Exploration of the Challenges of Construction Waste Management Practices: A Case-Study of the Greater Tzaneen Local Municipality

Lehlogonolo P. Chuene *, Josephine M. Letsoalo , Margaret H. Mollel

Posted Date: 8 May 2025

doi: 10.20944/preprints202505.0531.v1

Keywords: Construction waste; Challenges; Waste management; Construction sector

Article

Exploration of the Challenges of Construction Waste Management Practices: A Case-Study of the Greater Tzaneen Local Municipality

Lehlogonolo P. Chuene [1,*], Josephine M. Letsoalo [1] and Margaret H.N. Mollel [2]

[1] Department of Geography and Environmental Studies, University of Limpopo, Sovenga 0727, South Africa

[2] Department of Water and Sanitation, University of Limpopo, Sovenga 0727, South Africa

* Correspondence: pmachethe31@gmail.com; Tel.: (+27 67 212 4095)

Abstract: South Africa has a history of poor coordination in construction waste management, which has resulted in problems such as illegal dumping, a lack of legislation enforcement, and a lack of waste management practices. Problems linked with the management of construction waste have risen over the past decade because of increased waste production. This study assessed the challenges to the enforcement of waste management practices by the Greater Tzaneen Local Municipality construction sector. A qualitative study was conducted in the construction sectors in Limpopo province. Purposive sampling technique was used to interview 24 participants. The interviews were recorded, transcribed verbatim, and analysed thematically. The findings highlight challenges such as employees' behaviour, financial challenges, lack of knowledge and awareness, poor enforcement of the law, and inadequate resources that affects the construction waste management practices. This study draws attention to the challenges encountered when implementing effective waste management practices in the construction sector. The challenges are consistent with the broader challenges that the Sustainable Development Goals aim to solve. In order to achieve these goals, integrated waste management practices that support resource effectiveness and sustainable urban development are crucial.

Keywords: construction waste; challenges; waste management; construction sector

1. Introduction

The construction sector is one of the industries with the greatest economic, environmental, and technological influence when viewed on a worldwide scale [**1**]. Despite its economic impact, the construction sector's generated waste has increased as a result of the increasing number of construction activities [2–4]. The growth of construction waste is a major global challenge as landfills fill up and less space is available for disposal [**5,6**]. Globally, approximately 35% of construction waste is generated, with the majority going to landfills untreated [**7**]. Some countries like Brazil have alarmingly high landfill waste rates of above 40% [**8**]) while other countries like Hong Kong and Canada have attempted to keep their percentages below 30% [**9,10**].

Most of the components found in construction materials are hard to compose and therefore they accumulate [**11**]. The accumulation of these substances inhibits plant growth and may even cause plant death. Therefore, it is crucial to lessen the environmental impact of construction waste [**12**]. Given the detrimental impacts on the environment, it is essential that construction waste be properly and efficiently managed. To protect the environment and the public's health and safety, organisations producing waste and waste management companies are given targets and deadlines by regulating authorities to comply with national legislation [**13**]. Despite the existence of waste regulations, such as the National Environmental Management: Waste Act 59 of 2008 [**14**] and its amendment in 2014, as well as the National Environmental Management Act 107 of 1998 [**15**], construction companies still encounter challenges with management of construction waste [**16**]. South Africa consented to the

adoption and execution of the 2030 Agenda for Sustainable Development, which includes the 17 Sustainable Development Goals (SDGs) [**17**]. Out of all the SDGs, eight of them have some connection to waste management and the challenges associated with it. This shows how multifaceted the problem is and how crucial it is to approach it holistically. Reducing construction waste is critical as it can lessen environmental strain on the people who depend on agriculture and ecological systems for their sustenance [**18**]. It is however important to recognise that there are specific challenges and obstacles that must be overcome to attain these SDGs and the related objective of integrated waste management in the context of developing countries.

South Africa has a history of poor coordination in construction waste management (CWM), which has resulted in problems such as illegal dumping, a lack of legislation enforcement, and a lack of waste management practices [**19**]. Problems linked with the management of construction waste have risen over the past decade as a result of the waste production that has been increasing due to the number of buildings and other infrastructures that have been constructed [**4**]. In the Greater Tzaneen Local Municipality (GTLM), construction activities take place within the natural environment, utilising various materials, including natural resources, which contribute to waste generation. This waste poses serious risks to both the environment and human health. The aim of this study was therefore to assess the challenges to the enforcement of CWM practices in the GTLM construction sectors. Addressing waste-related challenges in GTLM will contributes to creating more sustainable urban environments and promoting resource efficiency, which are key targets of SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production).

2. Materials and Methods

2.1. Study Design and Setting

This study used a qualitative case study design to better comprehend the challenges that construction companies face when implementing CWM practices. The qualitative method was appropriate as it allowed the researchers to explore and understand the phenomenon [**20**]. The study was conducted at the construction sectors in the GTLM, which is in the eastern part of the Limpopo Province within the Mopani District. There are five (5) local municipalities found within the Mopani District, namely: Greater Tzaneen, Greater Giyani, Greater Letaba, Maruleng, and Ba-Phalaborwa Municipalities. The selection of the GTLM as the case study area for this research was grounded in its relevance to the study of CWM practices. The municipality has a population of approximately 390,098, with 108,926 households [**21**]. This population growth and the associated demand for infrastructure development make the municipality an important site for investigating the challenges related to CWM. The region's economic activity, particularly in the construction sector, further strengthens the case for this municipality as the research area. Several construction companies operate within the GTLM, and as a developing region, it is crucial to address issues of waste management to ensure sustainable development.

2.2. Population and Sampling

To ensure that adequate information was gathered, a purposive sampling strategy was employed to choose the participants (i.e., construction site managers, construction site engineers, environmental officers, and safety officers) who were thought to be knowledgeable about CWM [**22**]. The study employed Total Population Sampling (TPS), a technique in which all members of the population who fit the criteria are included [**23**].

2.3. Data Collection and Procedure

The first author (L.P) conducted the key informant interviews. The researcher spent between 30 to 70 minutes conducting the face-to-face and virtual interviews. Nineteen interviews were conducted through face-to-face at the constructions sites at a time that was prearranged over the phone and adjusted to the participants' preferences while five interviews took place virtually. With

the permission of the participants [**24**], the face-to-face interviews were recorded using an audiotape while virtual interviews were conducted and recorded using Microsoft Teams. English language was used to conduct the interviews with participants. Participants were asked the following primary question, which was followed by several follow-up inquiries based on their answers: 'What are the challenges that you experience in implementing the waste management strategies or complying with them?'

The primary goal of the interviews was to gather information about the participants' challenges with CWM, therefore one of the guiding principles was to encourage them to openly discuss their own encounters and narratives. The researcher followed up on the information provided by the participants. As a result, rather than using a question-and-answer style, the interviews were able to be interactive. The researcher was able to determine whether the interpretation mirrored what the participants wanted to say by summarising their responses and following up with related clarifying questions.

2.4. Data Analysis

Following the conduction of the interviews, the first author (LP) prepared transcripts for thematic analysis by transcribing the voice recordings. The thematic analysis followed the Tesch's open coding technique [**25**]. The findings are illustrated in the results section using the participant quotes that are italicised and enclosed in quotation marks. Since this paper is based on the first author's Master of Science in Geography study project, the second and third authors (JM & MHN), who supervised the study, confirmed the emerged themes of the study.

2.5. Strategies to Enhance Rigor

The following strategies were used to guarantee trustworthiness: confirmability, dependability, credibility, and transferability [**26**]. To ensure the credibility, this study was conducted following ethical approval from the university's ethics committee. To guarantee that the information given accurately reflects the opinions of the participants, the data was confirmed with the participants during the interview process. The first author (LP) often summarised the information that was presented during the interviews and sought explanations to ensure that the information was accurate. The supervisors (JM and MHN) who are skilled, and qualified, provided guidance throughout the study. All authors participated in the study's design, analysis, and team discussions to foster consensus with the study's findings and conclusions. A thorough explanation of the study's design, environment, participant details, data collection and analysis processes, and findings were provided to establish the data's transferability. An audit trail of field notes, recordings, and audio-taped text was used to guarantee dependability criterion.

2.6. Ethical Considerations

Prior to the study, the study protocol was reviewed and approved by the Turfloop Research Ethics Committee (TREC/70/2023: PG). Participants gave their written informed consent after being made aware of the study's objectives. Confidentiality was maintained for all the data collected for the study. The audio recordings were kept in a safe place and were only accessible to the researchers. Transcripts did not contain names or other personally identifiable information.

3. Results

3.1. Participant's Demographic Information

Of the 24 participants, male participants constituted 67% of the sample, while female participants made up 33%. Most of the participants (83%) were between 25-35 years while 13% of the participants were between 36-45 years. In addition, participants aged 46-65 years and above made up 4% of the workforce, as opposed to no participants in the 18-24 age group. The participants had different qualifications and experience of environment and CWM. The results show that there is an

almost even distribution between those who obtained national diploma, bachelor's degree, and honour's degree with 25%, 29% and 25%, respectively. Only 17% of the participants had a master's degree while 4% had a higher certificate. About 46% of the participants had 9-15 years of professional experience in the field of waste management, while 37% indicated that they had 6-8 years of professional experience and 17% had 3-5 years of professional experience. Most participants (84%) were construction site managers while 8% were site engineers. Additionally, the results show that there is equal distribution of 4% each between environmental officers and safety officers. Table 1 shows the demographic data of the participants.

Table 1. Participant's demographic information.

Participant	Gender	Age	Highest qualification	Years of work experience	Occupation	Type of construction
1	Male	25-35	Bachelor's degree	9-15 years	Construction site manager	Road
2	Male	36-45	National Diploma	9-15 years	Environmental officer	Road
3	Male	25-35	Bachelor's degree	9-15 years	Construction site manager	Bridges
4	Female	25-35	Master's degree	9-8 years	Construction site manager	Housing
5	Female	25-35	Honours degree	6-8 years	Construction site manager	Housing
6	Female	25-35	Master's degree	6-8 years	Construction site manager	Road
7	Female	25-35	Honours degree	6-8 years	Construction site manager	Housing
8	Male	25-35	Honours degree	3-5 years	Safety Officer	Bridges
9	Male	25-35	Bachelor's degree	9-15 years	Construction site manager	Dam
10	Female	25-35	Diploma	6-8 years	Construction site manager	Road
11	Male	25-35	Bachelor's degree	6-8 years	Construction site manager	Housing
12	Female	25-35	Honours degree	6-8 years	Construction site manager	Housing
13	Male	25-35	Master's degree	3-5 years	Construction site manager	Housing
14	Male	25-35	Master's degree	6-8 years	Construction site manager	Bridges
15	Male	36-45	National Diploma	9-15 years	Construction site manager	Road
16	Male	25-35	National Diploma	6-8 years	Construction site manager	Housing

 doi:doi:10.20944/preprints202505.0531.v1

17	Male	46-65	National Diploma	9-15 years	Construction site manager	Dam
18	Male	25-35	Higher certificate	9-15 years	Construction site manager	Bridges
19	Male	25-35	Honours degree	9-15 years	Construction site manager	Bridges
20	Male	36-45	National Diploma	9-15 years	Construction site manager	Road
21	Male	25-35	Bachelor's degree	9-15 years	Site Engineer	Road
22	Male	25-35	Honours degree	9-15 years	Site Engineer	Dam
23	Female	25-35	Bachelor's degree	3-5 years	Construction site manager	Dam
24	Female	25-35	Bachelor's degree	3-5 years	Construction site manager	Road

3.2. Themes Emerged from Data Analysis

Six themes emerged from the research findings, and they were: (i) The impact of employees' behaviour on waste management practices at construction sites, (ii) Financial challenges in managing construction waste, (iii) Lack of knowledge and awareness on CWM, (iv) Lack of financial incentives for effective waste management, (v) Poor enforcement of the law by the Environmental Authorities, and (vi) Inadequate resources to manage construction waste.

3.2.1. Theme 1: The Impact of Employees' Behaviour on Waste Management Practices at Construction Sites

This theme highlights how employees' behaviour, despite training and supervision, impacts the effective implementation of CWM practices. It draws attention to how difficult it can be to alter unprofessional or uncooperative behaviour. One of the participants made the following observations:

> "*One of the challenges is that we are dealing with behavioural issues. You must ensure that someone behaves in a certain way, and you might not win*."

A participant from the road construction projects highlighted that they do advice their employees through different strategies such as toolbox talk weekly. However, employees continue to do the opposite besides such trainings and one of the participants said:

> "*Sometimes we advise them through our weekly toolbox talks but they still do the same things we advised against. You can see that it is a behavioural issue, so we just have to continue undertaking the same activity until they are aware*."

In adding to the challenge of behaviour, one of the participants from dam construction projects emphasised that one of the key challenges they encounter in encouraging workers to implement waste management methods within their construction site is the behaviour of the workers. The participant said:

> "*We make every effort to teach them about waste, but the issue we have is the unprofessional behaviour of our employees regarding waste management. This indicates that even under rigorous supervision, there is little chance of beneficial waste management behaviour among workers if their perceived behavioural control is low*."

In clarifying behavioural aspects of employees, one of the participants from the bridge construction site was of the view that education and experience play a significant role in shaping

 doi:doi:10.20944/preprints202505.0531.v1

employees' attitudes and behaviours toward waste management on construction sites. The participant emphasised that employees who have received specific training in waste management tend to exhibit more positive attitudes and behaviours, highlighting the effectiveness of targeted training programs. The participant said:

> "*In my experience, employees who have taken part in waste management training programs have more positive attitudes toward waste management as opposed to the employees who have not participated*."

3.2.2. Theme 2: Financial Challenges in Managing Construction Waste

This theme reflects the key issue highlighted by participants, which is the high cost associated with waste management at construction sites. It highlights how expenses related to waste disposal, labour, and logistical issues are significant financial burdens, particularly for smaller construction companies. The theme also emphasises how challenging it is to strike a balance between financial sustainability and legal compliance, since some companies put profit ahead of environmental improvements because waste management is so expensive. Most of the participants complained about the high expenses of maintaining costs associated with management of waste within the construction sites. The cost associated with disposal of waste at the landfill was frequently mentioned by most of the participants from different project sites. For instance, one of the participants from a project dealing with road construction stated that:

> "*Maintenance of waste is expensive. To dump waste at a landfill we must pay and sometimes we require more labourers for the management and logistics of getting waste dumped*."

Another participant from building and commercial projects also highlighted that they usually encounter late payments of the work done which becomes a challenge when they must continue managing waste within their construction sites:

> "*We struggle with payments to implement the waste management strategies as we do not get paid on time and it is costly to transport waste to the landfill*."

The financial difficulty was also cited by another participant from the dam construction site who stated that: "*We find it difficult to pay the regular fees for landfill sites as new entrepreneurs just starting up our businesses. Therefore, we rather work with the truck owners who pick up the waste rather than worrying too much about where these truck owners dispose of the waste*." The participant emphasised that in the construction business financial sustainability is crucial since money is required for efficient waste management. In agreeing with other participants from other construction sites, a participant from the road construction site also explained the financial difficulties to manage construction waste. She claimed that because appropriate waste disposal is expensive, some smaller construction companies struggle with it:

> "*We have challenges with finances, so the high costs associated with waste collection and disposal are some of the reasons that make us not to comply with the law*."

Due to their primary focus being financial profit, the participants highlighted that the companies have no interest in making environmental improvements to their processes. As indicated by one of the participants from the road construction projects, the costs associated with managing waste from construction projects are the source of the financial obstacles:

> "*As much as we have to comply with the law, but we also have to make profit, so the cost associated with management of construction waste is a problem because somehow along the way we lose profit as we have to pay a lot of money for waste to be taken care of*."

3.2.3. Theme 3: Lack of Knowledge and Awareness on Construction Waste Management

This theme encapsulates the challenge of lack of knowledge and awareness surrounding both CWM and the relevant environmental legislation among construction workers, contractors, and even professionals. It draws attention to how this knowledge gap impedes both legal compliance and

efficient waste management practices. The theme also emphasises the need for better education and training for workers, as well as a more serious approach to environmental regulations, to improve waste management outcomes at construction sites. In highlighting how lack of knowledge and awareness affects waste management at construction sites, one of the participants emphasised that there is lack of knowledge and awareness regarding CWM by saying:

> "*Even though sometimes we do environmental induction, some people do not understand the importance or impacts of waste on the environment, and we must always remind the workers. Most workers do not understand the waste management and how waste can impact the environment*."

Lack of knowledge is, however, a broad problem as it is not only on the site of the employees but cut across to professionals. Participants indicated that they sometimes source experienced people to manage waste on their behalf due to lack of knowledge of their own staff. One participant said:

> "*But sometimes we're not trained to manage certain types of hazardous waste. So, we must now bring in an experienced third party to come and manage that waste on our behalf, like, for example, sewage waste, because we bring toilets on site. So, such waste whereby our toilets need to be cleaned, we bring a third party to come in and clean those toilets and dispose of waste on our behalf*."

Most participants in the road construction projects attested to challenges that are bound to hinder the effectiveness of the legislation such as a lack of knowledge of the law among most contractors and construction workers, a lack of funding, and a shortage of human capital. One of the participants from housing and commercial projects agreed with participants from road construction projects that there is lack of understanding of the legislation: The participant said:

> "*The environmental legislation is new, and it requires understanding for it to be executed successfully*."

3.2.4. Theme 4: Lack of Financial Incentives for Effective Waste Management

This theme reflects the participants' concerns that construction companies are not provided with sufficient financial rewards or incentives, such as tax credits or rebates for adopting waste management practices. It highlights how the absence of these incentives discourages companies from exploring alternative waste management options, like recycling and recovery and this may hinder their efforts to reduce waste at construction sites. The theme emphasises the necessity of more encouraging laws that supports companies to use environmentally friendly waste management strategies.

Most participants stated that companies are not provided with any financial incentives, such as rebates or tax credits, or any other kind of reward, for creating or implementing waste management strategies that the government has suggested. Some participants expressed the opinion that construction businesses lack the incentive to go through alternative possibilities like recovery and recycling before resorting to landfills. As a result, they indicated that there are insufficient incentives for construction companies (e.g., cash for waste materials exchanged, or prizes for building sites reaching predetermined waste reduction targets). Most of the participants who deal with dam constructions stated that they were unaware of any incentives provided to companies for creating or implementing waste management strategies that are mandated by the government.

3.2.5. Theme 5: Poor Enforcement of the Law by the Environmental Authorities

This theme captures the challenges of non-enforcement and the uneven application of environmental laws across different types of construction projects. Among the challenges identified by the participants was the inadequate enforcement of environmental law. Participants indicated that as much as there are environmental laws governing the construction site, such laws are not enforced. One of the participants said:

> "*There are laws, but they are not enforced as much as they should be. When driving around the Greater Tzaneen Local Municipality, you will casually see construction waste all over the place*."

Most of the participants were aware of the National Environmental Waste Management Act, 2008 (Act No. 59 of 2008), however, they indicated that some of the laws are not enforced. In emphasising the issue of poor law enforcement, one of the participants said:

> *"There are municipality environmental officers and the environmental compliance officers from LEDET but somehow, they do not care much about the enforcement of the environmental laws, because they never visit our sites to check if we comply with waste management strategies but some areas of the Municipality, especially the rural side, there are a lot of construction waste along the roads or in bushes."*

One of the participants from the road construction projects acknowledged that some provisions of the law ought to be obeyed without question. According to the participant, a significant number of people who work on the site do not know much about some of the environmental laws, let alone know how to comply with it. In explaining his acknowledgement of the law, the participant said:

> *"Law is law, and it must be followed. For instance, the aspect of classification of waste cannot be compromised. However, it becomes difficult to enforce the law because most of the workers do not know much about the laws and regulations governing waste management. So, we still must educate them more before we can talk of penalties."*

A participant from housing and commercial properties sites opined that the legislation has not been followed effectively at their site. The participant further highlighted that the legislation generally favours large construction companies because they have money and resources to dispose of their waste in accordance with the law:

> *"We are a small company with lack of capital and insufficient human capital. So, it can occasionally be challenging to adopt some of the practices, such as sorting on site unlike large construction companies who have their waste sorted on site, making the process of waste disposal much simpler."*

3.2.6. Theme 6: Inadequate Resources to Manage Construction Waste

This theme emphasises how important resources like waste bins are to maintaining efficient waste management practices at construction sites. It also highlights how inappropriate waste disposal practices, such littering, are exacerbated by a shortage of these vital resources. One of the participants indicated that, lack of proper equipment such as bins resulted in problems such as littering. *"On the site that we are currently working at right now, we do not have bins."*

One of the challenges mentioned by a participant from a road building site was the scarcity of supplies, such as skip bins. This backed up the participant's judgment from the dam construction site, which mentioned resource availability challenges. Another participant in the dam construction projects expressed the opinion that there is a lack of funding, which results in inadequate resources and ineffective monitoring. Another participant from the road construction site also mentioned some of the difficulties encountered in trying to implement the law efficiently, like a lack of resources:

> *"It is challenging to implement the waste management laws because of lack of resources within the site."*

The scarcity of bins for management of waste was also mentioned by one of the participants from housing and commercial project. The participants highlighted that when waste bins are not available it causes littering within the site:

> *"You'd find that they are minimal, or few which in turn encourages people to end up throwing the waste on open spaces."*

4. Discussion

The findings of our study highlight the challenges in fostering ethical behavior in employees. The results show that despite continuous efforts like toolbox talks and training, employees frequently still act in ways that are inconsistent with waste management practices. This point to the difficulty in changing ingrained habits or attitudes, despite clear guidance. Even after being taught the

significance of compliance, employees' reluctance or lack of interest in appropriate waste management reveals that behavioural problems are frequently at the heart of substandard waste management practices. The study's findings also demonstrate how important training is in influencing employees' perspectives on waste management. Employees with specialised waste management training demonstrated more positive mindsets and behaviour. Our findings are consistent with a study which highlighted that changing people's perceptions can prevent the main causes of waste production in the construction industry [**27**]. Similarly, research has demonstrated that understanding attitudes and behaviours associated with waste management is necessary for efficient CWM [**28**,**29**].

Thus, when managing construction waste, human factors must be considered. Because environmental issues are closely linked to human behavior, people's environmentally conscious beliefs and activities will have beneficial effects for communities [**30**]. The results further suggest that behaviour control is a prerequisite for putting effective CWM policies into practice and that employees' willingness to embrace construction waste measures is largely dependent on their perception of behaviour control. However, McKenzie-Mohr [**31**] contends that attitude modification and awareness-raising have little to no effect on behavior change. To improve CWM practices and foster an accountable culture, it is imperative to strengthen behavioural change techniques employing reinforcement strategies including rewards, recognition, and peer accountability. There is a need for more interactive training and awareness campaigns that are tailored to different levels of proficiency and supported by multimedia tools for continuous learning. Knowledge is an essential first step in the pursuit of improved waste management techniques and a key driver of meaningful environmental action [**32**]. To improve staff understanding of waste management practices and legal requirements, regular, practical training programs such as environmental orientations, practical training sessions, and continuing education must be implemented.

The results of this research draw attention to the complex financial difficulties that construction companies encounter while handling waste, especially the burden that these expenses place on smaller companies. Even though companies recognise how important it is to follow environmental regulations, compliance is frequently hampered by the high costs of disposing of waste and logistical challenges. Given that companies place a higher priority on financial viability than rigorous adherence to waste management regulations, the conflict between profitability and ecological consciousness is a major concern. This issue highlights the need for sustainable and reasonably priced waste management systems that enable construction companies to strike a balance between their financial reality and legal compliance. The result of this study is in line with a study that found that contractors usually lose money due to higher overhead costs and delays, decreased productivity due to more time commitment, and high waste disposal charges [**27**]. A number of construction companies lack the financial as well as technological capabilities necessary to properly manage construction waste [**33**]. Given the constraints of the construction sector as well as the local market, different countries have varied strategies for managing construction waste [**34**]. Although participants expressed dissatisfaction with the financial challenges of waste management, they have highlighted the fact that there are financial benefits to reducing construction waste. Participants believe that financial gains can be achieved through sales of recycled materials to other parties and cost savings realised by the client through waste minimisation. More financial savings can be achieved by the customer and, to some extent, by the lead contractor as more waste is diverted from landfills. These financial savings can be derived from reduced waste disposal costs, purchase costs, and transportation expenses.

To lower the financial burden of waste management on construction sites, companies should employ cost-effective strategies to maintain revenue and adherence to regulations. Waste reduction and recycling initiatives, for example, can save disposal costs by reusing materials and lowering dependency on landfills. This idea is endorsed in a study which suggested that methods such as reduced production, waste classification, reuse, and recycling should be prioritized because they are more economical [**35**]. Therefore, establishing relationships with recycling facilities and waste

management companies may open up more affordable and ecologically suitable disposal alternatives. Streamlining logistics, which involves spending money on on-site waste segregation, utilizing shared disposal services, and efficiently planning waste pickup, can further reduce costs.

Lack of knowledge and awareness about waste management and its effects on the environment is still a major problem in the construction sector. The study participants noted that both the professionals managing the projects and the employees on the ground need to be better informed about the negative effects of improper waste management and the significance of following environmental regulations. Lack of public awareness regarding the environmental repercussions of waste has been noted as one major obstacle to adopting the advised health behaviours [**36**]. According to research, one of the most effective indicators of an individual's recycling behaviour is possessing the right knowledge [**37**]. Therefore, it is critical that those handling construction waste understand how it affects human health and the environment.

As previously mentioned, certain employees and contractors could disregard legal obligations like maintaining waste records and using appropriate disposal techniques. This is made worse by the fact that these regulations receive less serious attention than those pertaining to the Health and Safety Act. Ideally, all construction waste should be recycled and reused, however, there are numerous challenges along the way which are confirmed by literature. For instance, a case study in Australia discovered that some of the main challenges to recycling construction waste are: lack of knowledge within the industry about the significance of recycling and its possible benefits; lack of business-related policy incentives, uncertainty about recycled materials and technological obstacles to recycling waste resources for beneficial purposes [**38**]. Lack of information position by citing insufficient knowledge of construction workers coupled with insufficient training on waste management issues are some of the challenges to achieving the reduction of construction waste [**39**].

A major gap that significantly affects the construction sector's capacity to implement sustainable waste management techniques is the lack of financial incentives for efficient waste management. According to our study findings, construction companies frequently give financial considerations top priority when making operational decisions, which can have a direct impact on their readiness to implement new procedures or technological advancements. In the absence of monetary incentives or rewards, construction companies could be reluctant to spend money on waste reduction techniques like material reuse, recycling, or recovery. Insufficient incentives to encourage sustainable construction, a lack of knowledge about the potential and financial benefits of sustainable constructions, a narrow selection of sustainable materials, and a lengthy process for environmentally friendly construction certifications and authorisations are some of the factors identified to affect the management of waste [**40**]. The findings are also comparable to a study which discovered that the four primary challenges for implementing source separation into practice are expectations of receiving incentives, individuals' inadequate awareness, and lack of responsibility, and issues with the waste collection system [**41**].

The provision of monetary and market-based incentives for sustainability adopters serves as a catalyst for the adoption of waste management approaches [**36**]. Therefore, one of the elements influencing CWM efforts is offering financial incentives to stakeholders. This is viewed as a strategy that can increase their desire to manage construction waste more effectively and their interest in recycling it. To encourage sustainable practices and effective waste management in the construction sector, financial incentives such as tax credits, rebates, and subsidies should be put in place. These incentives may make waste reduction, recycling, and recovery programs more reasonable for companies. Reward-based initiatives, like cash incentives for exchanging waste products and recognition programs for accomplishing waste reduction targets, can further boost compliance. Nahman [**42**] also supports that tax breaks, subsidies, and incentives should be put in place to promote sustainable activity.

Inadequate legal enforcement by environmental authorities exposes serious problems in the construction sector, especially with regard to adherence to environmental laws controlling waste disposal. This problem highlights the discrepancy between environmental regulations' existence and

their practical application, particularly in construction projects. Non-compliance has serious consequences for environmental protection and is caused by a variety of factors, including improper enforcement, inconsistent application of the law, and a lack of knowledge about the needs of the law. Waste management practices that are insufficient or ineffective are often associated with a number of challenges that developing countries face [**35**]. This is due to the fact that ineffective waste management techniques pose major risks to the environment and public health at every stage of the waste collection, storage, processing, disposal, and treatment process.

The study shows that waste management is at its lowest point regardless of the existing legislations and regulatory organisations established to promote the initiative at all three levels of government. Therefore, to address this challenge, authorities should strengthen monitoring and compliance through regular inspections and more severe penalties for non-compliance in order to accelerate the implementation of environmental standards in CWM. Enhancing the percentage of environmental officers on construction sites can help assure responsibility and promote adherence to waste management regulations. In this study, participants indicated that if the laws are effectively enforced, the compliance with waste management strategies within the construction sites will improve. This is supported by a study which found that effective waste minimisation implementation can be facilitated by the enforcement of current rules and regulations [**33**].

A significant issue facing the construction sector is the influence that insufficient resources have on efficient waste management on construction sites. The lack of essential resources, such as waste bins, that are necessary for implementing proper waste management practices significantly contributes to improper waste disposal practices, poor site cleanliness, and even environmental pollution. This problem has wider ramifications for adherence to environmental laws and sustainability objectives in addition to having an impact on the actual physical environment on construction sites. To accomplish a successful plan regarding waste separation at source, a collection system must be supplied [**43**]. This is related to respondents' assertions that they are unable to separate various types of waste because they do not have sufficient containers for that purpose. One of the most important elements in encouraging waste minimisation is the availability of waste skips for certain materials and maximising on-site material reuse [**44**]. Therefore, to improve waste management at construction sites, it is essential to ensure that the resources required, such as waste bins and the right tools, are available. Construction companies should establish clear waste segregation protocols and invest in appropriate waste disposal facilities to reduce littering. Governments and industry stakeholders should collaborate to provide financial aid or incentives, particularly for smaller businesses, to provide access to vital resources.

5. Limitations and Future Research

Most companies were reluctant to take part in the study because they feared that by participating might place them in problems with the environmental authorities if any non-compliance were identified. The researcher however reassured the participants that their companies or identities would remain private to lessen this risk. The sample size was therefore limited to 24 participants. Additionally, the study was conducted in one local municipality within the Mopani District and therefore the findings cannot be generalised to other settings. A similar approach may be used in other research projects with a larger sample size. Although this study was conducted in one local municipality, the methodology used could be applied to other districts in the future.

6. Conclusions

This study draws attention to the challenges encountered when implementing effective waste management practices in the municipality's construction sector. The challenges are consistent with the broader challenges that the SDGs of the UN aim to solve. In order to achieve these goals, integrated waste management practices that support resource effectiveness and sustainable urban development in addition to regulatory framework compliance are crucial. This study supports the

global endeavour to minimize environmental impact, promote sustainable practices, and preserve public health by addressing the challenges to effective CWM in the GTLM.

Author Contributions: Conceptualization, L.P., J.M., and M.H.N.; methodology, L.P., J.M., and M.H.N.; validation, J.M. and M.H.N.; formal analysis, L.P.; investigation, L.P.; data curation, L.P., J.M., and M.H.N.; writing—original draft preparation, L.P.; writing—review and editing, L.P. and M.H.N.; supervision, J.M. and M.H.N.; project administration, L.P., J.M., and M.H.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Turfloop Research Ethics Committee of the University of Limpopo (TREC/70/2023: PG).

Informed Consent Statement: Informed consent was obtained from all participants involved in the study.

Data Availability Statement: The Interview data on which the study is based is not publicly available due to privacy regulations.

Acknowledgments: We would like to thank the participants for their time and contributions.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CWM	Multidisciplinary Digital Publishing Institute Construction Waste Management
GTLM	Greater Tzaneen Local Municipality
SDGs	Sustainable Development Goals

References

1. Chikezirim, O., & Mwanaumo, E. (2013). Evaluation of waste management strategies adopted in Tshwane building industry. *Journal of Construction Project Management and Innovation*, *3*(1), 498-510.
2. Liu, J., Gong, E., Wang, D., Lai, X., & Zhu, J. (2019). Attitudes and behaviour towards construction waste minimisation: a comparative analysis between China and the USA. *Environmental Science and Pollution Research*, *26*, 13681-13690. https://doi.org/10.1007/s11356-018-2247-0
3. Bakshan, A., Srour, I., Chehab, G., El-Fadel, M., & Karaziwan, J. (2017). Behavioral determinants towards enhancing construction waste management: A Bayesian Network analysis. *Resources, Conservation and Recycling*, *117*, 274-284. https://doi.org/10.1016/j.resconrec.2016.10.006
4. Calvo, N., Varela-Candamio, L., & Novo-Corti, I. (2014). A dynamic model for construction and demolition (C&D) waste management in Spain: Driving policies based on economic incentives and tax penalties. *Sustainability*, *6*(1), 416-435. https://doi.org/10.3390/su6010416
5. Olusanya, O.O. (2016). Assessing the compliance to legislation pertaining to management and disposal of construction and demolition waste. Thesis, Degree of MSc Project Management in Construction. University of Witwatersrand. Johannesburg.
6. Jin, R., Yuan, H., & Chen, Q. (2019). Science mapping approach to assisting the review of construction and demolition waste management research published between 2009 and 2018. *Resources, Conservation and Recycling*, *140*, 175-188. https://doi.org/10.1016/j.resconrec.2018.09.029
7. Menegaki, M., & Damigos, D. (2018). A review on current situation and challenges of construction and demolition waste management. *Current Opinion in Green and Sustainable Chemistry*, *13*, 8-15. https://doi.org/10.1016/j.cogsc.2018.02.010

8. Saraiva, T. S., Borges, M. M., & Filho, A. C. (2012). The importance of recycling of construction and demolition waste. In *Proceeding: 28th conference, opportunities, limits & needs towards an environmentally responsible architecture Lima*. Perú 7-9 November 2012.
9. Yeheyis, M., Hewage, K., Alam, M. S., Eskicioglu, C., & Sadiq, R. (2013). An overview of construction and demolition waste management in Canada: a lifecycle analysis approach to sustainability. *Clean Technologies and Environmental Policy*, *15*, 81-91. https://doi.org/10.1007/s10098-012-0481-6
10. Lu, W., & Tam, V. W. (2013). Construction waste management policies and their effectiveness in Hong Kong: A longitudinal review. *Renewable and Sustainable Energy Reviews*, *23*, 214-223. https://doi.org/10.1016/j.rser.2013.03.007
11. Kong, L., & Ma, B. (2020). Evaluation of environmental impact of construction waste disposal based on fuzzy set analysis. *Environmental Technology & Innovation*, *19*, 1-13. https://doi.org/10.1016/j.eti.2020.100877
12. Chen, K., Wang, J., Yu, B., Wu, H., & Zhang, J. (2021). Critical evaluation of construction and demolition waste and associated environmental impacts: A scientometric analysis. *Journal of Cleaner Production*, *287*, 1-16. https://doi.org/10.1016/j.jclepro.2020.125071
13. Young, W., Davis, M., McNeill, I. M., Malhotra, B., Russell, S., Unsworth, K., & Clegg, C. W. (2015). Changing behaviour: successful environmental programmes in the workplace. *Business Strategy and the Environment*, *24*(8), 689-703. https://doi.org/10.1002/bse.1836
14. National Environmental Management: Waste Act 59 of 2008, as amended in 2014. Gazette No. 32189. Pretoria: Government Printers.
15. National Environmental Management Act 107 of 1998. Government Gazette. 401(19519). Pretoria: Government Printer.
16. Chummun, B. Z., & Gaffar, K. (2018). A review of factors influencing environmental performance: A quantitative analysis of the waste industry in KwaZulu-Natal. *Journal of Contemporary Management*, *15*(1), 715-739.
17. South Africa. South Africa's implementation of the 2030 agenda for sustainable development: Voluntary National Review (VNR) report 2019. From: https://sustainabledevelopment.un.org/content/documents/23402SOUTH_AFRICA_RSA_Voluntary_National_Review_Report_Final__14_June_2019.pdf (accessed 21 January 2025)
18. Jerie, S., Shabani, T., & Shabani, T. (2024). Management of safety and health hazards associated with construction and demolition waste in Zimbabwe. *Discover Environment*, *2*(1), 56. https://doi.org/10.1007/s44274-024-00088-4
19. Amadi, I. G., & Mahachi, J. (2025). State-of-the-art review on construction and demolition waste: the South African context. *Cleaner Waste Systems*, 11, 1-13. https://doi.org/10.1016/j.clwas.2025.100251
20. Mantula, F., Mpofu, A. C., Mpofu, F. Y., & Shava, G. G. N. (2024). Qualitative Research Approach in Higher Education: Application, Challenges and Opportunities. *East African Journal of Education and Social Sciences*, *5*(1), 1-10. https://doi.org/10.46606/eajess2024v05i01.0343
21. Greater Tzaneen Local Municipality Integrated Development Plan, 2022. *Integrated Development Plan 2022/2023*. From: http://www.greatertzaneen.gov.za/?q=IDP (accessed on 22 January 2025).
22. Hunter, D., McCallum, J., & Howes, D. (2019). Defining exploratory-descriptive qualitative (EDQ) research and considering its application to healthcare. *Journal of Nursing and Health Care*, *4*(1), 1-8
23. Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*, *5*(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11
24. Xu, A., Baysari, M. T., Stocker, S. L., Leow, L. J., Day, R. O., & Carland, J. E. (2020). Researchers' views on, and experiences with, the requirement to obtain informed consent in research involving human participants: A qualitative study. *BMC Medical Ethics*, *21*, 1-11. https://doi.org/10.1186/s12910-020-00538-7
25. Theron, P. M. (2015). Coding and data analysis during qualitative empirical research in Practical Theology. *In die Skriflig*, *49*(3), 1-9. http://dx.doi.org/10.4102/ids.v49i3.1880

26. Ahmed, S. K. (2024). The pillars of trustworthiness in qualitative research. *Journal of Medicine, Surgery, and Public Health*, *2*, 1-4. https://doi.org/10.1016/j.glmedi.2024.100051
27. Udawatta, N., Zuo, J., Chiveralls, K., & Zillante, G. (2015). Improving waste management in construction projects: An Australian study. *Resources, Conservation and Recycling*, *101*, 73-83. https://doi.org/10.1016/j.resconrec.2015.05.003
28. Razali, F., Daud, D., Weng-Wai, C., & Jiram, W. R. A. (2020). Waste separation at source behaviour among Malaysian households: The Theory of Planned Behaviour with moral norm. *Journal of Cleaner Production*, *271*, 1-10. https://doi.org/10.1016/j.jclepro.2020.122025
29. Kumar, S., Smith, S. R., Fowler, G., Velis, C., Kumar, S. J., Arya, S., ... & Cheeseman, C. (2017). Challenges and opportunities associated with waste management in India. *Royal Society Open Science*, *4*(3), 1-11. https://doi.org/10.1098/rsos.160764
30. Wang, Q., Niu, G., Gan, X., & Cai, Q. (2022). Green returns to education: Does education affect pro-environmental attitudes and behaviors in China? *PLoS One*, *17*(2), 1-20. https://doi.org/10.1371/journal.pone.0263383
31. McKenzie-Mohr, D., 2011. *Fostering sustainable behaviour: An introduction to community-based social marketing*. 3rd ed. Gabriola Island, Minneapolis: New Society Publishers, Limited Consortium Book Sales & Distribution.
32. Etim, E. (2024). Leveraging public awareness and behavioural change for entrepreneurial waste management. *Heliyon*, *10*(21), 1-11. https://doi.org/10.1016/j.heliyon.2024.e40063
33. Umar, U. A., Shafiq, N., Malakahmad, A., Nuruddin, M. F., & Khamidi, M. F. (2017). A review on adoption of novel techniques in construction waste management and policy. *Journal of Material Cycles and Waste Management*, *19*, 1361-1373. https://doi.org/10.1007/s10163-016-0534-8
34. Ismaeel, W. S., & Kassim, N. (2023). An environmental management plan for construction waste management. *Ain Shams Engineering Journal*, *14*(12), 1-13. https://doi.org/10.1016/j.asej.2023.102244
35. Abubakar, I. R., Maniruzzaman, K. M., Dano, U. L., AlShihri, F. S., AlShammari, M. S., Ahmed, S. M. S., ... & Alrawaf, T. I. (2022). Environmental sustainability impacts of solid waste management practices in the global South. *International journal of environmental research and public health*, *19*(19), 1-26. https://doi.org/10.3390/ijerph191912717
36. Dosumu, O., & Aigbavboa, C. (2021). Drivers and effects of sustainable construction in the South African construction industry. *Acta Structilia*, *28*(2), 78-107. https://doi.org/10.18820/24150487/as28i2.4
37. Erhabor, N. I., & Don, J. U. (2016). Impact of environmental education on the knowledge and attitude of students towards the environment. *International Journal of Environmental and Science Education*, *11*(12), 5367-5375.
38. Zou, P., Hardy, R., & Yang, R. (2015). Barriers to building and construction waste reduction, reuse and recycling: A case study of the Australian Capital Region. Building Today- Saving Tomorrow: Sustainability in Construction and Deconstruction Conference: Auckland, New Zealand. 15-17 July 2015
39. Abarca-Guerrero, L., Maas, G., & Van Twillert, H. (2017). Barriers and motivations for construction waste reduction practices in Costa Rica. *Resources*, *6*(4), 69. https://doi.org/10.3390/resources6040069
40. Simpeh, E. K., & Smallwood, J. J. (2015). Factors influencing the growth of green building in the South African construction industry. In *Smart and Sustainable Built Environment (SASBE) Conference* (Vol. 2). Pretoria, South Africa, 9-11 December 2015.
41. Babazadeh, T., Nadrian, H., Mosaferi, M., & Allahverdipour, H. (2018). Identifying challenges and barriers to participating in the source separation of waste program in Tabriz, Northwest of Iran: A qualitative study from the citizens' perspective. *Resources*, *7*(3), 1-14. https://doi.org/10.3390/resources7030053
42. Nahman, A., Oelofse, S., & Haywood, L. (2021). Implementing Economic Instruments and Incentives to Divert Waste from Landfill. *A Guideline for National Government. Department of Science and Innovation. Report compiled by the CSIR*.

43. Rousta, K., Ordoñez, I., Bolton, K., & Dahlén, L. (2017). Support for designing waste sorting systems: A mini review. *Waste Management & Research*, *35*(11), 1099-1111. https://doi.org/10.1177/0734242x17726164
44. Ajayi, S. O., Oyedele, L. O., Bilal, M., Akinade, O. O., Alaka, H. A., & Owolabi, H. A. (2017). Critical management practices influencing on-site waste minimization in construction projects. *Waste Management*, *59*, 330-339. https://doi.org/10.1016/j.wasman.2016.10.040