 10.229$, $p < .001$). These incentives, such as tax breaks, subsidies, or grants, provide the financial support needed for firms to invest in waste management technologies and implement effective practices. Economic incentives reduce the financial burden of adopting sustainable practices, making it easier for firms to comply with regulations and improve their waste management systems. Together with regulatory frameworks, financial support is a crucial external driver of successful waste management. In addition to external factors, firm characteristics emerged as the strongest predictor of waste management practices ($\beta = 0.269$, $t = 17.928$, $p < .001$). This finding underscores the importance of internal organisational factors, such as size, structure, and resources, in shaping a firm's ability to implement effective waste management strategies. Larger or better-resourced firms may have the capacity to invest in infrastructure, technologies, and processes that support sustainable practices, making firm-specific characteristics a pivotal determinant of waste management performance.

Furthermore, staff training and awareness significantly contributed to waste management practices, albeit to a smaller extent than regulatory frameworks and firm characteristics ($\beta = 0.108$, $t = 7.065$, $p < .001$). This indicates that training programs and awareness campaigns are vital for equipping employees with the knowledge and skills necessary to implement sustainable practices. While not as impactful as structural or external factors, staff training ensures that firms have a workforce capable of adhering to waste management principles, which is critical for long-term success. Finally, cultural or regional factors also had a significant but relatively minor influence on waste management practices ($\beta = 0.074$, $t = 5.447$, $p < .001$). Cultural attitudes and regional norms can significantly influence perceptions of waste management, either supporting or hindering the adoption of sustainable practices. For instance, traditional resistance to change may impede progress, whereas cultural alignment with sustainability goals can drive the adoption of improved practices. Although these factors were the least influential among the predictors, their significance highlights the importance of addressing regional and cultural nuances in waste management strategies.

Therefore, the analysis reveals that both external factors (regulatory frameworks and economic incentives) and internal factors (firm characteristics) have a significant impact on waste management practices. Firm characteristics emerged as the strongest predictor, with staff training and cultural factors playing supporting roles. Policymakers should enhance regulations and financial incentives, while firms must strengthen internal capacity and prioritize training to improve waste management in construction firms in the Volta and Oti regions.

Table 4. 3: Regression Analysis of the Influence of Local Regulatory Frameworks and Economic Incentives on Waste Management Practices

Predictors	**Coefficients**	**Standard Error**	**t Stat**	**P-value**
Intercept	0.542	0.137	3.948	0.000
Local Regulatory Frameworks	0.255	0.015	17.500	0.000

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Economic Incentives	0.150	0.015	10.229	0.000
Firm Characteristics	0.269	0.015	17.928	0.000
Staff Training and Awareness	0.108	0.015	7.065	0.000
Cultural or Regional Factors	0.074	0.014	5.447	0.000
F-Statistics	138.024			0.000
Multiple R	0.895			
R Square	0.800			
Adjusted R Square	0.795			
Standard Error	0.112			

Source: Field Data, November 2024

To assess whether the observed differences in descriptive statistics were statistically significant, a MANOVA was conducted. The results are presented with its analysis. To begin with, Box's Test was conducted to evaluate the assumption of equality of covariance matrices for the dependent variables across the two groups, Volta and Oti. This assumption is significant for ensuring that the MANOVA results are valid and interpretable. As shown in Table 4.9, the test was not significant (Box's M = 52.998, F = 0.900, p = .684), indicating that the covariance matrices of the dependent variables do not differ significantly between the two regions. This result satisfies a key assumption of MANOVA, confirming the robustness of the multivariate analysis.

The non-significant result of Box's Test supports the application of Wilks' Lambda, Pillai's Trace, Hotelling's Trace, and Roy's Largest Root as valid test statistics for assessing multivariate differences. A violation of this assumption could have undermined the validity of the multivariate test results, but since this assumption is met, the findings from MANOVA are reliable and can be interpreted with confidence.

Table 4. 4: Box's Test of Equality of Covariance Matrices

Statistic	Value	F-Statistics	DF1	DF2	Sig. Value
Box's M	52.998	0.9	55	61620.56	0.684

Source: Field Data, November 2024

The Multivariate Analysis of Variance (MANOVA) results demonstrated a statistically significant effect of region on the combined dependent variables, which represent waste management practices. This indicates that when all ten constructs are considered together, there are substantial differences in waste management practices between firms in the Volta and Oti regions as shown in Table 4.10. Using Wilks' Lambda, the results revealed a considerable difference (Wilks' Lambda = 0.329, F(10, 167) = 34.071, p < .001). This statistic indicates that the differences between the two regions explain 32.9% of the variance in the combined dependent variables. The small value of Wilks' Lambda (closer to 0) suggests a strong multivariate effect.

Additional multivariate test statistics further corroborated the significance of the regional differences. Pillai's Trace, a more robust statistic, yielded a significant result (Pillai's Trace = 0.671, F(10, 167) = 34.071, p < .001), which indicates that 67.1% of the variance in the linear combination of the dependent variables is associated with regional differences. Similarly, Hotelling's Trace (Hotelling's Trace = 2.040, F(10, 167) = 34.071, p < .001) and Roy's Largest Root (Roy's Largest Root = 2.040, F(10, 167) = 34.071, p < .001) confirmed these findings. These results suggest that firms in the Volta and Oti regions differ significantly in their waste management practices when analyzed as a group. The significant multivariate test statistics provide a strong basis for examining univariate results to identify which specific waste management constructs contributed to these differences.

Table 4. 5: Multivariate Test Results

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Effect	Test Statistic	Test-Value	F-Stat	Hypothesis DF	Error DF	Sig. Value
Region	Pillai's Trace	0.671	34.071	10	167	<.001
	Wilks' Lambda	0.329	34.071	10	167	<.001
	Hotelling's Trace	2.040	34.071	10	167	<.001
	Roy's Largest Root	2.040	34.071	10	167	<.001

Source: Field Data, November 2024

Levene's Test was conducted to assess the homogeneity of error variances for each dependent variable across the two regions. This assumption ensures that the variability in each dependent variable is approximately equal for the groups being compared, which is particularly important for interpreting univariate results in MANOVA. A non-significant Levene's Test ($p > .05$) indicates that the variances are equal across groups. Conversely, significant results ($p \leq .05$) suggest that the variances are unequal, signaling a potential violation of the assumption.

As shown in Table 4.11, several constructs yielded significant results, indicating a violation of the homogeneity of error variances assumption. For instance, "Clear Protocols for Separating Construction Waste" ($F = 6.343$, $p = .013$) and "Employee Training to Minimize Waste" ($F = 13.955$, $p < .001$) exhibited significant differences in error variances between Volta and Oti regions. These findings suggest that the variability of responses for these constructs differed across the two regions. However, several other constructs, such as "On-Site Sorting of Recyclables" ($F = 3.080$, $p = .081$), did not show significant violations, indicating that the assumption of equal variances was met for these variables.

Despite some violations, it is important to note that MANOVA is robust to moderate violations of the homogeneity of error variances assumption, particularly when group sizes are relatively equal. Research by Finch (2005) supports this, demonstrating that MANOVA remains robust even when the assumption of equal variances is violated, provided that sample sizes are sufficiently large and balanced across groups. In this study, the sample sizes for Volta ($n = 112$) and Oti ($n = 66$) are reasonably proportional, minimizing the potential impact of these violations on the multivariate results.

Therefore, while caution is warranted when interpreting univariate results for constructs with significant Levene's Test results (e.g., "Employee Training"), these violations are unlikely to undermine the validity of the overall MANOVA findings. The robust nature of MANOVA, combined with the relatively balanced sample sizes, ensures that the results remain reliable and interpretable.

Table 4. 6: MANOVA Results for the Effectiveness of Waste Management Strategies

Dependent Variable	F-Stat	DF1	DF2	Sig. Value
Clear Protocols for Separating Construction Waste	6.343	1	176	0.013
Designated Waste Bins at Sites	7.522	1	176	0.007
Regular Waste Audits Conducted	14.447	1	176	<.001
Waste Management Considered During Design Phase	18.21	1	176	<.001
Proper Storage to Minimize Waste	23.465	1	176	<.001
On-Site Sorting of Recyclables	3.08	1	176	0.081
Collaboration with Suppliers to Reduce Packaging Waste	6.793	1	176	0.01
Use of Reusable/Durable Materials	6.531	1	176	0.011
Use of Digital Tools for Waste Management	7.442	1	176	0.007
Employee Training to Minimize Waste	13.955	1	176	<.001

Source: Field Data, November 2024

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The univariate results from the MANOVA, presented in Table 4.12, reveal statistically significant differences across all ten waste management constructs between firms in the Volta and Oti regions. This indicates that Volta consistently outperformed Oti in waste management practices across various dimensions. Each construct exhibited a significant F-statistic, with p-values below .001, underscoring the regional differences in the adoption and implementation of waste management strategies.

Firms in Volta demonstrated significantly higher scores for Clear Protocols for Separating Construction Waste (M = 3.991, SD = 0.593) compared to Oti (M = 3.621, SD = 0.548), with F(1, 176) = 17.085, p < .001. Similarly, Volta outperformed Oti in terms of Designated Waste Bins at Sites, with Volta achieving a mean score of 4.125 (SD = 0.539), compared to Oti's 3.561 (SD = 0.530), resulting in F(1, 176) = 46.096, p < .001. This reflects Volta's superior infrastructure for waste segregation.

In the construct Regular Waste Audits Conducted, Volta firms scored significantly higher (M = 3.955, SD = 0.527) than Oti firms (M = 3.530, SD = 0.533), F(1, 176) = 26.831, p < .001, highlighting Volta's stronger emphasis on accountability and performance monitoring. For Waste Management Considered During Design Phase, Volta firms reported greater integration of waste management principles early in the construction process (M = 4.071, SD = 0.532) compared to Oti (M = 3.530, SD = 0.638), with F(1, 176) = 36.984, p < .001. The most significant difference between the two regions was observed in Employee Training to Minimize Waste, where Volta firms scored significantly higher (M = 4.116, SD = 0.515) than Oti firms (M = 3.409, SD = 0.581), F(1, 176) = 71.010, p < .001. This finding emphasizes the substantial focus in Volta on equipping employees with the necessary skills and knowledge to implement effective waste management practices.

Effect sizes (R-squared values) offer additional insights into the significance of these constructs in distinguishing between the two regions. The construct Employee Training to Minimize Waste exhibited the largest effect size (R^2 = .287), followed by Proper Storage to Minimize Waste (R^2 = .213) and Use of Digital Tools for Waste Management (R^2 = .178). These results highlight the crucial roles of training, infrastructure, and technology in fostering effective waste management practices.

Table 4. 7: MANOVA Results for Waste Management Strategies

Dependent Variable	F-Stat	DF	Sig. Value	R^2 (Effect Size)
Clear Protocols for Separating Construction Waste	17.08	(1, 176)	<.001	0.088
Designated Waste Bins at Sites	46.096	(1, 176)	<.001	0.208
Regular Waste Audits Conducted	26.831	(1, 176)	<.001	0.132
Waste Management Considered During Design Phase	36.984	(1, 176)	<.001	0.174
Proper Storage to Minimize Waste	47.6	(1, 176)	<.001	0.213
On-Site Sorting of Recyclables	46.234	(1, 176)	<.001	0.208
Collaboration with Suppliers to Reduce Packaging Waste	24.215	(1, 176)	<.001	0.121
Use of Reusable/Durable Materials	20.139	(1, 176)	<.001	0.103
Use of Digital Tools for Waste Management	38.209	(1, 176)	<.001	0.178
Employee Training to Minimize Waste	71.01	(1, 176)	<.001	0.287

Source: Field Data, November 2024

Ultimately, the analysis conducted in this section comprehensively meets Objective 1. The descriptive statistics in Table 4.8 reveal clear differences in the implementation of waste management practices between Volta and Oti regions, while the MANOVA results confirm that these differences are statistically significant. The findings demonstrate that construction SMEs in Volta consistently outperform those in Oti across all measured constructs, particularly in

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areas such as employee training, digital tool adoption, and on-site waste segregation. These results offer valuable insights into regional disparities and provide a solid empirical foundation for developing targeted waste management interventions and policies in Ghana's construction sector.

4.2.2 Relationship Between the Adoption of Waste Minimisation Strategies and their Perceived Effectiveness

The second objective of the study evaluates the relationship between the adoption of waste minimization strategies and their perceived effectiveness among construction firms in the Volta and Oti regions. To achieve this, the study employed both correlation analysis and multiple regression analysis, as shown in Table 4.13 and Table 4.14, respectively. These analyses aimed to examine the strength of the relationships between the adoption of waste minimization strategies (e.g., prefabrication, digital tools, reuse of materials) and their perceived effectiveness, and to determine the predictors of effectiveness.

Correlation analysis revealed significant positive correlations between perceived effectiveness and the three key strategies: prefabrication adoption, digital tools adoption, and reuse of materials. Prefabrication adoption exhibited the strongest positive correlation with perceived effectiveness ($r = 0.940$, $p < 0.001$), indicating that firms with higher adoption of prefabrication strategies perceive greater effectiveness in waste minimisation efforts. This relationship underscores the value of prefabrication in minimising material waste and enhancing operational efficiency. Similarly, digital tools adoption demonstrated a very strong positive correlation with perceived effectiveness ($r = 0.935$, $p < 0.001$), suggesting that firms using technologies such as Building Information Modeling (BIM) or waste tracking systems achieve better outcomes in waste reduction. The adoption of digital tools is likely to enhance the planning, monitoring, and management of waste, leading to improved performance. Reuse of materials also showed a strong positive correlation with perceived effectiveness ($r = 0.869$, $p < 0.001$). While slightly weaker than prefabrication and digital tools, this finding underscores the role of material reuse in reducing waste volumes, promoting sustainability, and achieving cost savings.

The predictors themselves were strongly correlated, indicating a complementary relationship between the strategies. Prefabrication and the adoption of digital tools were highly correlated ($r = 0.874$, $p < 0.001$), suggesting that firms adopting prefabrication are also likely to incorporate digital tools. Similarly, digital tools adoption and material reuse were positively correlated ($r = 0.821$, $p < 0.001$), reflecting the synergy between these strategies in optimizing waste management practices. Prefabrication and material reuse also exhibited a strong positive relationship ($r = 0.798$, $p < 0.001$), indicating that firms that adopt prefabrication are more likely to reuse materials. These interrelationships suggest that firms often implement these strategies as part of a comprehensive waste minimisation approach. However, the dummy

variable representing region (Volta = 1, Oti = 0) showed no significant correlation with perceived effectiveness ($r = 0.010$, $p = 0.891$) or with any of the waste minimisation strategies (all $p > 0.05$). This indicates that regional differences do not influence the adoption or effectiveness of these strategies. Instead, the success of waste minimisation appears to be primarily determined by the level of strategy adoption, regardless of geographical location. Therefore, the correlation analysis underscores the critical role of adopting waste minimisation strategies, particularly prefabrication, digital tools, and reuse of materials in achieving perceived effectiveness. The strong interrelationships between these strategies suggest that they are often implemented together to enhance waste reduction outcomes. The lack of significant regional differences highlights that the effectiveness of these strategies is consistent across the Volta and Oti regions, reinforcing the importance of promoting their adoption regardless of location.

Table 4. 8: Correlation Matrix of Relationship Between the Adoption of Waste Minimization Strategies and their Perceived Effectiveness

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	Effectiveness (Perception)	Prefabrication (Adoption)	Digital Tools (Adoption)	Reuse of Materials (Adoption)	Dummy Variable
Effectiveness (Perception)	1.000				
Prefabrication (Adoption)	.940**	1.000			
Digital Tools (Adoption)	.935**	.874**	1.000		
Reuse of Materials (Adoption)	.869**	.798**	.821**	1.000	
Dummy Variable	0.01	0.008	0.015	0.034	1.000

Source: Field Data, November 2024

On other hand, the regression model demonstrated a strong fit, with a Multiple R of 0.974, indicating a very strong positive correlation between the predictors and perceived effectiveness. An R^2 of 0.950 shows that the predictors explain 95% of the variance in perceived effectiveness, while the Adjusted R^2 of 0.948 confirms the model's robustness. The ANOVA results further validate the model's overall significance ($F(4, 173) = 815.699$, $p < 0.001$), highlighting that the predictors collectively have a meaningful impact on effectiveness.

The adoption of prefabrication strategies emerged as the most significant predictor of perceived effectiveness, with a regression coefficient of 0.494 ($p < 0.001$, Table 4.14). Correlation analysis (Table 4.13) also revealed a strong positive relationship between prefabrication and perceived effectiveness ($r = 0.72$). This indicates that for every 1-point increase in the adoption of prefabrication strategies, perceived effectiveness improves by 0.494 units on the 5-point Likert scale. Prefabrication strategies likely reduce material wastage, improve construction efficiency, and support sustainability efforts, making them a critical component of waste minimisation practices.

Also, the adoption of digital tools, such as Building Information Modeling (BIM), also had a significant positive effect on perceived effectiveness, with a regression coefficient of 0.424 ($p < 0.001$, Table 4.14). Correlation analysis (Table 4.2) revealed a strong positive association ($r = 0.68$). A 1-point increase in the use of digital tools is associated with a 0.424-unit increase in perceived effectiveness, highlighting the critical role of technology in optimising waste management processes. These tools enable construction firms to monitor, analyse, and minimise waste effectively, demonstrating their value in improving waste minimisation outcomes.

Additionally, the reuse of materials also positively influenced perceived effectiveness, with a regression coefficient of 0.212 ($p < 0.001$, Table 4.14). Correlation analysis (Table 4.12) supported this relationship, with a moderate positive correlation ($r = 0.54$). For every 1-point increase in the reuse of materials, perceived effectiveness increases by 0.212 units. Recycling and reusing materials contribute to waste reduction, cost savings, and sustainable construction practices, albeit to a lesser extent than prefabrication or digital too.

Interestingly, the dummy variable for region (Volta = 1, Oti = 0) was not statistically significant ($B = -0.009$, $p = 0.742$, Table 4.14), indicating that regional differences do not significantly influence perceived effectiveness when controlling for the adoption of waste minimization strategies. This suggests that the effectiveness of these strategies is primarily driven by their level of adoption, rather than geographical location.

Ultimately, the findings from both correlation and regression analyses underscore the importance of adopting waste minimization strategies to enhance their perceived effectiveness. Prefabrication emerged as the strongest predictor, followed by the use of digital tools and the reuse of materials. The lack of significant regional differences highlights the need to focus on increasing the adoption of these strategies across both the Volta and Oti regions, which would likely yield comparable improvements in waste minimisation outcomes and support sustainable construction practices.

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Table 4. 9: Regression Analysis of Adoption of Waste Minimization Strategies on Perceived Effectiveness

Predictors	Coeff.	Standard Error	T-Test Value	P-value
Intercept	0.286	0.082	3.489	0.001
Prefabrication (Adoption)	0.494	0.040	12.329	0.000
Digital Tools (Adoption)	0.424	0.044	9.648	0.000
Reuse of Materials (Adoption)	0.212	0.033	6.438	0.000
Dummy Variable	-0.009	0.026	-0.330	0.742
F-Statistics	815.699			0.000
Multiple R	0.974			
R Square	0.950			
Adjusted R Square	0.948			
Standard Error	0.166			

Source: Field Data, November 2024

4.2.4 Local Regulations and Economic Incentives on Waste Management Practices

The fourth objective of this study evaluates the influence of local regulatory frameworks and economic incentives on the waste management practices. This analysis aimed to evaluate the impact of external drivers, alongside firm characteristics, staff training, and cultural factors, on the adoption of sustainable waste management practices. The findings highlight the relationship between regulatory frameworks and economic incentives as critical enablers of improved waste management performance. Local regulatory frameworks were found to have a significant positive impact on waste management practices, as they provide a structured foundation for firms to adopt sustainable strategies. Well-defined regulations ensure that firms align their operations with mandated environmental standards, thus improving compliance and efficiency. This finding supports the observations of Daskal, Ayalon, and Shechter (2019), who emphasized the importance of regulatory frameworks in reducing landfill dependency and enhancing recycling rates in Israel. Similarly, Rogoff and Screve (2019) identified how regulations in the United States, when combined with economic instruments, strengthen adherence to waste management protocols.

However, the effectiveness of regulations is context-dependent, as shown by Kubanza and Simatele (2020), who identified institutional weaknesses and insufficient enforcement as barriers to effective waste management in Johannesburg, South Africa. The current study corroborates these findings by demonstrating that robust enforcement mechanisms and regular monitoring are essential for ensuring compliance. This underscores the importance of designing regulatory frameworks that are not only robust but also enforceable within the socio-economic and institutional capacities of the regions they govern. Economic incentives, such as tax breaks, subsidies, and grants, also emerged as significant predictors of waste management practices. These incentives reduce the financial burden associated with adopting sustainable technologies and systems, enabling firms to comply with regulations more easily. This finding aligns with Mak et al. (2019), who demonstrated that economic incentives, such as increased waste disposal fees, encourage recycling behaviors in Hong Kong's construction industry. Similarly, Han et al. (2023) observed that tailored financial incentives significantly enhance household waste classification participation in rural China, highlighting the importance of local customization.

Nevertheless, the financial challenges associated with implementing economic incentives are noteworthy. Valach and Cifranič (2024) caution that while economic incentives drive behavioral change, they may place a strain on municipal budgets, particularly in resource-constrained regions. This calls for a balanced approach that optimizes the allocation of financial resources to achieve both environmental and economic sustainability. Among the factors assessed, firm characteristics proved to be the strongest predictor of waste management practices. Internal organisational attributes, such as firm size, financial resources, and operational capacity, play a pivotal role in determining a firm's ability to implement sustainable strategies. Larger firms with better resources are more likely to invest in advanced waste

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management systems and technologies. This finding is supported by the Resource-Based View (RBV) theory, which posits that firms achieve competitive advantages by leveraging their unique internal resources (Ali & Singh, 2024). The study highlights the importance of strengthening internal capacities, as firms with limited resources may struggle to adopt sustainable practices even when external regulatory and financial support is available.

Staff training and awareness programs also had a significant, though relatively more minor, influence on waste management practices. Training equips employees with the necessary knowledge and skills to effectively implement and maintain sustainable waste management systems. This finding aligns with Nzima (2022), who identified limited training as a barrier to effective waste management in South Africa's construction sector. Similarly, Rahmawati et al. (2024) emphasized the role of capacity-building initiatives in overcoming technological and regulatory challenges in Indonesia. Although training is not the primary driver of success, it complements external drivers by ensuring that firms have a skilled workforce capable of operationalizing sustainable practices.

Cultural and regional factors, while the least influential, also played a significant role in shaping waste management practices. Societal attitudes, norms, and resistance to change can either support or hinder the adoption of sustainable practices. Han et al. (2023) and Mak et al. (2019) both emphasized the importance of tailoring incentives to local socio-cultural contexts, with Han focusing on rural households and Mak addressing urban industries. The present study reinforces this perspective by highlighting the need for culturally sensitive approaches that align with regional attitudes toward sustainability. While cultural factors were less impactful than structural or financial factors, addressing these nuances can further enhance the effectiveness of waste management initiatives.

This study contributes to the growing body of knowledge on waste management by providing a comprehensive understanding of how local regulatory frameworks, economic incentives, internal factors, and cultural factors interact to influence waste management practices in the construction sector. Thus, by identifying the relationship between these factors, the study bridges gaps in the existing literature, such as the limited exploration of the combined effects of regulations and financial mechanisms, as well as the socio-cultural dimensions of waste management in developing regions.The findings underscore the importance of developing and implementing robust regulatory frameworks that are underpinned by financial incentives to foster compliance and innovation. Policymakers are encouraged to focus on enforceable and regionally appropriate regulations while allocating financial resources to incentivize sustainable practices. At the organizational level, firms must prioritize capacity building, invest in training programs, and leverage their internal resources to complement external drivers. Additionally, addressing cultural barriers and tailoring strategies to local contexts can further enhance the adoption of waste management practices.

Combining Institutional Theory, which emphasizes the role of external pressures, and the Resource-Based View, which focuses on internal resource optimization, this study provides a robust theoretical foundation for understanding the dynamics of waste management practices. It offers actionable insights for policymakers, industry stakeholders, and construction firms, paving the way for more sustainable and effective waste management systems in the Volta and Oti regions and beyond.

5.0 CONCLUSION

5.1 Findings

Waste Management Practices: The study revealed significant disparities in waste management practices between SMEs in the Volta and Oti regions. Firms in the Volta region consistently outperformed those in Oti across all measured constructs, including waste segregation, use of designated bins, regular waste audits, and employee training. The largest gap was observed in employee training, where Volta scored 4.116 compared to Oti's 3.409.

Effectiveness of Strategies: The adoption of waste minimisation strategies—such as prefabrication, digital tools, and material reuse—showed strong positive correlations with perceived effectiveness. Prefabrication had the highest impact ($\beta = 0.494$), followed by digital tools ($\beta = 0.424$) and material reuse ($\beta = 0.212$). Regional differences did not significantly influence effectiveness, indicating that strategy adoption is the primary driver of success.

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Regulatory and Economic Influences: Local regulatory frameworks (β = 0.255) and economic incentives (β = 0.150) significantly improved waste management practices. Firm characteristics (e.g., size, resources) were the strongest predictor (β = 0.269), highlighting the importance of internal capacity. Staff training (β = 0.108) and cultural factors (β = 0.074) also played supportive roles.

Challenges: Key barriers included limited access to recycling facilities, high costs, and a lack of skilled workers. The study identified a need for better enforcement of regulations and tailored economic incentives to address regional disparities.

5.2 Recommendations

Enhance Regulatory Frameworks: Strengthen enforcement mechanisms to ensure compliance with waste management standards. Develop region-specific policies to address the unique challenges of the Oti region, such as limited infrastructure and lower awareness.

Provide Economic Incentives: Introduce tax breaks, subsidies, or grants to encourage SMEs to invest in waste reduction technologies (e.g., digital tools, prefabrication). Allocate municipal budgets to support recycling infrastructure and waste audits, particularly in underserved areas.

Capacity Building: Implement targeted training programs for employees and managers to improve waste handling skills and awareness. Promote collaborations between SMEs and suppliers to reduce packaging waste and adopt reusable materials.

Leverage Technology: Encourage the adoption of digital tools like Building Information Modelling (BIM) for waste tracking and optimisation. Pilot scalable waste management technologies in rural and peri-urban areas to bridge the urban-rural divide.

Stakeholder Engagement: Foster multi-stakeholder partnerships involving regulators, firms, and communities to align cultural attitudes with sustainability goals. Conduct awareness campaigns to highlight the economic and environmental benefits of waste minimisation.

5.3 Conclusion

The study highlights the importance of integrating regulatory support, economic incentives, and firm-level capacities to improve waste management practices among construction SMEs in Ghana. While the Volta region demonstrated more advanced practices, the Oti region requires targeted interventions to address infrastructural and educational gaps.

The findings advocate for a holistic approach that combines policy enforcement, financial incentives, and technological adoption to achieve sustainable waste reduction. By addressing these factors, SMEs can make significant contributions to environmental conservation and operational efficiency, aligning with Ghana's broader sustainability objectives. Future research could explore longitudinal impacts of these interventions and their scalability across other developing regions.

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