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The Factors Influencing Material Wastage on Construction Site

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Abstract

This study addresses building waste by identifying significant contributors and proposing viable solutions. Its main research aims are to uncover causes and provide practical solutions to decrease construction waste. The study interviews Gred 7 contractor in Johor Bahru, Malaysia, and prioritises material waste in residential and commercial projects. Despite a small sample size of 86 respondents, informative findings reveal important factors contributing to material waste, including insufficient site management (mean = 4.03), whereas strong inventory control reduces waste and improves construction efficiency. Teaching staff proper methods reduces waste from inefficient activities (mean = 3.92). Inadequate construction monitoring (mean = 3.91), a strong agreement, reduces errors and waste. Waste reduction may be achieved by simplifying operations, using Lean Construction Principles (mean = 3.98), and eliminating non-value-added jobs. Eco-friendly building methods (mean = 3.97), decreasing waste by using recycled resources. Emphasising recyclable resources enhances recycling efficiency and promotes sustainable architecture (mean = 3.94). These findings demonstrate the need for competent management and ecologically friendly waste reduction in construction projects. Further waste reduction requires innovative technology, circular economy concepts, and sustainable material research in building waste management.

1. Introduction

Recognising the role architects can play in waste reduction by incorporating sustainable design principles and fostering collaboration among all construction process stakeholders is an important aspect of the study. This is significant because architects have a substantial impact on the design and planning of construction projects, and their decisions can affect the generation of refuse materials (Osmani, M., *et al* 2019). Effective communication and collaboration between contractors and suppliers is importance in waste reduction. Adopting a collaborative procurement and supply chain management process can reduce construction site material waste. This emphasises

the need for streamlined communication and coordination between these parties in order to maximise material utilisation and reduce waste (Vasconcelos, Lia T., *et al*, 2021).

1.1 Research Background

In recent years, construction waste has become a significant environmental concern due to the industry's high refuse generation rates. The purpose of this report is to provide an overview of building waste issues, including their causes, effects, and possible solutions. Inefficient construction practices, dearth of recycling facilities, and excessive use of non-renewable resources are the root causes of building waste. In addition to concrete and steel, unsustainable building materials also contribute to construction waste. In addition, demolition, renovation, and construction generate a substantial quantity of building detritus (Anil Soharu *et al*, 2022). Construction refuse has a variety of detrimental effects on the environment. These include the degradation of land and soil, air and water pollution, and the devastation of habitats. Also significant are the economic effects of construction refuse, which include increased disposal costs and lost revenue due to inefficient practices. There are health hazards for construction workers and nearby residents, as well as a decrease in the quality of life due to the negative environmental consequences (Khalfan *et al*, 2021).

1.2 Problem Statement

Construction waste wastes energy, emits greenhouse gases, and depletes resources. These ecological and economic costs may be mitigated by reducing material waste. This issue affects architects, contractors, suppliers, and others. Studies (Soharu *et al*., 2022; Norman Miller *et al*., 2021) indicate that stakeholder collaboration may lead to effective waste management systems that prioritize segregation, recycling, and reuse. Ineffective stakeholder communication is a significant cause of material waste, highlighting the necessity for inclusive engagement in waste reduction activities (Khalid K *et al*., 2022). By using sustainable design and promoting stakeholder collaboration, architects may promote this transformation (Olanrewaju *et al*., 2020). According to Ahmed Ramadan (2023), collaborative procurement practices reduce material waste by requiring contractors and suppliers to communicate and collaborate. These findings highlight the necessity for stakeholder collaboration and communication to design effective waste management methods that reduce construction material waste (Ann T. W. *et al*., 2021).

1.3 Research Question

Based on the problem statement above, two main questions are formed as below:
(i) What are the factors that cause building waste on the construction site?
(ii) What methods to reduce the waste of building materials?

1.4 Research Objectives

Based on the research objectives above, two main questions are formed as below:
(i) To determine the factors that cause building waste on the construction site.
(ii) To suggest the methods to reduce the waste of building materials.

1.5 Research Scope

This research investigates Johor Bahru, Malaysia, building site material waste by interviewing contractors, managers, and workers. The research uses purposive sampling to choose Johor Bahru's building process-savvy construction personnel over the last five years. Due to waste, residential and commercial projects will be prioritized above industrial ones. Only material waste parameters are examined, leaving project cost, time, and quality for future research. This cohort and location are studied to comprehend Johor Bahru's construction industry's material waste.

1.6 Significance of the Study

The article stresses architects, contractors, and suppliers' crucial role in building waste reduction. Sustainable design and cooperation by architects save waste. Contractor-supplier cooperation improves procurement, waste, and resource use. Researchers help contractors identify and optimize wasteful construction processes, improving planning, coordination, and procurement. Architects may design buildings to be demolished or use recyclable and renewable materials to reduce waste. Sustainable procedures, eco-friendly options, and inventory optimization may decrease supplier waste. This research benefits the environment and communities outside business by saving energy, natural resources, greenhouse gas emissions, and sustainable trash disposal.

2. Literature Review

2.1 Factors that Cause Building Waste on the Construction Site

Several things produce construction waste. They may arise from procurement until project completion. Erroneous estimations or inadequate stakeholder participation may squander resources when overordering construction materials. Construction mistakes or design changes might waste materials (Erich Lawson, 2020).

2.1.1 Data Acquisition

Data acquisition for a construction project involves gathering essential project plans, requirements, and paperwork, including details about materials used, requested quantities, delivery dates, and waste disposal (Annabel Maw, 2023). This encompasses collecting architectural and technical blueprints that outline the project's design and component requirements (Michael Hennesy, 2022). Obtaining detailed measurements, quality standards, and necessary criteria for building materials facilitates accurate estimations and identifies alternative solutions (Tina Pringle, 2017). Gathering purchase orders and invoices offers insights into order amounts, expenditures, suppliers, and delivery timelines (Trevor Stansbury, 2020). Maintaining records of supply deliveries, including amounts, dates, and any damages, aids in tracking material quantities and detecting faults (Mark Wedel, 2019). Information on waste disposal methods, types, and quantities provides an overview of potential development areas and waste extent (Bretton Keenan, 2023). Keeping accurate inventory records enables tracking material consumption, identifying inefficiencies, and managing excess stock (Trevor Stansbury, 2020). Regular site inspections and observations provide data on material consumption, storage techniques, and generated waste (Jim Kane, 2023). Finally, conducting surveys and interviews with staff offers insights into material usage, waste, and potential areas for improvement (Jeff Raymond, 2022).

2.1.2 Observations Made Directly on Spot

Conducting thorough investigations directly at the construction site is essential to evaluate diverse building approaches, scrutinize material handling, storage, and utilization, and identify deficiencies in waste management processes (Mark Wedel, 2019). Observing the handling of building materials during delivery, storage, and transportation is crucial, focusing on signs of mishandling, improper layering, and inadequate protection (Carlos H. Caldas *et al*, 2015). Evaluating storage procedures and conditions, including stacking, sorting, and safeguarding methods, is imperative to prevent damage or degradation due to issues like overcrowding or improper practices (Volodymyr Barabakh, 2021). Attention should also be directed towards organizing and managing resources to address symptoms of inefficient inventory management, such as excessive buildup or inadequate record-keeping (Patrick Hogan, 2020). Monitoring resource utilization during project execution is vital to reduce waste, considering factors like excessive rubbish production, inadequate trimming, or mishandling (Sayaka Nishino, 2022). Scrutinizing waste management protocols, including sorting, disposal sites, and recycling programs, is essential for effective implementation in the workplace (Ravindra Ambegaonkar, 2019). Assessing the role of equipment in the building process is crucial to mitigate material loss due to inefficiencies or excessive use (Herb Brownett, 2020). Moreover, improving daily work practices, management, and training among construction workers is pivotal for enhancing productivity and minimizing material waste (Albert P. C. Chan *et al*, 2023). Adhering to material handling safety rules and precautions remains paramount to prevent accidents or damage leading to material loss (Ravindra Ambegaonkar, 2020).

2.1.3 Interviews with Persons Who Took Part in the Construction

Engaging in extensive interviews with various project stakeholders, including architects, engineers, contractors, suppliers, project administrators, and construction crew, is pivotal for understanding their perspectives on waste accumulation factors and fostering positive social transformation (Erich Lawson, 2020). Conversations with architects should delve into design goals' influence on material selection and strategies to optimize resource use while minimizing waste (Sori Tesema *et al*, 2021). Engineers' insights on structural requirements and cooperation improvements between design and construction teams to reduce material wastage are invaluable (Sam Kubba Ph.D., 2023). Contractors' interviews should focus on planning methods, challenges in waste reduction, and enhancing supplier communication for optimized material quantities (Cindy L. Menches, 2015). Discussions with suppliers about delivery issues and sustainable alternatives can offer key insights into waste reduction strategies (Celine Cherel-Bonnemaison, 2021). Engaging project administrators sheds light on project organization strategies, waste reduction approaches, and efficient trash management practices (Sheyla Serra, 2023). Finally, conversations with the construction crew provide valuable perspectives on challenges faced and suggestions for promoting environmentally responsible practices and waste reduction methods (Binxin Yang, 2020).

2.1.4 Waste Tracking and Examination are being Done

Establishing an effective waste monitoring system to track, measure, and analyze various types and quantities of waste generated during construction projects is crucial for informed decision-making and waste reduction (Lance Hodgson, 2021). Implementing a methodical tracking process involves producing waste monitoring reports, utilizing technology, and initiating waste management initiatives as the project progresses (Paul Netscher, 2016). Maintaining records of losses incurred during handling, storage, or transportation is essential, encompassing damaged or missing items due to negligence or poor storage conditions (Woyesa Ararsa *et al*, 2021). Accurately documenting the amount of waste generated at different stages, including discarded materials due to measurement errors or design alterations, is crucial (Abd Razak Omar *et al*, 2018). Comprehensive documentation of removed or omitted project components due to design changes or outdated items aids in understanding waste streams (Rhonda Sherman, 2018). Consistent data collection and analysis allow for the identification of recurring waste patterns, facilitating targeted waste reduction efforts (Mohamed Osmani *et al*, 2019). Leveraging waste data to identify areas for improvement, such as procurement processes, storage conditions, material handling, and recycling initiatives, is essential (R. Prakash *et al*, 2019). Subsequently, implementing remedial actions based on waste analysis findings, including alterations in project planning, enhanced stakeholder cooperation, additional training, or sustainable alternative exploration, becomes imperative for effective waste reduction (Binglin Guo *et al*, 2022).

2.1.5 Looking at Trash

Conducting a waste audit through meticulous inspection and classification of on-site waste is crucial for understanding its composition and origins, providing valuable insights into waste generation (Erich Lawson, 2020). Sorting and categorizing trash into distinct groups based on material types and relevant characteristics enable a comprehensive understanding of waste streams (Liang Wang *et al*, 2020). Analysing the component parts of waste sheds light on the prevalent items being discarded, aiding in understanding factors contributing to significant waste generation (Won-Jun Park, 2020). Moreover, tracing back waste sources to specific construction procedures, activities, or site locations helps identify the root causes of waste generation (Kambiz Ghafourian *et al*, 2018).

2.1.6 Analysing Data and Determining the Elements That Influence it are Two Types of Data Analysis

Analysing accumulated data, observations, and stakeholder input is pivotal in identifying prevalent causes of material waste in construction projects, including inadequate planning, incorrect material management, excessive procurement, design modifications, cooperation issues, and site-specific challenges (Tareq Khaleel, 2018). Conducting a comprehensive examination of project data and stakeholder feedback provides a foundation for targeted waste reduction methods (Muhammad Bila *et al*, 2016). Simplifying the procurement process through sustainable practices, like accurate material computation and exploring sustainable alternatives, aids in reducing leftover resources and overordering, thus curbing waste generation (Shannon Greaney, 2021). Identifying and addressing site-specific variables contributing to waste, such as adverse weather or storage limitations, and implementing professional waste management practices like improved storage and safety measures, are instrumental in reducing waste in challenging areas (Joe Lindemann, 2022).

2.1.7 Options and Recommendations are Provided

To effectively reduce material waste in construction projects, several strategies should be considered based on discovered reasons, including promoting sustainable design concepts, enhancing material handling and storage procedures, and fostering exceptional communication among stakeholders (Tom Napier, 2016). Improving planning and coordination processes on construction sites is crucial to minimize unnecessary material purchases, errors in specifications, and resource mismanagement. Precise forecasting of material needs, controlling overordering, and fostering good communication among stakeholders significantly reduce waste and enhance resource utilization (Salman Zafar, 2022). Additionally, modifying procurement procedures through meticulous needs analysis, consideration of environmentally friendly alternatives, and implementing just-in-time delivery systems can minimize excessive resource wastage, ensuring the appropriate quantity of supplies is ordered at the right time, thereby enhancing resource efficiency (Salman Zafar, 2022).

2.2 To Suggest the Methods to Reduce the Waste of Building Materials

Construction waste may be reduced in several ways. Sustainable design should optimise resource efficiency, minimise waste creation, and reduce waste output. Modular components, standard dimensions, reuse, and

disassembly are included. Based on project parameters, estimate material quantities. This requires accurate take offs, computerised quantity computations, and consideration of building material losses (Daniels, 2016).

2.2.1 Efficacious Planning and Layout of the Building

Leveraging good project planning and design approaches is crucial to accurately estimate material needs and quantities, subsequently boosting resource efficiency and reducing material waste (Diana Ramos, 2017). Precise estimation of building supplies considers various project aspects such as structure size, components, finishing, and material requirements, ensuring accurate material estimates (Bruno Pasini *et al*, 2023). Improving design efficiency by adopting techniques like prefabrication, modularity, and defined proportions minimizes waste from cutting and material usage (Anuj Srivastava, 2018). Opting for environmentally friendly materials with longer lifespans, recyclability, and reduced negative environmental impact aids in waste reduction (Jean-Marc Moulin, 2021). Implementing value engineering approaches to explore cost-effective alternatives while maintaining quality and performance helps in finding efficient and eco-friendly solutions (Tathawade, 2015). Fostering collaboration and open communication among project stakeholders, including architects, engineers, contractors, and suppliers, ensures alignment with project goals and facilitates valuable insights for material selection and waste reduction strategies (Billy Guinan, 2023).

2.2.2 Choosing Components that are Kinder to the Natural World is a Crucial Step

Utilizing environmentally preferable and durable materials, including recycled or repurposed resources, aids in reducing landfill waste and minimizing the need for virgin materials (Phanos Hadjikyriakou, 2021). Opting for recycled materials like steel, recovered timber, recycled concrete aggregates, and plastics lessens reliance on new resources and reduces landfill dumping (Duncan Wiliams, 2019). Preferring renewable materials such as bamboo, cork, and sustainably sourced lumber lowers environmental impact and encourages repeated recycling (Christelle Rabbat *et al*, 2022). Considering materials easily recyclable or reusable, like glass and aluminium, promotes a circular economy and significantly reduces waste production (Benedette Cuffari, M.Sc., 2016). Selecting items produced with low emissions, reduced energy consumption, and environmentally beneficial components like low-carbon cement and eco-friendly paints minimizes negative impacts on the natural world (Isidore C. Ezema, 2019). Conducting Life Cycle Assessments (LCAs) to evaluate a material's environmental impact across its life cycle, including extraction to disposal, aids in informed decision-making based on potential contamination, embodied energy, and carbon footprint (Anderson, J., D. Shiers, *et al*, 2022). Prioritizing materials certified by BREEAM or LEED ensures adherence to predetermined environmental standards, promoting sustainable choices (Isidore C. Ezema，2019).

2.2.3 Accuracy is Required in Both Purchasing and Inventory Management

Implementing accurate procurement strategies and efficient inventory management systems is crucial to avoid overordering, reduce excess stock, and prevent waste from expired or damaged items (Pushpendra Kumar Sharma *et al*, 2022). Accurate material procurement through comprehensive assessments and considering project needs minimizes overordering and unnecessary inventory, ensuring only essential purchases are made (Farzaneh Golkhoo *et al*, 2019). Prioritizing environmentally conscious purchasing practices, such as buying from local suppliers and opting for eco-friendly options, minimizes emissions from transportation and supports sustainable initiatives (Marta Holyk, 2023). Implementing just-in-time delivery systems reduces on-site storage needs, mitigating the risk of items becoming obsolete or damaged due to prolonged storage (Svetlana Besklubova *et al*, 2019). Efficient inventory management involving consumption trend tracking and rotation scheduling prevents items from expiring or becoming obsolete (Krista Fabregas *et al*, 2023). Emphasizing waste reduction and reuse within inventory management involves reprocessing leftover materials, reclaiming usable products, and implementing effective material recovery procedures (Melanie, 2018). Additionally, employing proper material storage and management practices, including adequate storage facilities and worker training, prevents deterioration or damage to materials (John Mathew, 2023).

2.2.4 Separating Recyclable Materials from Rubbish is Required

Implementing on-site procedures for segregating recyclable materials from other waste is crucial for effective waste management in construction (Madeh Izat Hamakareem, 2019). Establish segregation stations with properly marked containers for recyclables, non-recyclables, hazardous items, and organic waste, ensuring clear signage

and easy access for employees (Paul Cox, 2016). Conduct training sessions to educate construction workers about waste segregation techniques, environmental benefits, and the importance of recycling (Hongping Yuan, 2020). Utilize educational posters and signage across the site to reinforce waste segregation practices and proper disposal areas, maintaining open communication for addressing queries or concerns (Tom Napier, 2016). Collaborate with recycling facilities and waste management firms to ensure appropriate handling and processing of various site-generated wastes (B H Widayanti, 2017). Track and record the types and quantities of generated waste, including recycled and correctly disposed amounts, to assess waste management efficacy (Cassie Bottorff *et al*, 2023). Conduct regular waste audits to evaluate segregation initiatives, monitoring waste management procedures for necessary adjustments (Marcela Spisakova, 2021). Encourage continuous improvement by soliciting input from stakeholders and employees, considering incentive programs to actively engage staff in recycling and segregation activities (C. William Young, 2015).

2.2.5 On-site Material Reuse

Encouraging material reuse throughout construction and remodelling projects significantly reduces landfill waste and positively impacts the project's economy and environmental footprint (Adrian Arenas, 2016). On-site recycling minimizes landfill contributions, making construction more environmentally friendly and resource-efficient (Fahzy Abdul-Rahman, 2014). Utilizing salvaged materials on-site or from completed projects cuts construction costs and enhances overall project economics (J. Paul Guyer, 2022). Strategic dismantling and storage of reusable items like masonry, timber, windows, and fixtures prevent damage and enable their future reuse (Katherine Gallagher, 2022). Considering salvaged materials during the project planning phase, integrating them into new construction, and collaborating with architects and designers ensures effective design integration (Athena Waligore, 2020). Assessing salvaged materials for adaptability, making necessary repairs or modifications, and fostering collaboration among stakeholders maximize material reuse opportunities (Gaurav Mishra, 2022; Katrin Knoth, 2022). Maintaining detailed records of reused materials aids in monitoring environmental and economic benefits for future decision-making (Megan White, 2017).

2.2.6 A Material Storage and Management System that Works Effectively

Employing suitable approaches for material handling and storage significantly impacts resource longevity and waste reduction, safeguarding materials from deterioration and damage throughout the project (Ravindra Ambegaonkar, 2023). Meticulous administration and storage processes maintain materials in optimal condition, minimizing risks of degradation, spoiling, or damage, while appropriate storage environments such as dry and sheltered spaces further ensure material integrity. These practices reduce waste, mitigate the need for material replacements, and contribute to cost savings, positively impacting project timelines and overall efficiency (Dan Taylor, 2019).

2.2.7 Education and Teaching are Equally Important and Necessary

Educating construction workers and project stakeholders about waste reduction measures is crucial for implementing sustainable practices within the construction industry (Madeh Izat Hamakareem, 2019). Through various training and educational efforts, individuals gain awareness of the environmental impact of material waste and the necessity of reducing it. This awareness fosters a sense of responsibility and encourages active participation in waste reduction initiatives. Equipped with knowledge about proper management, storage, and disposal of materials, workers are empowered to make informed decisions that contribute to minimizing waste generation (Edward Ayebeng Botchway *et al*, 2023).

2.2.8 Communication and Working Together are Really Important

Encouraging collaboration and communication among architects, engineers, contractors, and suppliers plays a vital role in waste reduction efforts within projects (Kendall Jones, 2021). When these stakeholders actively engage and share their expertise, it fosters a collective responsibility toward waste reduction goals. This collaborative approach enables the identification of potential waste sources and facilitates the implementation of innovative solutions. Involving various professionals ensures a comprehensive understanding of waste reduction practices, pooling diverse insights, and considering the project's entirety for more effective waste management (Samuel Senyah Asare *et al*, 2023).

2.2.9 Frequent Monitoring and Assessment are Strongly Encouraged

Keep track of the amount of material that is utilised, the amount of waste that is created, and the ways in which the amount of waste might be minimised. Make use of the data you have acquired to determine areas in need of improvement, then adapt your strategy to address those areas (Erich Lawson, 2020).

3. Research Methodology

The research was conducted using quantitative methodology, primary data, and secondary data.

3.1. Population

The author performed a thorough investigation on the official web page of the Construction Industry Development Board (CIDB) to compile the necessary information. The exact scope of the author's respondent demands contains contractors in a grade 7, localised operation, and conformance with the conditions of validity for their building category and general validity status. The author has found, according to the results, that there are a total of 530 licenced contractors in Johor Bahru, including both businesses and individuals.

3.2 Respondent

With a population size value nearest to 530 in the Krejcie and Morgan table, which happens to be 550. The author has determined that 226 respondents comprise an adequate sample size for the research using the Krejcie and Morgan method. This sample size is based on a population of 530 individuals. The Krejcie and Morgan method provides guidelines for calculating the sample size required to achieve a predetermined level of confidence in the population's representation.

Contractors have valuable construction experience and expertise, including understanding the factors that contribute to material waste (I. Saidu and W. Shakantu, 2017). By conducting interviews with contractors, the author can delve into their practical knowledge and insights, obtaining an in-depth knowledge of the particular issues and challenges associated with material wastage on construction sites.
But in the end, unfortunately, I only collected 38%, which is 86 respondents.

3.3 Data Analysis

Quantitative data analysis techniques play a pivotal role in extracting valuable insights from the survey responses collected through Google Forms. These techniques involve rigorous statistical analysis, including calculating frequencies and percentages, which provide a succinct summary of the survey data. Furthermore, inferential statistics are employed to delve deeper into the data and explore relationships and associations between variables. Statistical tests such as correlation analysis and regression analysis allow for a more rigorous examination of the factors influencing building waste on construction sites.

4. Result and Discussion

4.1 Demographic

By referring appendix, Table 1 the demographic data collected from 86 individuals who responded to the survey about the construction industry provides insights on a wide range of subjects. The majority of respondents were male, as shown by a mean of 1.40 and a mode of 1, which indicates that male respondents outnumbered female respondents. This is something that can be seen in terms of the gender distribution of the respondents. The data on ages showed that the mean was 2.17 and the median was 2.00, indicating that there was a distribution that was well balanced across all age groups. Considering the racial variety of the sample, the fact that the mode is 2, which most likely represents a certain race, shows that a particular racial group is well represented in the sample. A significant proportion of the population had education levels that were greater than high school, as shown by the average level of education, which was 3.44. This indicates a tendency towards higher education levels. It was found that respondents had an average of 2.30 years of experience in the construction sector, with a median of 2.00 years of experience. This indicates that the range of experience levels was generally balanced. According to the statistics, the sector is dominated by men, has a wide range of educational levels, and a diverse range of experiences, although the majority of those surveyed had just few years of experience.

4.2 Discussion of Factors that cause Building Waste on the Construction Site

4.2.1 Discussion of Factors that cause Building Waste on the Construction Site by refer to appendix, Table 2 shows the data collection

i. Inadequate Planning Procedures

The respondents' moderate level of agreement regarding the impact of inadequate planning on material waste is indicated by the mean score of 3.83. However, as indicated by the high median score of 4.00, a sizeable proportion of respondents hold the firm conviction that inadequate planning results in increased wastage. The importance of

accurate predictions and calculations of quantity throughout the planning phase cannot be overstated when it comes to reducing the amount of waste that occurs (Daniels, 2016).

ii. Inadequate Material Procurement

In line with inadequate planning, the majority of respondents (3.79) concur that ineffective material procurement results in wastage. The participants' considerable accord regarding the impact of this aspect on waste generation is indicated by the median score of 4.00. To highlighting the need of being precise while procuring supplies, the focus was placed on reducing the amount of waste and excess inventories (Farzaneh Golkhoo *et al*, 2019).

iii. Insufficient Site Management

This concern received the highest average score of 4.03, indicating that participants concurred regarding its significance in the generation of waste. The median aligned score of 4.00 indicates a significant degree of consensus regarding the impact of site management on material waste. A significant focus was placed on efficient inventory management as a crucial component in the process of minimising waste on construction sites (Pushpendra Kumar Sharma *et al*, 2022).

iv. Storage Practices

While the mean score is a mild 3.73, the median score of 4.00 suggests that a sizable number of participants strongly believe that storage practices have an influence on trash output. This shows a high degree of agreement. Inadequate storage leads to material damage, decomposition, or misplacement, resulting in increased waste. This influence is shown by the high degree of agreement among responders. It was emphasised how important it is to have efficient storage methods, which are essential for avoiding damage and increasing efficiency in waste reduction (Herb Brownett, 2022).

v. Influence of Design and Scope Changes

The mean score of 3.87 and the median score of 4.00 show that participants' perspectives on the influence of design and scope changes on the development of surplus reject materials are somewhat aligned. This indicates that people agree on the importance of this factor. Changes in design or scope can result in surplus materials or rejects, which lead to waste. The alignment among responses indicates agreement on the importance of this element. The necessity of correct estimate throughout the design process was emphasised in order to reduce the amount of waste that was produced (Bruno Pasini *et al*, 2023).

vi. Inadequate Waste Generation Training

The participants showed a moderate degree of agreement (mean = 3.79) on the consequences of insufficient waste generation training. A median score of 4.00 indicates unanimous agreement among the responders about this problem. Inadequate training leads to the mishandling or incorrect disposal of waste items. The prevailing agreement among participants emphasises the influence of training in waste reduction. The provision of personnel with instruction about the appropriate procedures for the management and segregation of rubbish was the primary focus (Madeh Izat Hamakareem, 2019).

vii. Inadequate Construction Monitoring

With a mean score of 3.91, respondents were more in agreement about the negative effects of inadequate construction monitoring. With a median alignment score of 4.00, there is clear agreement that refuse manufacturing needs supervision. Mistakes in material handling, which reduce their usefulness and cause waste, might occur when monitoring is inadequate. Respondents' unanimous agreement highlights the significance of this factor. The need of good supervision in reducing construction-related mistakes and waste (Tathawade, 2015).

viii. Inefficient Procedures

The relevance of process inefficiency in creating waste is reinforced by mean and median scores of 3.92 and 4.00, respectively, indicating that respondents agree on this point. Inefficient procedures result in inefficiencies in material utilisation and processing, which contributes to increasing waste creation. The agreement among responses emphasises the importance of this topic. Instruction of staff with the appropriate processes for the management and separation of garbage was the major emphasis of the training. (Anuj Srivastava, 2018).

ix. Environmental Restrictions have a Modest Impact on the Quantity of Garbage Generated

The participants maintain the notion (mean = 3.74) that environmental restrictions have a modest impact on the quantity of garbage generated. The median score of 4.00 indicates that a significant number of respondents strongly agree about the impact of this aspect. The aligned median score of 4.00 also shows that there is substantial consensus among participants regarding the influence of economic variables on material waste generation, suggesting a moderate level of agreement (mean = 3.72). Waste production is influenced by environmental rules

and economic variables, which affect the selection of materials and project procedures. The responders' alignment underscores the importance of these criteria. In the course of the investigation, environmental constraints were investigated in terms of their influence on the selection of materials and the reduction of waste in construction projects (Isidore C. Ezema, 2019).

x. The Impact of Improper Disposal Methods

The substantial degree of consensus among the participants (mean = 3.80) regarding the impact of improper disposal methods on refuse accumulation is highlighted by the high level of concurrence denoted by the median score of 4.00. The environment and the sanitation of the site are adversely affected by the escalated refuse production caused by improper disposal. Notwithstanding the moderate consensus, the striking difference between the mean and median scores highlights the substantial influence. In an effort to reduce the amount of trash generated by building projects, there was a strong focus placed on the significance of effective material recovery procedures (Melanie, 2018).

xi. Project Delays

The median score of 4.00 shows that all participants agree on the impact of project delays on the creation of material waste, as supported by the moderate consensus (mean = 3.92). Delays lead to heightened material wastage as a consequence of prolonged storage or changes in project specifications. The general agreement among participants highlights the immediate influence on trash production. The author set out to investigate the relationship between the delays in construction projects and the rise in the amount of material waste that occurs during construction projects (Kendall Jones, 2021).

4.2.2 Discussion of Methods to Reduce the Waste of Building Materials

By refer appendix, Table 3 shows the data collection an effective material procurement system was established, with a mean value of 3.93 and a standard deviation of 0.968. This highlights the significance of effective procurement processes in the reduction of waste. By ensuring the acquisition of suitable commodities, quantities, and delivery dates, effective procurement helps to minimise the generation of waste and excess inventory (Farzaneh Golkhoo *et al*., 2019). Processes that prioritize inventory management (mean = 4.20, standard deviation = 0.879) contribute to reducing material waste by optimizing stock levels and minimizing the surplus of items that might be discarded (Pushpendra Kumar Sharma *et al*., 2022).Consistent training and awareness activities (mean = 3.91, standard deviation = 0.953) within the construction sector build a culture of resource awareness, fostering the appropriate utilization of resources and the exchange of ideas for waste reduction (Edward Ayebeng Botchway *et al*., 2023).Adherence to environmentally responsible building methods (mean = 3.97, standard deviation = 0.926) aligns with sustainability goals, emphasizing recycled materials and techniques to curtail waste production (Isidore C. Ezema, 2019).

Effective on-site resource management solutions (mean = 3.90, standard deviation = 0.983) proficiently handle and preserve resources, thus enhancing utilization while minimizing waste (Krista Fabregas *et al*., 2023). Improved resource efficiency is achieved through effective project planning and design (mean = 3.92, standard deviation = 0.871), reducing material waste linked to repairs or modifications (Erich Lawson, 2020). Collaborative waste reduction programs (mean = 3.79, standard deviation = 0.828) involving various stakeholders offer clear objectives and strategies to optimize available resources (Samuel Senyah Asare *et al*., 2023). Implementing lean construction principles (mean = 3.98, standard deviation = 0.933) aims at streamlining workflows and eliminating non-value-added activities to minimize waste (Megan White, 2017). Emphasizing the use of recyclable materials on construction sites (mean = 3.94, standard deviation = 0.974) enhances recycling efficiency and reduces dependence on new resources (B. H. Widayanti, 2017). Monitoring and reporting material consumption (mean = 3.91, standard deviation = 0.849) aids in identifying areas for improvement, leading to enhanced resource utilization and reduced waste (Cassie Bottorff *et al*., 2023). Establishing waste reduction targets (mean = 3.91, standard deviation = 0.903) serves as a guide and incentive for waste reduction efforts in construction operations (Erich Lawson, 2020).

5. Conclusion

5.1 Factors that cause Building Waste on the Construction Site

Research conducted by a number of different researchers has provided insight on the multifaceted issue of trash from construction. When it comes to planning, emphasizes the need of accurate calculations (Daniels, 2016). He

emphasizes how inaccurate estimations may lead to an abundance or a lack of resources, which ultimately leads to a higher amount of waste. In their study, underline the need of meticulousness in the process of material procurement (Golkhoo *et al*., 2019). They highlight the fact that careless purchasing often results in excess inventory, which in turn leads to waste due to products that have expired or been damaged. An emphasis is placed by on the significance of efficient site management in reducing the amount of supplies that are lost or destroyed, and therefore, the amount of trash that is produced overall (Sharma *et al*. , 2022) . Storage practices, play a significant role in maintaining the quality and usability of materials, which is essential for the reduction of waste (Ambegaonkar, 2023). The need of accurate design estimates in order to avoid the waste that might be created by alterations to the scope of the project (Pasini *et al*., 2023). On addition, emphasizes the need of worker education on how to effectively separate garbage in order to limit the amount of waste that is produced(Hamakareem, 2019). Although places more of an emphasis on the significance of efficient building methods in minimizing waste(Srivastava, 2018),but the importance of supervision in reducing construction-related mistakes and waste also needed (Tathawade, 2015). The purpose of research is to explore the impact that environmental limitations have on the selection of materials and waste reduction strategies across the building industry (Ezema's, 2019). The need of using efficient material recovery strategies in order to reduce the amount of trash generated by buildings (Melanie, 2018). By examining the connection between delayed building projects and increasing material waste (Jones, 2021). This study emphasizes the need of timely execution in order to minimize the amount of trash that is produced.

An in-depth investigation into the numerous facets of construction waste accumulation was carried out by of factors that result in an excessive amount of material waste on manufacturing sites. The research was carried out by conducting a comprehensive survey of construction professionals in order to identify the primary factors that contribute to the generation of waste. These factors include ineffective planning techniques, inefficient material procurement, and inadequate site management. A lack of waste management training, storage tactics, and design modifications were all brought to light as contributing factors in the deterioration of material waste. Particularly noteworthy is the fact that this study not only brought to light problems, but it also presented a wide range of strategies and approaches for reducing waste. As a means of fostering knowledge and responsible resource consumption among construction workers, it underlined the need of having efficient processes for the acquisition of materials, robust inventory control systems, and regular training sessions. In addition, it highlighted the need of using ecologically responsible building processes, establishing waste reduction objectives, and aligning with lean construction ideas in order to significantly cut down on waste. Incorporating both scientific and industrial perspectives, this research offers a comprehensive road map for the construction industry. By identifying significant waste sources and providing specific solutions and best practices, it encourages an approach to the consumption of building materials that is both environmentally friendly and efficient. The industry stakeholders that are aiming to optimize resource utilization and decrease environmental effect in building operations may benefit from such an all-encompassing strategy, which includes solution-oriented advice, discovery, and analysis.

5.1.2 Methods to Reduce the Waste of Building Materials

i. Programmes for In-Service Training and Certification

Departments of human resources or training may be responsible for organising and facilitating training courses. Active participation may be encouraged and rewarded by senior management. Investigate the possibility of forming partnerships with reputable training institutions or groups that are considered industry standards. Conduct research into the various certification programmes and determine how effectively they may be applied to your construction operations.

ii. Working in Partnership with Providers of Eco-Friendly Materials

It is possible for the departments of Procurement and Sustainability to establish agreements with suppliers after conducting investigations. You should do an audit of your suppliers, investigate their policies on sustainability, and investigate certification bodies or groups that are focused on green purchasing. Maintain open lines of contact in order to have a deeper comprehension of their dedication to sustainability.

iii. Implementation of the Principles of Lean Construction Technology

Those in charge of construction projects and construction managers have the ability to incorporate lean techniques. Conduct research on lean building methodologies and collaborate with lean firms or consultants. In order to educate the staff on these concepts, you should organise workshops or seminars.

iv. Technology Solutions and Building Information Modelling (BIM) Implementation
It's possible that the Department of Information Technology, Project Management, or Technology will be the ones to lead this project. Conduct research on building information modelling (BIM) solutions and innovative construction-related businesses. It is necessary to carry out feasibility studies and pilot projects in order to uncover the benefits and challenges associated with the integration.

v. Engagement in Different Forums and Initiatives Within the Industry
Individuals that are responsible for Corporate Communications or Sustainability may be in charge of managing participation in industry forums. Determine the right industry forums or groups that are focused on being environmentally responsible in the building business. It is beneficial to attend events, conferences, or seminars in order to get new perspectives and to network with other professionals.

vi. Research Collaborations and Pilot Projects are Being Undertaken
These efforts might be directed by teams responsible for research and development or project management. Work together with academic institutions or research groups that are focused on building. Develop ideas for collaborative projects and choose specific research subjects to investigate.

vii. Participation of Service Providers and Independent Contractors
There is a possibility that the Procurement and Vendor Management teams may communicate with the contractors and suppliers. In order to promote ecologically responsible actions, it is recommended to set sustainable procurement standards, give training to suppliers, or provide incentives. Conduct frequent audits of the performance of suppliers in comparison to the sustainability criteria.

viii. Committees On Sustainability Within the Organisation
Constancy of existence There is a possibility that officials or a cross-functional team will be responsible for forming and leading these committees. Invite individuals who are willing to volunteer from a variety of departments to join the committee. To motivate efforts to reduce waste, it is necessary to set goals, key performance indicators, and activities.

5.2 Suggestion for Reduce the Waste of Building Materials

i. Programmes for In-Service Training and Certification
Departments of human resources or training may be responsible for organising and facilitating training courses. Active participation may be encouraged and rewarded by senior management. Investigate the possibility of forming partnerships with reputable training institutions or groups that are considered industry standards. Conduct research into the various certification programmes and determine how effectively they may be applied to your construction operations.

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Conflict of Interest

There is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design****: Ngu Chieng Huang, Seow Ta Wee;* ***data collection****: Ngu Chieng Huang;* ***analysis and interpretation of results****: Ngu Chieng Huang;* ***draft manuscript preparation****: Ngu Chieng Huang, Seow Ta Wee, Roshartini Omar,Md Asrul Nasid Masrom. All authors reviewed the results and approved the final version of the manuscript.*

Appendix

Fig, 1 *Psychological Pyramid*

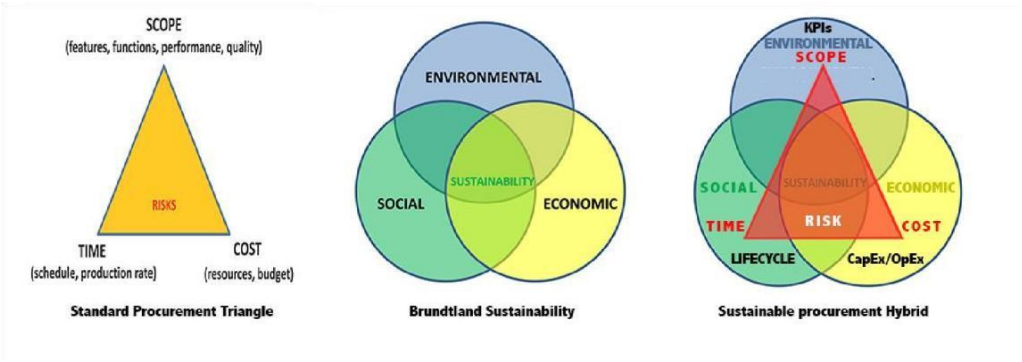

Fig. 2 *Sustainable procurement*

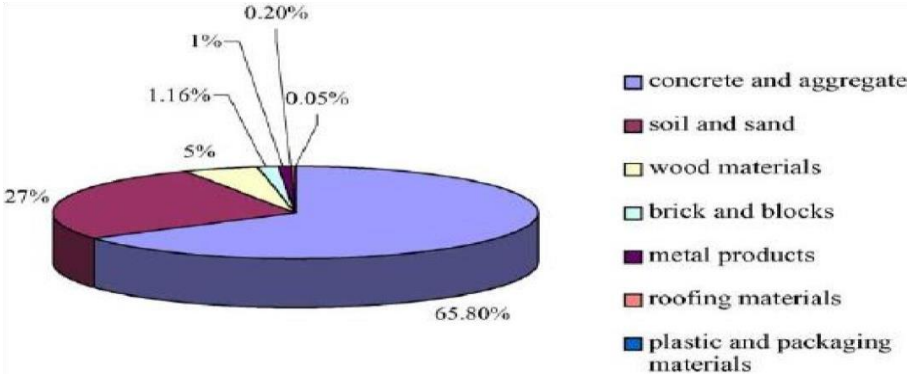

Fig. 3 *Composition of generated construction waste materials on the site.*

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970

Fig. 4 *Krejcie and Morgan table*

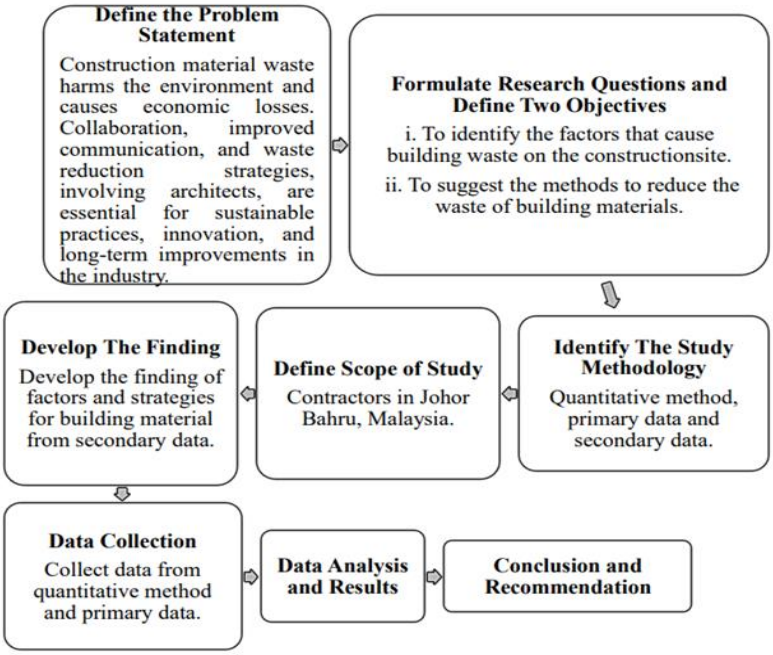

Fig. 5 *Research flow*

Table 1 *SPSS of Demographic*

DEMOGRAPHIC

Frequencies

Statistics

		Gender	Age	Race	Level of Education	Experience in the Construction Industry (in years)
N	Valid	86	86	86	86	86
	Missing	0	0	0	0	0
Mean		1.40	2.17	1.71	3.44	2.30
Median		1.00	2.00	2.00	4.00	2.00
Mode		1	2	2	4	2
Std. Deviation		.492	.814	.717	.876	1.096
Variance		.242	.663	.515	.767	1.202
Sum		120	187	147	296	198

Table 2 *SPSS of Factors that cause Building Waste on the Construction Site*

FACTORS THAT CONTRIBUTE TO THE ACCUMULATION OF TRASH ON CONSTRUCTION SITES USING THE SCALE PROVIDED

Frequencies

Statistics

		Inadequate planning procedures frequently result in material waste.	Suboptimal material procurement procedures frequently result in material waste.	Inadequate site management can result in the generation of waste.	Storage practices' can result in the generation of waste	Changes to the project's design, scope may result in the generation of superfluous refuse materials.
N	Valid	86	86	86	86	86
	Missing	0	0	0	0	0
Mean		3.83	3.79	4.03	3.73	3.87
Median		4.00	4.00	4.00	4.00	4.00
Mode		3	4	5	3	3[a]
Std. Deviation		.910	.909	.951	.913	.955
Variance		.828	.826	.905	.834	.913
Sum		329	326	347	321	333

Statistics

		A lack of training among construction workers can result in in waste	Inadequate supervision during the construction process could lead to the production of superfluous refuse.	Inefficiency in the construction process contributes to the production of refuse materials.	Environmental regulations affect the treatment of construction refuse.	Material waste is affected by economic factors, such as cost constraints.
N	Valid	86	86	86	86	86
	Missing	0	0	0	0	0
Mean		3.79	3.91	3.92	3.74	3.72
Median		4.00	4.00	4.00	4.00	4.00
Mode		3	5	4	3	4
Std. Deviation		.909	.953	.843	.935	.966
Variance		.826	.909	.711	.875	.933
Sum		326	336	337	322	320

		The contribution of inefficient disposal methods to the accumulation of building refuse is significant.	The occurrence of project delays may result in the generation of refuse materials.
N	Valid	86	86
	Missing	0	0
Mean		3.80	3.92
Median		4.00	4.00
Mode		3	4
Std. Deviation		.892	.923
Variance		.796	.852
Sum		327	337

Table 3 *SPSS of Methods to Reduce the Waste of Building Materials*

STRATEGIES FOR REDUCING CONSTRUCTION MATERIAL WASTE USING THE SCALE PROVIDED

Frequencies

Statistics

		Implementing efficient material procurement is crucial to reducing waste.	Inventory management practice is crucial to reducing waste	Implementing regular training, awareness programmer for construction personnel has the potential to effectively reduce material waste	It has been demonstrated that the implementation of sustainable construction practice, such as the use of recycled materials, effectively reduces waste production.	The implementation of appropriate protocols on-site for the management, storage, protection of resources has the potential to effectively reduce waste production.
N	Valid	86	86	86	86	86
	Missing	0	0	0	0	0
Mean		3.93	4.20	3.91	3.97	3.90
Median		4.00	4.00	4.00	4.00	4.00
Mode		4	5	4	4	4[a]
Std. Deviation		.968	.879	.953	.926	.983
Variance		.936	.772	.909	.858	.965
Sum		338	361	336	341	335

Statistics

		Through efficient project planning design, it is possible to effectively reduce material waste by minimizing changes.	The implementation of collaborative initiatives involving multiple stakeholders could lead to a reduction in waste.	The implementation of lean construction principles can optimism workflows.	Implementing recycling on construction sites has proved to be a highly effective waste reduction strategy.	Monitoring, reporting on material usage can be essential for identifying potential enhancement areas.
N	Valid	86	86	86	86	86
	Missing	0	0	0	0	0
Mean		3.92	3.79	3.98	3.94	3.91
Median		4.00	4.00	4.00	4.00	4.00
Mode		4	4	5	5	4
Std. Deviation		.871	.828	.933	.974	.849
Variance		.758	.685	.870	.950	.721
Sum		337	326	342	339	336

Statistics

		The establishment of waste reduction goals to stimulate their achievement can serve as an impetus for garbage reduction efforts.
N	Valid	86
	Missing	0
Mean		3.91
Median		4.00
Mode		4
Std. Deviation		.903
Variance		.815
Sum		336

References

A comprehensive review of "waste-to-energy" management potential in Pakistan. (n.d.). Www.linkedin.com. Retrieved December 28, 2023, from https://www.linkedin.com/pulse/comprehensive-review-waste-to-energy-management-potential-mohsen-gul

Accurate Inventory Records are Crucial for Success - Unleashed. (2017, June 4). Unleashed Software. https://www.unleashedsoftware.com/blog/accurate-inventory-records-success

Acquire Better Data for Critical Equipment Decisions Using Maintenance Software. (n.d.). Constructionexec.com. Retrieved December 28, 2023, from https://constructionexec.com/article/acquire-better-data-for-critical-equipment-decisions-using-maintenance-software

Akadiri, P. O., Chinyio, E. A., & Olomolaiye, P. O. (2012). Design of A Sustainable Building: A Conceptual Framework for Implementing Sustainability in the Building Sector. *Buildings*, *2*(2), 126–152. https://doi.org/10.3390/buildings2020126

Annabel Maw - The EO Blog. (2021, May 19). Blog.eonetwork.org. https://blog.eonetwork.org/tag/annabel-maw/

Best Practice Municipal Waste Management Information pool on approaches towards a sustainable design of municipal waste management and supporting technologies and equipment. (n.d.). https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2018-05-30_texte_40-2018-municipal-waste-management_en.pdf

Best Practices for Cost-Saving Construction Waste Management. (2020, August 24). For Construction Pros. https://www.forconstructionpros.com/profit-matters/article/21172658/best-practices-for-costsaving-construction-waste-management

Biedron, R. (2021, August 19). *Collaborative Procurement: Advantages and Disadvantages*. PLANERGY Software. https://planergy.com/blog/collaborative-procurement/

BYJU'S. (2018). *Waste Disposal*. Byjus.com. https://byjus.com/biology/waste-disposal/

CCIFP, H. B. (2023, January 4). *Six Key Maintenance KPIs to Track*. Construction Equipment. https://www.constructionequipment.com/topical/executive-institute/equipment-operations/article/21452293/six-key-maintenance-kpis-to-track

Collaborative Contracting Strategies in the Construction Industry: Procuring Better Outcomes. (n.d.). Www.linkedin.com. Retrieved December 28, 2023, from https://www.linkedin.com/pulse/collaborative-contracting-strategies-construction

Construction Blueprints: The Ultimate Guide | ProEst. (2022, March 15). https://proest.com/construction/process/blueprints/

Construction Project Management - an overview | ScienceDirect Topics. (n.d.). Www.sciencedirect.com. https://www.sciencedirect.com/topics/engineering/construction-project-management

Construction Site Waste Management Lessons from Successful Green Building Projects. (n.d.). Utilities One. Retrieved December 28, 2023, from https://utilitiesone.com/construction-site-waste-management-lessons-from-successful-green-building-projects

Construction Sites: Waste Management + Disposal. (2022, February 1). SafetyStratus. https://www.safetystratus.com/blog/waste-management-on-construction-sites-tips-to-reduce-waste-disposal/

Dania, A., Kehinde, J., & Bala, K. (n.d.). *A Study Of Construction Material Waste Management Practices By Construction Firms In Nigeria*. https://www.irbnet.de/daten/iconda/CIB10782.pdf

filipeboni. (2023, April 3). *Understanding Zero Waste Design: A Guide For Building Professionals*. UGREEN. https://ugreen.io/understanding-zero-waste-design-a-guide-for-building-professionals/

How to start a waste management business. (2020, August 28). Think Business. https://www.thinkbusiness.ie/articles/how-to-start-a-waste-management-business-ireland/

Lawson, E. (2021, January 5). *9 Benefits of Going Green for Businesses*. MoneyHighStreet. https://moneyhighstreet.com/benefits-of-going-green-for-businesses/

Naji, Khalid K., *et al*. "Major Factors Affecting Construction Waste Management in Infrastructure Projects Using Structural Equation Model." *Journal of Construction Engineering and Management*, vol. 148, no. 10, Oct. 2022, https://doi.org/10.1061/(asce)co.19437862.0002358. Accessed 20 Aug. 2022.

Nick. (2023, June 25). *How Does Construction Waste Affect the Environment?* ETM Recycling. https://www.recyclingbristol.com/the-effect-of-construction-waste-on-the-environment/

Osmani, M., *et al*. "Architects' Perspectives on Construction Waste Reduction by Design." *Waste Management*, vol. 28, no. 7, Jan. 2008, pp. 1147–1158, https://doi.org/10.1016/j.wasman.2007.05.011. Accessed 1 Mar. 2019.

Oyetunji, A. K., Oluleye, B. I., Olukolajo, M. A., & Chan, D. W. M. (2022). Is green good: Unveiling the latent benefits of sustainable housing delivery. *Cities*, *129*, 103809. https://doi.org/10.1016/j.cities.2022.103809

Purchase Order Management: a Key to Efficient Business. (2022, February 11). Precoro Procurement and Spend Management Blog. https://precoro.com/blog/purchase-order-management/

Purchase, C. K., Al Zulayq, D. M., O'Brien, B. T., Kowalewski, M. J., Berenjian, A., Tarighaleslami, A. H., & Seifan, M. (2021). Circular Economy of Construction and Demolition Waste: A Literature Review on Lessons, Challenges, and Benefits. *Materials*, *15*(1), 76. https://doi.org/10.3390/ma15010076

Rasheed, S. (n.d.). Evaluating and Developing the Sustainable Procurement system of Materials in Construction Industry in Iraq. *Www.academia.edu*. Retrieved December 28, 2023, from https://www.academia.edu/33011457/Evaluating_and_Developing_the_Sustainable_Procurement_system_of_Materials_in_Construction_Industry_in_Iraq

Salvia, G., Zimmermann, N., Willan, C., Hale, J., Gitau, H., Muindi, K., Gichana, E., & Davies, M. (2021). The wicked problem of waste management: An attention-based analysis of stakeholder behaviours. *Journal of Cleaner Production*, *326*, 129200. https://doi.org/10.1016/j.jclepro.2021.129200

Tafesse, S., Girma, Y. E., & Dessalegn, E. (2022). Analysis of the socio-economic and environmental impacts of construction waste and management practices. *Heliyon*, *8*(3), e09169. https://doi.org/10.1016/j.heliyon.2022.e09169

Tawasha, R. (2022, November 16). *Maximizing Construction Employee Efficiency: 10 Proven Methods*. Constructive Solutions, Inc. https://www.solutionsgc.com/10-ways-to-improve-productivity-of-construction-employees/

The Missing Link: Architecture and Waste Management. (n.d.). Harvard Design Magazine. https://www.harvarddesignmagazine.org/articles/the-missing-link-architecture-and-waste-management/

todd. (2022, February 25). *How to Safely Handle and Store Construction Materials | GoCodes*. Tool Tracking Software. https://gocodes.com/handle-construction-materials/

Waqar, A., Othman, I., Saad, N., Azab, M., & Khan, A. M. (2023). BIM in green building: Enhancing sustainability in the small construction project. *Cleaner Environmental Systems*, *11*, 100149. https://doi.org/10.1016/j.cesys.2023.100149

Waste, W. B. (2019, September 13). *Methods for Waste Disposal*. WB Waste. https://www.wbwaste.com/blog/five-methods-for-waste-disposal/

Yu, A. T. W., Wong, I., Wu, Z., & Poon, C.-S. (2021). Strategies for Effective Waste Reduction and Management of Building Construction Projects in Highly Urbanized Cities—A Case Study of Hong Kong. *Buildings*, *11*(5), 214. mdpi. https://doi.org/10.3390/buildings11050214

(2023). Rhumbix.com. https://www.rhumbix.com/blog/10-tips-to-improve-productivity-at-work-in-the-construction-industry