

Project Waste Management and Recycling Reduce Project Material Expenses

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Abstract

To obtain the best project waste management or to save project material costs through recycling or reuse, consider construction waste management as a solution. The goal of construction waste management can take into account a variety of factors, including waste reduction, reuse, recovery, and disposal. The size, kind, location (Khudhair and Hamid, 2015). and volume of the project as well as whether it is a building or road project all affect the circumstances for managing construction trash. The development of methods, systematic practices, and the various ways waste management might affect project cost and efficiency are all covered in this article's analysis of the development of construction waste management and its efficacy during the previous fifteen years (Shwedeh, 2020). Additionally, workers' attitudes and behaviours regarding construction waste can be influenced by the significance of training, attitudes, and awareness in management procedures. To aid with green construction projects, take into consideration the 3Rs. However, by minimizing the need for resources, a recycling-focused approach can lower project costs and boost expected profits. Furthermore, implementing defined waste management plan results in less garbage being dumped in landfills and less threats to people (Aljasmī, S., 2022). The ideas presented in this paper might help analyse the waste master plan and take into account how well it works with construction projects. By reducing landfill waste, the Construction Waste Disposal Charging Scheme (CWDCS) proves the effectiveness of its waste management techniques. Take into account how the CWDCS strategy can affect the management system and lead to some control discrepancies in projects. According to Baskhan in Resources Conservation and Recycling (2017), a variety of elements, including employment experience, training, awareness of safety hazards, supervision, and peer pressure, can have an impact on how people act when it comes to managing rubbish. He also stressed the importance of these traits in managing construction waste and the advantages of adopting a behavior viewpoint to advance waste management practices. Construction waste management and waste and demolition management may differ in several ways. (Salameh , 2022).

Keywords: *Waste Management, Recycling, Construction Waste Disposal Charging Scheme (CWDCS).*

1. Introduction

Project management has an effect the management, planning, and control of many different initiatives. Management effectiveness has a lot to do with the procedures, guidelines, and standards that are implemented in the management control system. The

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rubbish generated by the building industry poses a serious threat to the environment (Formoso, 2002). This findings indicates that management of construction waste is a critical aspect of sustainable development in the construction industry. Notably, with the increase in urbanization and infrastructure development, construction activities generate a significant amount of waste. (Alsaud, and Yas, 2021). The proper management of construction waste is necessary to minimize its environmental impact and promote resource efficiency (Ravikumar, 2022). One of the key strategies for managing construction waste is adopting a waste management plan. This plan includes measures to reduce waste generation, such as purchasing materials with minimum packaging or recyclable materials (Lu, 2011). It also outlines strategies to reuse and recycle waste materials on-site, such as concrete, timber, and metals. It implies that implementing a waste management plan, construction firms can significantly reduce the amount of waste sent to landfills, conserving resources and minimizing the carbon footprint of their projects (Shwedeh,, Hami and Bakar, 2021). The other significant aspect of construction waste management is promoting awareness and training among employees and workers. Markedly, construction site workers should be educated about proper waste segregation and disposal practices. This can be achieved through regular training sessions and the use of clear signage and labeled waste bins. By encouraging worker participation and awareness, construction companies can ensure that waste is disposed of correctly and efficiently, leading to a cleaner and environmentally friendly construction site. Furthermore, collaboration with waste management companies and recycling centres is essential for effective waste management in the construction industry (Khudhair and Hamid,2015). By partnering with these entities, construction companies can ensure that waste is collected, sorted, and recycled appropriately (Ameh and Daniel, 2013). Waste management companies can provide dumpsters and recycling bins on construction sites, making it easier for workers to dispose of waste correctly. Recycling centres can process and recycle materials such as concrete, metal, wood, and plastics, transforming them into reusable products. Through these collaborations, construction waste can be diverted from landfills and turned into valuable resources (Yas, H., Alnazawi, 2022).

Consideration management encompasses a wide range of projects, but it also focuses on quality, cost, and time efficiency. The size of the materials used in a project is related to the enormous development in construction projects today. Utilizing readily available resources and waste management practices is crucial to organizing, sorting, reducing, reusing, recycling, recovering, and achieving zero landfills. Projects that are successful in terms of quality, cost, and timeliness implement transparent and effective management (Khudhair and Mardani, 2019).

Many factors view waste management as a crucial component that may be improved and developed the projects from various angles. A study found that the cost of construction projects is between 21 and 30 percent accounted for by waste materials (Ameh and Daniel, 2013). Waste management focuses on keeping waste under control and limits disposal to landfills. The waste management system that has been put in place will make sure that every construction site manages waste segregation and reduces waste to ensure that the cost of the projects and the amount of materials, which have an impact on the project budget, are minimized (Aburayya. and Shaalan, K., 2023). Additionally, the usage of construction waste management lessens rubbish in landfills, a long-standing issue, and safeguards the environment from hazardous building materials. The challenges of construction waste management are to include how to handle construction waste and how to dispose of it in a green way that does not harm the environment in project scope (Alsaud, A. B., Yas, H., & Alatawi, A., 2021). However, from a management standpoint, it is important to take into account the large number of fleets of concrete trucks that pour thousands of cubic meters of concrete at numerous construction project sites in a single day, as well as the fresh concrete from fleets that use recycling or landfilling methods (Shwedeh, 2022). By combining two or three ways to build a reliable waste management method, the CWDCS approach and the 3Rs principal can have an impact on the waste

management system. Strategies and practices for managing waste from construction and garbage from demolition must differ significantly (Yas, H., Mardani, A., & Alfarttoosi, A., 2020).



Figure 1. Construction waste

2. Theoretical background

Applying optimum waste management practices can improve the sustainability and quality of a project (Kulatunga, 2006). A study on construction waste in China found that 1.5 billion tonnes of it were made from recycled materials (ShuweiJia, Guangle Yan, Aizhong Shen, Jun Zheng, 2017). The quantity of garbage produced was investigated using the qualitative analysis (Lu, 2011). The value of construction waste management is significant today. The significant increase in waste landfills has an effect on the environment (Poon, 2003). The core idea behind the 3Rs is to reduce the price of materials, cut back on transportation and disposal costs, and make money by selling waste (Bossink and Brouwers, 1996; Yuan, 2013). The application of the 3Rs has an impact on stockholders including owners, contractors, and employees (Johnston and Mincks, 1995). The country loses money, time, and has an adverse effect on the environment when it does not take sustainable waste construction management procedures into account (Lu and Yuan, 2010).

Lack of training has an impact on how waste is managed. The way a person handles their garbage depends on their mind-set (Begumet, 2009). By increasing employees' awareness of the need of protecting the environment and financial resources, construction waste management performance can be enhanced (Yuan, 2013). If awareness-raising training is undertaken, recycling may benefit (Sidique, 2010). Training has a beneficial effect on reducing trash and raising recycling knowledge (Osmani, 2008; Udawatta, 2015). Waste can be avoided by developing personal factors (Loosemore, 2002). Due to the impact of project expenses, clients place less priority on waste management (Guthrie, 1995). Construction waste involves more than just processing expenses; it also involves the disposal procedure (Hao, 2008). To meet waste management goals, stockholders need to be aware of the requirements for waste management (Manowong, 2012). According to culture and economic factors, trash size varies per nation (Kourmpanis, 2008). Sustainability, and quality are achieved in the building industry through clear waste management practices (Kulatunga, 2006). Waste management strategies can lower the cost of material use (Lingard, 1997). The risk to humans associated with garbage disposal can be reduced, and landfill space can be reduced, with proper waste management (Lingard, 2000). Organizing waste management contributes to higher productivity and secure development sites (Gavilan and Bernold, 1994).

Bakshan comes to the conclusion that characteristics like training, work experience, supervision, and social pressure might affect how construction waste management is conducted. Shen (2004) asserts that excavation, road construction, building and demolition activities, as well as concrete, steel, and wood, have contaminated site components.

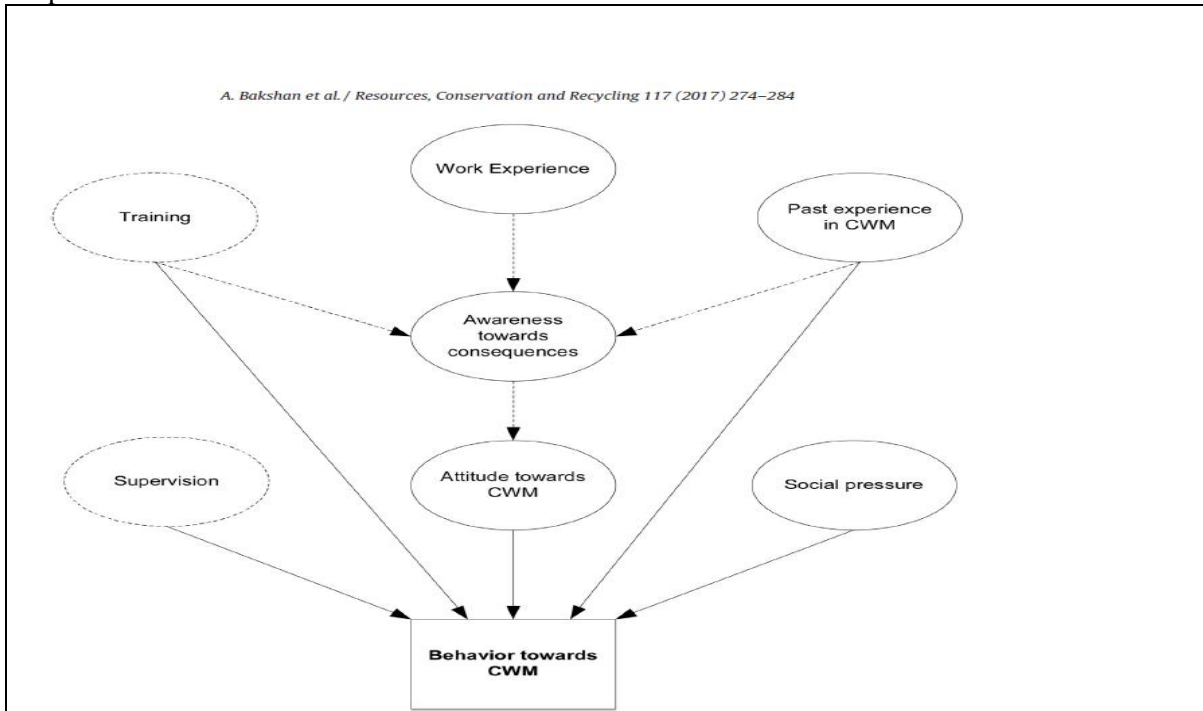


Figure1. Resources, Conservation and Recycling 117 (2017) 274–284 by A. Bakshan

It's crucial to concentrate on the planning stage of the building development in order to reduce waste in construction projects (Poon, 2004). The creation of garbage can be decreased by supporting waste management procedures in the building sector (Poon, 2004; Wang, 2008). In the construction business, a suitable site area should be set aside to design storage and equipment segregations for waste management (Peng, 1997; Wang, 2010). The location does not have adequate room for trash management, and the effectiveness of waste management depends on how easily recycling infrastructure is accessible in the area (Lingard, 2000). By focusing on the manufacturing processes and creating value along the way, lean principles can be applied to all waste management methods to reduce waste (Thomas, 2002; Zhang and Chen, 2010). By relying on prefabricated technologies, it is possible to overlook the production of building waste (Tam, 2007). The average reduction in building waste caused by employing ready-made methods is 52%. The prefabricated approach is also organized, saves the environment, and cuts down on labor time. However, relying on pre-made techniques will not prevent building waste. The limitations of prefabricated technology include transportation, production flexibility, and site constraints (Jaillon, 2009).

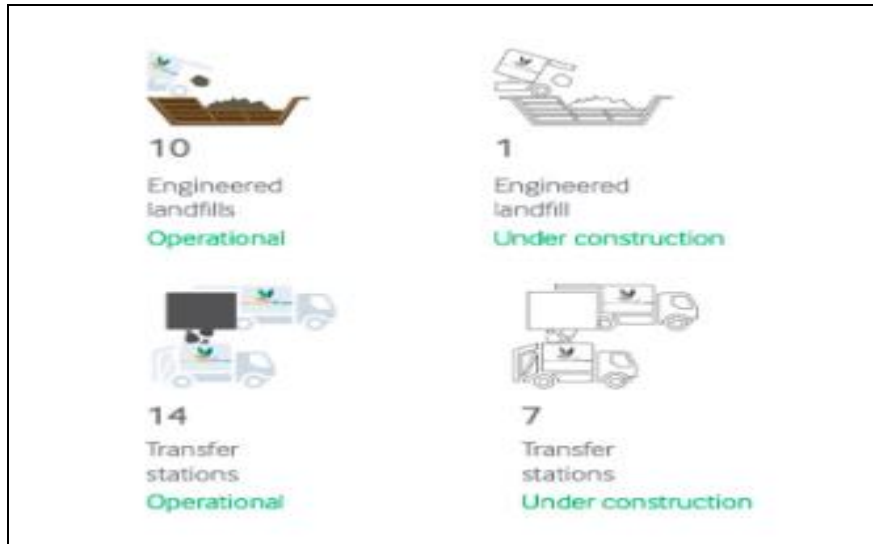


Figure 2. Waste infrastructure

All stakeholders should contribute to and make immediate steps to prevent and minimize waste (Alwi, 2002; Manowong, 2012). To control construction trash right away, pick and include people in your waste management plan (Johnston and Mincks, 1995). To understand and manage the waste requirements, conduct a methodical examination on the site (Poon, 2004). In order to enforce good waste management in project domains, researchers have noted the significance of communication (Poon, 2004; Wang, 2008). Waste is decreased as a result of good communication between contractors and subcontractors (Gavilan and Bernold, 1994). Join the two parties' waste management strategies together (Teo and Loosemore, 2001). As a result, communication is effective and unambiguous (Gavilan and Bernold, 1994; Kulatunga, 2006). There should be frequent meetings with employees to address the problems with waste management (Lingard, 2000). Determine how responsive the project's members are to making waste management improvements (Wong and Yip, 2004). Training and knowledge expansion are two efficient ways to reduce waste management (Wang, 2008). Staff waste management education is essential to develop better WM strategies that link the value of time, money, quality, and safety in construction projects (Johnston and Mincks, 1995).

Increase the effectiveness of waste management by focusing on the critical role associated with stakeholders' openness to resource and environmental conservation (Yuan 2013). Despite managers' statements to the contrary, workers believe behaviour training is inappropriate (Lingard, 2000). Environmental considerations must be taken into account during the procurement process (Wang, 2008). To promote and enhance contractors' awareness of waste management, rules and procedures must be put into place (Manowong, 2012). Legislation and regulations are important tools for motivating architects to create waste plans for construction projects (Osmani, 2008). Implement crucial plans and procedures to reduce waste (Merino, 2010). Policies and regulations governing building sites should take behavioral changes into consideration (Lingard, 1997). The findings of a study carried out by the city of Hong Kong demonstrate the effects of the Construction Waste Disposal Charging Scheme (CWDCS). There is no guarantee that these trends will continue in the next three years, despite landfill waste being reduced and waste management techniques being improved in the first three years of CWDCS implementation (Yu, 2013). When CWDCS was adopted, there was a modest reduction in waste (Poon, 2013). Incentives can change employees' attitudes about waste (Lingard, 2000). According to Osmani (2008) and Skoyles and Skoyles (1987), the avoidance of waste management can be impacted by changing staff attitudes. One way to reuse trash is to educate people about the negative effects of waste and the positive effects of reuse, recycling, and effective material management (Poon, 2004). The financial

advantages of managing construction and demolition waste for all parties have been shown in numerous studies (Coelho and Brito, 2013; Zhao, 2010). Lu (2016) estimates that 1.13 billion tonnes of waste from construction and demolition were handled in 2014.

3. Research gaps

It's crucial to study the results and identify some potential routes to take the investigation because there are some gaps in the research that need to be addressed in order to evaluate the missing pieces and fill in the information gaps. Applying best practices for the management of construction waste requires a number of steps, including reduce, reuse, recycle, recover, and eliminate landfills (Streimikiene, 2020). In order to continuously enhance the system as a whole, the optimal method should be used at each level. For instance, decreasing waste required the use of an appropriate quantity survivor to establish the appropriate project material quantity, which helps reduce the use of unnecessary additional resources (Yas and Alfarttoosi, 2020). However, rather than viewing resources as waste, it is advantageous for the environment to reuse them at various construction sites. Recycle another significant technique component that needed stabilization at project sites (Al Mansoori and Alessa, 2021). The recycling process is being subjected to several procedures that have an impact on efficient waste management techniques, including cost, quality, and time. Recover the recycling process' initial step, which needs energy production to get going. However, the use of effective waste management techniques is essential to eliminate landfills. For instance, one practical strategy to reach zero waste at landfills is to start from the early stages of trash management, such as the reduction and reuse stages (Yas, Almaghrabi and Othman, 2021).

Reducing, reusing, and recycling waste is the second pillar of 3R's, which is to protect the environment. Poor construction management can be seen when only using the 3Rs. Analyzing the core concept will show how well the waste management system is doing. The combined waste integrated waste management system with the 3Rs principle to investigate the management phase all stakeholders is not available in this section (Khudhair, 2020). The literature review's constraint on sustainable waste management practices does not make clear what the practices should include in project tenders, which demand that all stakeholders monitor and adhere to it.

Thirdly, minimal waste management cannot be ensured by only doing training and creating awareness. For example, the project's waste management practices should be based on the goals and business plans that are KPI-measured. Following the development of reliable procedures that insist on the use of waste stages such as manage trash and recycle, it is essential to implement training and raise employee understanding of waste management (Streimikiene, 2019).

Fourth, the cost of recycling, a stage in the waste management cycle, is one area where the study is lacking. Due to the expenditures involved in creating the waste facility, a project's restrictive budget may have an effect on the waste management component of the project. Additionally, the waste master plan lacked details on how to make plans and account for crucial elements like project size, quantity, and hazardous building materials (Kulatunga, 2006).

Fifth, there is still study to be done in the field of managing garbage at construction sites with congested space, which has an impact on waste management techniques. Pick locations for trash facilities, though, that encourage the preservation of materials for recycling or reuse. Additionally, recycling facilities that can recycle materials were built on building sites (Yas and Alfarttoosi 2020). Sixth, rebuilding methods that enable the recycling of construction materials and stop rubbish from being dumped into the environment are another topic that needs exploration. The research mostly focuses on

transportation, which is expensive, rather than safeguarding the environment from hazardous elements after it is demolished. Additionally, give instructions that demand that everyone engaged follow them and carry out the appropriate tasks (Khudhair and Hamid, 2015) Seventhly, when waste management is involved with demolition, it is handled differently from when waste management is involved with construction. The constraints of the literature review demonstrate that the primary goal of construction waste management is to control development fields and sites when developing or building roads. However, the primary challenge of garbage and demolition management is how to handle the waste that is left over when a project is completed. Concerns exist surrounding plans for demolishing structures, roadways, and trash management (Aburayya and Shaalan, 2023).

4. Possibility of expanding existing literature

There are different ways to look at the chance to develop research. It is crucial to specify which building materials can be recycled and reused (Alsaud, and Alatawi, 2021). There should be appropriate management criteria for different sorts of materials. For instance, the types, quantities, costs, and timeliness of the waste materials generated during building and road construction are different. trash is frequently managed using a single strategy, however when handling trash for several projects and materials at once, it can be challenging to identify precise objectives and targets. Examining recycling practices and how trash is reduced through their use could enhance the literature review (Yas and Alfarttoosi 2020). The current focus of the literature review is on the effectiveness and cost of waste management via recycling in the construction industry. Examples include reduction, reuse, recycling, recovery, and disposal in the hierarchy of waste management. Overall, recycling strives to lessen the demand for new materials by reusing and recovering the materials through recycling techniques that avoid disposal and result in the creation of zero-waste landfills. Control techniques can minimize waste and encourage reusing (Alsaud, and Alatawi, 2021).

Table 1. Research Gaps and Possibility of Expanding Existing Literature

Researcher (Year)	Research Gaps and Possibility of Expanding Existing Literature
Wang (2008)	Specific building materials suitable for recycling and reuse should be identified.
Yu (2013)	In-depth analysis of recycling costs in waste management cycles.
Manowong (2012)	How project tenders should include waste management practices.
Merino (2010)	Crucial plans and procedures for waste reduction.
Lingard (1997)	Policies and regulations considering behavioral changes in waste management.
Lu (2016)	Focus on managing garbage in construction sites with congested space. Rebuilding methods to recycle construction materials effectively.
Lingard (2000)	Changing staff attitudes impact on waste management.

The literature analysis could be extended to apply waste management costs and examine efficacy from a variety of angles (Kulatunga, 2006). Although determining the cost of

waste management will serve as a starting point for project expenses. By keeping an eye on waste management expenses, it is possible to determine if recycling facilities should be installed on construction sites and whether materials should be recycled rather than sent to landfills (Yas and Alfarttoosi 2020). Different resources are employed when garbage from construction projects is reused, recycled, and released, according to analysis of waste management practices. One of the criticisms of the literature analysis is that it concentrates on management techniques rather than establishing a system that assigns duties and commitments and requires stakeholders to take part in waste management methods (Khudhair and Hamid, 2015). The research restriction argues that all site employees' conduct and attitudes must be professional, but what happens when the stack holder fails to apply the waste system? However, due of the relevance of the hazardous materials that will be handled, risk analysis of waste management should be taken into consideration. On project sites, building materials must to be divided in a safe manner (Aburayya and Shaalan, 2023). Furthermore, establishing sustainable waste management is necessary for the process and implementation of waste management efficacy toward recycling technologies such as the 3Rs principal's application, might be integrated (Salameh ,Salloum and Varshney, 2022). Construction waste management and garbage and demolition management must be handled in two distinct ways, each with its own procedures and processes (Alsaud, and Alatawi, 2021).

Research questions

The articles that are included have some research questions. The questions include a variety of topics, such as:

1. How do building projects fare when waste management plans are implemented?
2. What effect does employee behavior have on construction waste management?
3. How might the 3Rs principle impact management of construction waste?
4. How might recycling be used in construction projects to lessen the amount of waste that ends up in landfills?
5. How do projects fare with the Construction Waste Disposal Charging Scheme (CWDCS)?
6. Can all parties involved contribute to and work on projects to manage construction waste?
7. How can the project team and stakeholders better deliver the construction waste management procedure?
8. How do construction projects respond to waste management hierarchy?
9. How should construction waste management and waste and demolition management methods and procedures be put into practice?
10. How does merging the 3Rs principle affect garbage and demolition management?

5. Literature review

Construction waste management is a vital aspect of sustainable construction practices because it aims at promoting recycling and reuse, reducing waste generation, and minimizing environmental impacts. Notably, when waste management strategies are implemented effectively, it can contribute to increased project efficiency and cost savings (Shwedeh, 2020). In this literature review, the focus is placed on exploring the development and efficacy of construction waste management practices over the past fifteen years. In addition, the factors that influence waste management decisions, workers' behaviours and attitudes are also discussed. In the same way, other factors like

the significance of training and awareness as well as the impact of waste management plans on project outcomes are discussed.

There are several studies discussing the factors affecting construction waste management. According to Wang (2008), the size, type, location, and volume of construction projects significantly influence waste management decisions (Shwedeh,2020). The author adds that construction waste management plans should consider waste reduction, reuse, recovery, and disposal. In support of this, Yu (2013) emphasize the importance of integrating waste management strategies modified to meet the specific circumstances of building and road projects. It should be noted that construction waste management is a critical aspect of the construction industry that has recently received increased attention due to its environmental implications (Baker, 2020). Yu (2013) highlights that large-scale projects such as skyscrapers or infrastructure developments tend to generate more waste compared to smaller residential or commercial buildings. Additionally, the type of construction project, such as demolition or renovation, can also influence waste generation and management approaches (Aburayya and Shaalan, 2023). Other important factor affecting construction waste management is the level of awareness and commitment to sustainability among construction stakeholders.

Table 2. Factors Affecting Construction Waste Management

Researcher (Year)	Factors Affecting Construction Waste Management
Kulatunga (2006)	Application of optimum waste management practices for sustainability and quality improvement.
Shuwei Jia et al. (2017)	Recycling of 1.5 billion tonnes of construction waste in China.
Lu (2011)	Investigation of the quantity of garbage produced using qualitative analysis.
Poon (2003)	Significant increase in waste landfills and its environmental impact.
Bossink & Brouwers (1996), Yuan (2013)	3Rs principle: Reduce material costs, transportation, and disposal costs while making profits.
Johnston & Mincks (1995)	Impact of 3Rs on stakeholders, including owners, contractors, and employees.
Lu & Yuan (2010)	The importance of sustainable waste construction management procedures.
Begumet (2009)	Lack of training affects waste management and depends on mindset.
Yuan (2013)	Awareness-raising training can benefit recycling efforts.
Osmani (2008), Udawatta (2015)	Training's positive effect on reducing trash and increasing recycling knowledge.
Loosemore (2002)	Personal factors contribute to waste avoidance.
Guthrie (1995)	Client priorities on waste management affected by project expenses.

Hao (2008)	Construction waste involves both processing and disposal expenses.
Manowong (2012)	Stakeholders need awareness of waste management requirements.
Kourmpanis (2008)	Trash size varies per nation based on culture and economic factors.
Shen (2004)	Excavation, road construction, building, and demolition activities contaminate site components.

Markedly, construction companies that prioritize sustainability are more likely to implement effective waste management practices (Salameh, Salloum and Varshney, 2022). For instance, companies that adopt green building standards or use environmentally friendly materials are more likely to have proper waste segregation and recycling programs in place (Wang, 2008). On the other hand, in the absence of awareness or commitment to sustainable practices, waste management may be neglected, leading to detrimental consequences for the environment. Furthermore, the availability and accessibility of waste management facilities and services also impact construction waste management practices. It implies that construction sites located in areas with convenient access to recycling centers and waste management services have a higher likelihood of effective waste diversion practices. Conversely, sites located in remote or underserved areas may face challenges in waste management, leading to improper disposal or excessive transportation costs (Aburayya and Shaalan, 2023). The availability of recycling facilities and waste management policies at the local or regional level also plays a crucial role in determining waste management practices at construction sites. In the same way, governments can enforce regulations that require construction companies to adopt and comply with waste management guidelines, including waste reduction, recycling, and proper disposal. Ideally, these regulations can incentivize the adoption of sustainable construction practices which encourages responsible waste management.

Table 3. Summary of Existing Waste Management Systems

Author & Year	Scope	Strength	Limitation
Pendley, (2005)	Composting Operation Technology at Riverton Disposal Site, Kingston, Jamaica	deals composting technology used for wealth creation in agriculture	not web based GIS based.
Troschitz (2005)	Sustainable Recycling of Municipal Solid Waste	identified cheap source of raw materials via recycling and	not web based GIS based.

Jennifer L. (2007)	Solid Waste Management	identifies solid waste and their management.	not web based GIS based.
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On the other hand, Yu (2013) discusses the role of 3Rs in Green Construction indicating that this approach plays a significant role in promoting sustainability in construction projects. Wong and Yip (2004) suggests that incorporating recycling-focused approaches can help projects to reduce the demand for resources (Salameh, Salloum and Varshney, 2022). As a result, it lowers the costs and improves the expected profits. More so, a study by Manowong (2012) has shown that implementing the 3Rs can positively impact waste management and contribute to the overall success of green construction initiatives. Additionally, Manowong (2012) indicates that waste management plans have a significant on the landfill waste. The author adds that construction waste disposal charging scheme (CWDCS) has emerged as an effective waste management tool that encourages reduced landfill waste. Research by Poon (2013) has demonstrated that CWDCS's implementation leads to less garbage being dumped in landfills, resulting in decreased environmental threats and improved waste management practices.

6. Methodology

Research Design is research will adopt qualitative data collection techniques. Utilizing this design will offer a comprehensive understanding of construction waste management practise together with their efficacy in the past 15 years (Aburayya and Shaalan, 2023). On the other hand, the qualitative aspect will involve theoretical analysis of waste generation data, recycling rates, as well as cost savings, while looking at the worker's attitudes and behaviours towards waste management. Data Collection of Waste generation and recycling information will be collected from a sample of construction projects completed in the past 15 years (Kulatunga, 2006). This data will be obtained from studies conducted on different construction companies, government agencies, and waste management authorities. In the same way, attitudes towards waste management will be explored to acknowledge the level of awareness of safety hazards and the training received regarding the effectiveness of waste management plans (Aburayya and Shaalan, 2023). Data Analysis is data obtained from different studies will be interpreted and subjected to thematic analysis. In addition, the findings will be categorized to determine common themes related to the significance of training and awareness of waste management practices, and workers' attitudes and behaviours. This will help in assessing the effectiveness of waste management plans across different project types. Ethical Considerations of Before collecting this data, I will ensure to use information that has been provided for public use. In case of incorporating data from organizations, I will seek for ethical approval to ensure protection of privacy and rights.

7. Discussion and analysis

Findings regarding the waste management strategies and their efficacy indicate that the analysis employed in construction projects within the past fifteen years reveals a positive impact on waste reduction, recycling, and cost-saving measures (Shwedeh, and Bakar, 2021). Notably, the implementation of waste management plans tailored to the specific circumstances of building and road projects has proven effective in mitigating waste generation. On the other hand, the projects that adopted the 3Rs (Reduce, Reuse, Recycle) approach demonstrated notable success in minimizing the demand for resources and

achieving cost savings through recycling initiatives. This shows the importance of incorporating sustainable waste management practices in construction projects to improve environmental sustainability and economic efficiency (Aburayya and Shaalan, 2023).

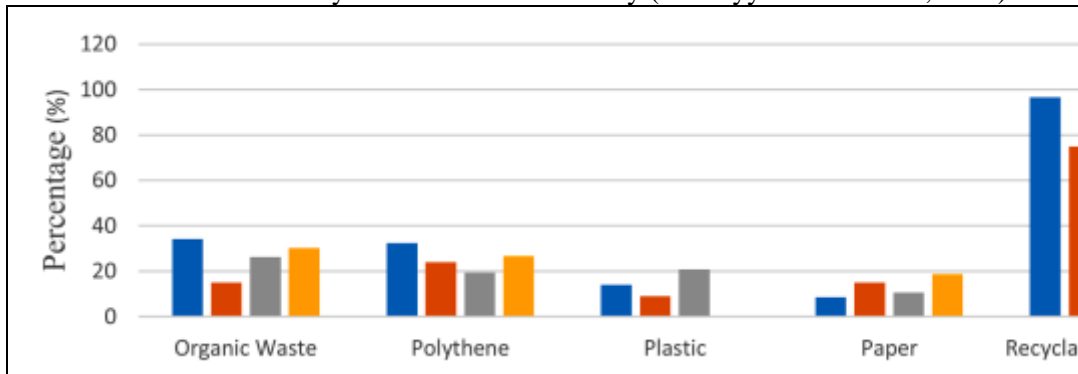


Figure 3. Major waste categories: Comparison of the major wastes

On the other hand, the worker’s attitudes and behaviours were analyzed in the study and it is provided that the factors play a significant role in construction waste management. It is stated that factors such as employment experience, training, awareness of safety hazards, supervision, and peer pressure significantly influence how workers handle waste on construction sites (Aburayya and Shaalan, 2023). It implies that proper training and awareness programs are crucial because they encourage responsible waste management behaviours among construction workers (Shwedeh, and Bakar, 2021). In the same way, the findings obtained in this study underscore the importance of behavioural-focused approaches in waste management practices. It is indicated that such approaches help to achieve positive outcomes and minimize environmental impacts (Aburayya and Shaalan, 2023).

Table 4. Quantities of Solid Waste Disposed of at Landfills

Waste type	Quantity (tpd)		
	Public	Private	Total
(a) Domestic waste			
- waste from household, public cleansing	5,822	1,644	7,466
- bulky waste	28	57	85
Sub-total	5,850	1,701	7,551
(b) Commercial waste			
- mixed waste from commercial activities	-	1,120	1,120
- bulky waste	-	68	68
Sub-total		1,187	1,187
(c) Industrial waste			
- mixed waste from industrial activities	-	534	534
- bulky waste	-	28	28
Sub-total		562	562
(d) Municipal solid waste received at disposal facilities	5,850	3,450	9,300 (55%)
(a+b+c)			
(e) Construction and demolition waste (landfilled)	-	6,408	6,408 (38%)

(f) Special waste (landfilled)	502	607	1,109 (7%)
(g) All waste received at landfills (d+e+f)	6,352	10,465	16,817

Notes: The Food and Environmental Hygiene Department's contractors and other government vehicles pick up public waste collectors.

Some commercial and industrial garbage is included in publicly collected home rubbish.

Animal carcasses, asbestos, clinical waste, confiscated products, livestock waste, sewage treatment and waterworks treatment sludge, sewage works screenings, and stabilized residues are examples of special trash.

from a facility that treats chemical waste

There has been an overwhelming promotion of environmental management and sustainable development in recent years. As a result, there is a growing awareness of environmental issues and the potential problems from deterioration of the environment (Shwedeh, and Bakar, 2021). Generally speaking, construction is not an environmentally friendly activity. Previous researches provided comprehensive reviews of the effects in construction activities (Alfarttoosi, 2020). These effects include land use and land deterioration, resource depletion, waste generation and various forms of pollution. In addition, the impact of waste management plans on landfill waste is discussed. It is presented that the implementation of the construction waste disposal charging scheme (CWDCS) has proved to be an effective waste management tool. As a result, it contributes to a reduction in landfill waste, which leads to minimizing environmental threats associated with landfills. More so, the CWDCS strategy successfully promotes recycling and encourages waste reduction measures, effectively diverting waste from landfills and improving overall waste management practices in construction projects (Kulatunga, 2006).

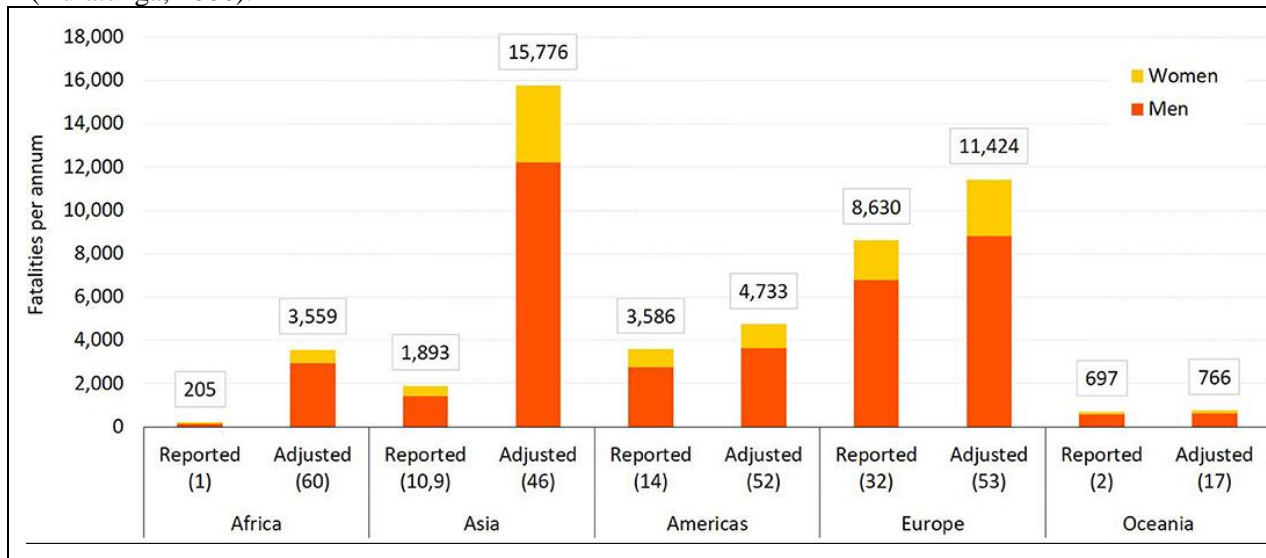


Figure 4. Deaths resulting from exposure to waste from different regions

Additionally, the study discusses the comparison between construction waste management and demolition waste management. The systemic review revealed notable differences between these two waste management practices (Shwedeh, and Bakar, 2021). Whereas construction waste management emphasizes waste reduction and recycling during the construction phase, demolition waste management prioritizes proper handling as well as disposal of waste resulting from building demolition. The findings in this study highlight the need for separate waste management strategies developed for every stage of the construction lifecycle (Kulatunga, 2006).

8. Limitations and Future Research

The study faced several limitations, including potential bias in self-reported data and limited generalizability due to the purposive sampling technique. Notably, the future research could address these limitations by incorporating a larger and more diverse sample to improve the study's external validity. More so, it is presented that conducting longitudinal studies to track the long-term impact of waste management strategies on project outcomes and environmental sustainability would provide valuable insights for the construction industry (Aburayya and Shaalan, 2023).

9. Implications and Recommendations

Based on the discussion and analysis, there are many several implications and recommendations that can be obtained to improve construction waste management practices (Alfarttoosi, 2020). The first thing to do is for project managers and construction companies to develop waste management plans customized to the specific characteristics of each project. Then, it is important to incorporate the 3Rs approach into waste management practices can lead to cost savings and promote sustainable construction (Aburayya and Shaalan, 2023). The other thing is to provide a comprehensive training and fostering positive attitudes among workers to improve waste management efficiency (Shwedeh, and Bakar, 2021). Lastly, the successful implementation of waste disposal charging schemes can be replicated in other regions to achieve similar waste reduction outcomes.

10. Conclusion

The research's conclusion is that all initiatives to reduce, reuse, recover, recycle, and attain zero landfills must consider building waste management. The study demonstrates the impact a waste master plan can have on construction projects from a variety of angles, including lowering the price of purchasing new materials, cutting down on the quantity of materials ordered, and achieving project sustainability by managing surplus building materials. The literature review also shows that the need for training and the attitudes of the workforce have a significant impact on how human behavior affects waste management (Yas, 2020). The system itself is affected when a waste management system is implemented without going through training and awareness requirements (Kulatunga, 2006). By reducing, reusing, and recycling waste, which attempts to reduce waste at landfills, save on transportation and disposal costs, and generate income from selling garbage, the 3Rs principle can have an impact on construction projects. Clients and stakeholders, on the other hand, are less concerned about construction waste because it takes money up front to develop the actual approach and put the process into place (Yas and Alfarttoosi, 2020).

Operations that recycle garbage are the best approach to cut waste. Recycling should be prioritized as a means to protect the environment and preserve resources (Kulatunga, 2006). There should be regulations and guidelines in place to guarantee contractors follow the waste management plan. How well the project manages trash will depend on how well the health, safety, and environmental strategy incorporates waste management criteria (Alfarttoosi, 2020). It can be challenging to manage waste when two separate systems and approaches are combined. For example, waste management in construction and demolition are two different things; as a result, these two aspects should interact in various concepts and methodologies, such the 3Rs principle (Aburayya and Shaalan, 2023). To guarantee proper waste management, it is essential that all construction projects include a waste master plan and strategy. Recycling, however, supports resource conservation and environmental protection (Salameh, Salloum and Varshney, 2022).

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