Scope
Volume 14 Number 01 March 2024

Efficient Strategies for Sustainable Construction and Demolition Waste Management: A Comprehensive Review

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Abstract : The proliferation of Construction and Demolition Waste (C&DW) due to rapid urbanization presents a significant global challenge. This surge in C&DW generation not only poses direct environmental concerns but also undermines the efficiency of the construction industry. A substantial portion of C&DW is currently destined for landfills worldwide, underscoring the need for effective management strategies to mitigate its adverse environmental effects. Recognizing the imperative for sustainable resource utilization, there's an urgent need for efficient C&DW management practices. Despite the existence of various well-formulated strategies, the outcomes of their implementation often fall short of optimal levels. This inefficiency primarily stems from a deficient understanding of key factors influencing C&DW management. Hence, this study aims to meticulously examine the concept of C&DW and its associated managerial challenges systematically to devise effective management strategies. Through a comprehensive review of pertinent research articles, our investigation identifies two principal categories influencing C&DW management: the hierarchy of C&DW management approaches encompassing reduction, reuse, and recycling strategies, and the pivotal contributing factors to effective C&DW management, which include sustainability considerations, stakeholder attitudes, project life cycle dynamics, and management tools. Subsequently, we delve into a detailed analysis of these factors to elucidate current and future trends in C&DW management, offering insights valuable for both academic research and practical applications.

Keywords: - Construction and Demolition Waste; Construction industry efficiency; Environmental concerns; Management tools; Urbanization

1. Introduction

The building sector plays a major role in the social and economic advancement of the country. Ineffective measures have been made to reduce illegal dumping and environmental harm as a result of inadequate waste management methods on building sites.

In the realm of sustainable waste management in construction, emerging nations like Malaysia are experiencing rapid expansion, which has resulted in a significant amount of construction trash being generated [1].Certain nations, like Brazil and Australia, have concerning landfill waste rates above 40%, while other nations, including the USA, Canada, and Hong Kong, have made an effort to keep their rates below 30%[2].Australia's construction and demolition (C&D) sector produced 16.9 million tonnes of waste in 2007 and 20.4 million tonnes in 2017, a 3.5 million tons increase in just ten years. Of this garbage, 13.6 million tonnes were recycled in 2017 and 10.1 million tons in 2007[3].Depending on how cost-effective waste management is, construction waste is divided into two primary categories: "natural or inevitable" waste and "prospective or avoidable" waste. Regardless of the kind of project, natural waste is the most common type of garbage. For instance, 1.91 percent of private commercial projects use natural waste as reinforcement due to cost-cutting initiatives [4], the newly created plaster composite is an environmentally responsible option for building because it uses less raw materials and more trash may be reused, in keeping with the circular economy principles defined in the European Commission's Green Deal [5]. Due to the 150 MT of construction waste produced annually in India—which makes up 35–40% of all C&D waste worldwide—construction waste management (CWM) has grown to be a significant environmental concern in the majority of Indian municipalities [6], In Europe nowadays, recycling construction and demolition waste are used in filling in the debris with freshly built roadways. For CDW to be recycled into premium applications, such as aggregates for making new concrete, it must undergo either selective demolition or a systematic recycling procedure[7], the design and construction of new buildings and engineering projects, as well as the renovation and improvement of existing ones, are all part of the extremely complex, dynamic, and diverse sector that comprises construction [8].

Meanwhile, construction and demolition waste (C&DW) can have a substantial negative influence on the environment, leading to increased energy consumption and carbon dioxide emissions, pollution, and degradation [9].One of the sectors that harms the environment and the ecological system the most is the construction sector. Consequently, a key component of moving towards sustainability is the adoption of sustainable practices in the building sector. Sustainable construction practices are those that involve building methods that have the least negative impact on the environment. In order to create a situation where everyone wins and the environment, society, and economy all benefit, this industry must adopt sustainable methods[10].Although this industry boosts the economy and creates a lot of jobs for the country, there are some issues that the general public has to be aware of. The majority of waste materials used in construction are composed of concrete, aggregates, dirt, sand, wood, bricks, blocks, metal products, roofing materials, plastics, and other materials. Any building activity that incurs costs—direct or indirect—but does not improve the product or add value is often referred to as waste[11].Numerous studies have addressed the recycling of trash from building and demolition, with a focus on decision analysis, technology adoption, and recycling methods. Reusing construction waste is the act of using the material once more without processing it into new materials, whereas recycling building trash is the process of turning waste into a new substance. If the material is still in good or partially good condition, construction waste can be reused; however, recycled materials can be converted into completely new materials with different compositions. However, only specific materials can be recycled and reused from building debris[12].The expanding building industry and the propensity of governments across the globe to prioritize sustainability are the primary drivers of the global market. The construction waste market is still being driven by the rising demand for recycled and sustainable building materials for commercial development projects. The solid waste market is predicted to grow by approximately 59% from its anticipated $2.01 billion in 2021 to $3.40 billion in 2050 [13]. It is recommended that the CDW pre-demolition audit be finished before starting any remodelling or demolition operations. The demolition works supplier can identify and categorize the demolition trash at the source based on the audit results. The demolition contractor can quickly identify and separate the CDW on the construction site. A pre-demolition audit of building and demolition waste is essential to increasing the recovery rate of construction and demolition waste, according to Waste Framework Directive 2008/98/EC[14], diverse waste management principles and management priorities can be observed in the existing lack of agreement regarding the definition of CDW. Depending on variables like national building industry, laws, population growth, and regional planning, different regions have different amounts and compositions of CDW. Generally speaking, a variety of internal (such as age, kind, construction materials, and construction technologies) and external (such as demolition technologies, builders' CDW management abilities, population expansion, etc.) elements affect both the quantity and quality of CDW[15].Almost one-third of the total waste produced by urban areas in China is made up of CDW. Over 300 million tons of CDW are generated annually. If a simple stacking method is applied, 150–200 million square meters of land are treated annually for fresh CDW. The majority of CDW is transported by the construction unit to open stacking or untreated landfilling in villages or suburbs[16], these difficulties include poor-quality waste data, law, and expense. The quality and application of recycled materials are not sufficiently encouraged by government incentives and restrictions, which could ultimately lower waste levels in the building sector[17],most existing barrier assessments only look at CDW recycling and reuse from different perspectives. Considering that cutting CDW at its source is crucial and that implementing a circular economy will present substantial obstacles for the CDW industry[18],C&D waste in the modern era and its effects on the environment in a given area are not just local problems. Instead, in order for the worldwide waste management community to share knowledge generated elsewhere, it is critical to assess performance and identify best practices in various economies [19].

Sustainable waste management on construction sites refers to a culture or discipline that addresses issues with solid waste generation, collection, storage, disposal, and processing of such unused materials while keeping in mind the concerns of the general public's health, the economy, the environment, and aesthetics[20]. Therefore, it should come as no surprise that legislators, business leaders, and academics all frequently address the subject of sustainability in the building sector. Achieving sustainable building requires striking a balance between social and economic considerations, including local community requests, health and safety, and technology sustainability, as well as economic factors like competitiveness, costs, and construction time. Businesses can utilize the triple-bottom-line concept—which considers the economic, social, and environmental aspects of sustainability—as a helpful framework to help them achieve effective sustainability. Businesses must put in place policies, practices, and projects that support the achievement of the sustainable development goals—which include social justice, economic growth, and environmental protection—if they are to be considered really sustainable[21].Waste generation will unavoidably increase if waste minimization techniques are not applied throughout the design and planning phases. Most people involved in the building sector are currently only concerned with making a profit; waste management is not a priority. Without sufficient attention, it would be difficult to restrict the garbage generated throughout the design and planning phases, which would raise the cost and duration of trash management[22].The relevant details regarding the disposal of construction waste are now included in the practice norms for registered structural engineers and registered building contractors in Singapore. Practitioners are therefore required to follow the rules and oversee the decrease of construction waste in actual construction projects [23], and due to the additional costs and time involved, Indonesian construction professionals hardly ever calculate the amount of construction waste generated in their projects. Construction waste is managed in a number of building construction projects in Indonesia through the sale of construction waste, the use of waste as a container, the distribution of waste and residual material to nearby residents and artisans, and the transportation of non-toxic (non-B3) liquid waste in the form of cement water to drainage channels surrounding the project. Nevertheless, it is believed that this approach is ineffectual in decreasing building waste and boosting recycling efforts related to construction trash. Reducing the amount of construction waste produced by project operations can save the contractor money and boost the business's profitability [24].Furthermore, sustainability performance demonstrates the extent to which the CDWM endorses sustainable development in general. Again, because it involves a number of activities like the organizing and designing stage, element distribution, on-site installation, construction, renovation, demolition, C&D waste collection, transportation, and processing, and residue disposal, this is an abstract idea that extends beyond what is visible on project sites[25].In an attempt to mitigate the negative consequences of building waste, governments worldwide are looking into the idea of a circular economy (CE), which would substitute a more circular approach for the traditional linear pattern of Take-Make-Use-Dispose [26]. Many policies and laws pertaining to waste management and environmental quality have been introduced in Malaysia. These include the Pembinaan Malaysia Act 1994 (PMA), which is overseen by the Construction Ministry, the Environmental Quality Act 1974 (EQA), which is overseen by the Ministry of Natural Resources and Environment, the Standard Specifications for Buildings Works (SBW), which is overseen by the Ministry of Works, and the Solid Waste and Public Cleansing Management Act 2007 (PPSPPA), which is overseen by the Ministry of Housing and Local Government. Similar to the majority of developing nations, waste creation and related disposal problems are on the rise in Malaysia[27]. A significant body of research has been conducted on C&DW and creative management strategies that facilitate a circular economy[28].

1.1. Research Significance

- Reviewed on sustainable waste management in construction.
- This study purpose on finding the impact of sustainable waste management in construction.
- Aim of this study is to minimize the amount of waste generated during construction activities and maximize the reuse and recycling of materials.

1.2. Objectives- The following are the primary goals of this review paper:

- The objective of this review article is to identify and analyse the current practices of waste management in the construction industry, and to propose sustainable solutions that can reduce the environmental impact of construction waste.
- This review article aims to provide a comprehensive understanding of the challenges faced by the construction industry in managing waste, and to suggest ways to overcome these challenges.
- The goal of this review article is to draw attention to the significance of environmentally friendly waste management techniques in the building sector and the ways in which they might support future sustainability.

2. Data Base Collection

Summary of "Sustainable Waste Management in Construction" implemented in construction field CWM, CDW, Textile fibres and dissolved expanded polystyrene (EPS) wasteetc are mentioned in the Table 1.

Table 1: List of contributions in SCI/ESCI and Scopus indexed journals from October 2016 to October 2023 for "Sustainable Waste Management in Construction".

INPUT	METHODOLOGY	TOOL	OUTPUT	REFRENCE	YEAR	COUNTRY
Construction Waste	Segregation, De-construction and Proper storage of material	Building Information and Modelling (BIM)	Concrete Pedestrian Blocks (CPB)	[1]	2016	Malaysia
Construction Waste	Degree of awareness/ Management of Construction & demolition waste	BIM	Cost Reduction	[2]	2023	Kuwait
Industrial waste	Data collection and data analysis	NVIVO Software	Economic values of diverted material	[3]	2020	Australia
Construction Waste	Design, storage, worker/equipment, on-site material management , and materials handling and transportation	Survey	Proper management in construction	[4]	2022	China
Textile fibres and dissolved expanded polystyrene (EPS) waste	Chemical Treatment	-	Prefabricated Elements	[5]	2023	Spain
Construction Waste	Survey and analysing the data	Structural equation	Onsite implementation	[6]	2022	India

		modelling	of CWM			
Construction Waste	Life cycle assessment (LCA) and life cycle costing (LCC)	-	Environmental and economic analysis/ New concrete production	[7]	2018	Belgium
Construction Waste	10R framework	BIM	Circular economy	[8]	2023	Sri Lanka
Construction Waste	Environmental impact assessment (EIA)	Survey, Relative Important Index RII	Sustainable development practice	[9]	2022	Malaysia
C&D waste management	Literature review Data collection and data analysis	Survey and data collection	**B**etter management and planning of policies for CDW	[10]	2017	Malaysia
Construction Industry waste	Survey and data analysis	EVR, IBS	Cost saving, sustainability	[11]	2019	Malaysia
Construction waste	Survey and data analysis	RII (Relative Important Index)	Recycle, reuse, preserve environment	[12]	2020	Malaysia
Construction waste	Recycle and hot – in-place	LCA	Circular economy, sustainable waste management	[13]	2022	Malaysia
Construction waste	Data analyses, and BIM	CDWA, Cost analysis M-learning	Economics benefits for environment	[14]	2021	Slovakia
Construction waste	Survey and data analysis	-	Awareness towards CDW	[15]	2018	Athens
Construction demolition waste	NARBP model, System Dynamics theory and LCA	VENSIM	Improve Government regulation of CDW management,	[16]	2022	China

			promote recycle product, and societal awareness			
Construction waste in Industry	Data collection and data analysis	Nvivo	Sustainable Environment, Cost benefitsand utilize recycle materials	[17]	2023	Australia
Construction waste management	Data collection and data analysis	3R principle	Promote CDW management base on 3R principle and CE design	[18]	2017	China
Construction waste management	Data collection data analysis	Analytical framework	GDP/ CGDP per construction, a universal benchmark is introduced to compare CWM across jurisdiction	[19]	2016	Australia
Construction solid waste	Critical Reviewed	-	3R strategies	[20]	2020	Saudi Arabia
Civil engineering and Construction material	(Review) data collection	Tripple Bottom Line Concept, BIM	Environmentally friendly project management	[21]	2023	Nigeria
C&D Waste management	SLR	CE framework	Three-layer CE framework Micro, Meso- and Macro framework	[22]	2017	Malaysia
Construction Waste	Case study	RFID, CWMF	SICS for low energy consumption and high efficient waste	[23]	2023	Singapore

			treatment			
Construction Waste	Data collection	Descriptive analysis	Construction knowledge, financial support and waste management policy	[24]	2019	Indonesia
C&D Waste management	Data Collection, Survey, DEMATEL method and data analysis	SmartPLS software (version 3.3.6), SEM	Enhancing sustainability in CDWM	[25]	2023	India
Construction and Demolition waste	Literature review, Case study	BIM, LCA, Cost-Benifit analysis, DSS	Environmental saving by recycle and reuse construction material and cost benifits	[26]	2023	America
Factor causing Construction waste generation	Data collection and data analysis	Survey and SPSS (Statistical Software Package)	Awarness to adopt sustainable waste control practice	[27]	2016	Malaysia
Construction and demolition waste	Survey, Awarness in CC	Data analysis	Smart demolition for re-use, onsite operation, awarnesson CDWM, 3R promotion and using inovative technologies(AI, IOT)	[28]	2019	UK

3. **Source of Literature:** -For this study, an extensive examination was conducted, gathering a substantial collection of 40 publications (For the progress report only) from reputable sources including Elsevier (www.elsevier.com), Google Scholar (www.scholar.google.com), and Science Direct (www.sciencedirect.com). However, certain research repositories such as Research Gate and Academia.edu were

deliberately omitted based on current findings that highlight the inability to match Google Scholar's ability to offer early citation indications.

This section compared several research publications produced between October 2016 and October 2023 for the recognition of Sustainable Waste Management in Construction. As indicated in Table 1, we tabulate numerous elements and qualities such as the dataset, kind of Sustainable Waste Management in Construction, Method Implemented, Input Variables, Tool, Output, and Reference Number, Year and Country. Figure 1represent the list of publicationthat have been considered for this review paper from October 2016 and October 2023.Figure 2 represent the Dough-nut chart showing the list of countries which are working in the field of Sustainable Waste Management in Construction (indexed in SCI/SCIE and Scopus) Between January 2016 and August 2023 and Figure 3 represent the count of peer-reviewed journal papers (indexed in SCI/SCIE and Scopus) related to October 2016 and October 2023 published within a specific year.

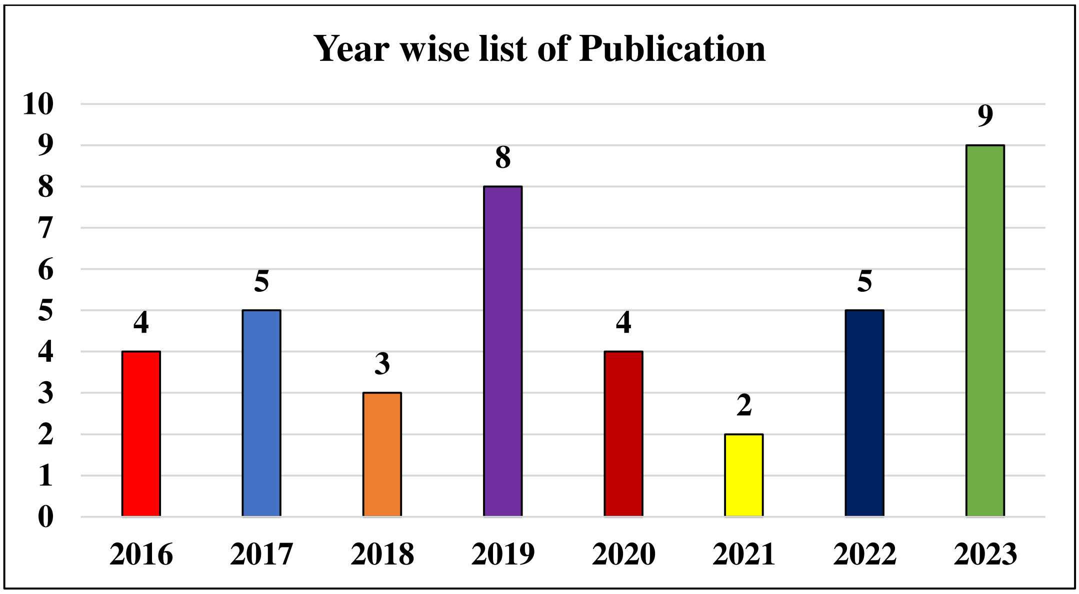

Figure 1: The count of peer-reviewed journal papers related to sustainable waste published within a specific year.

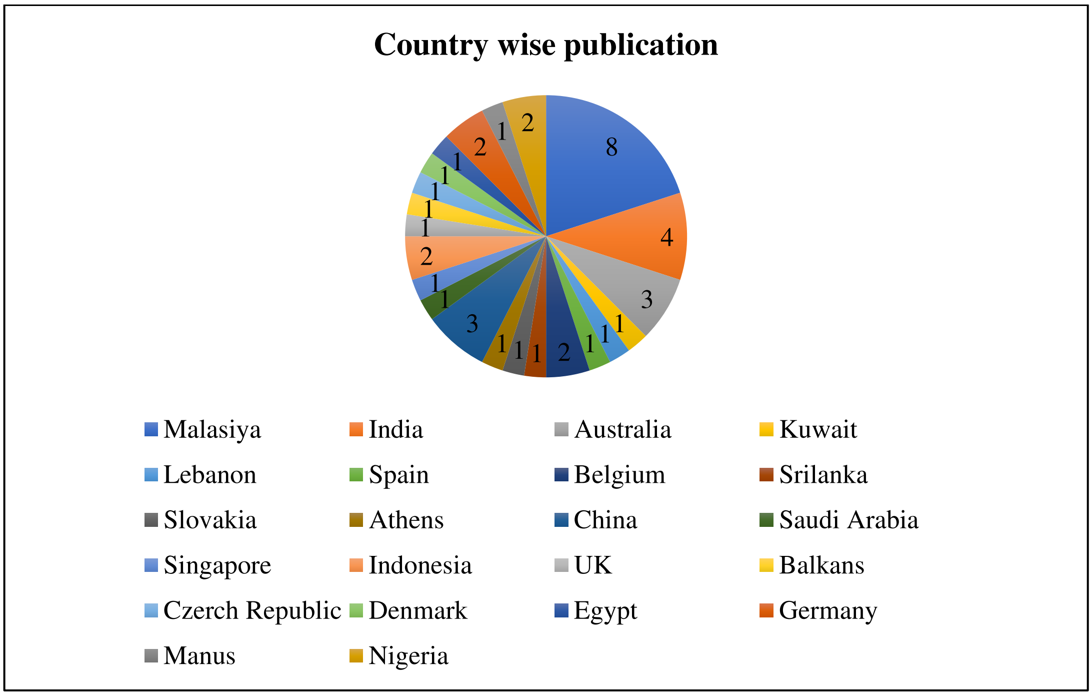

Figure 2: Donout chart depecting countrywise publication

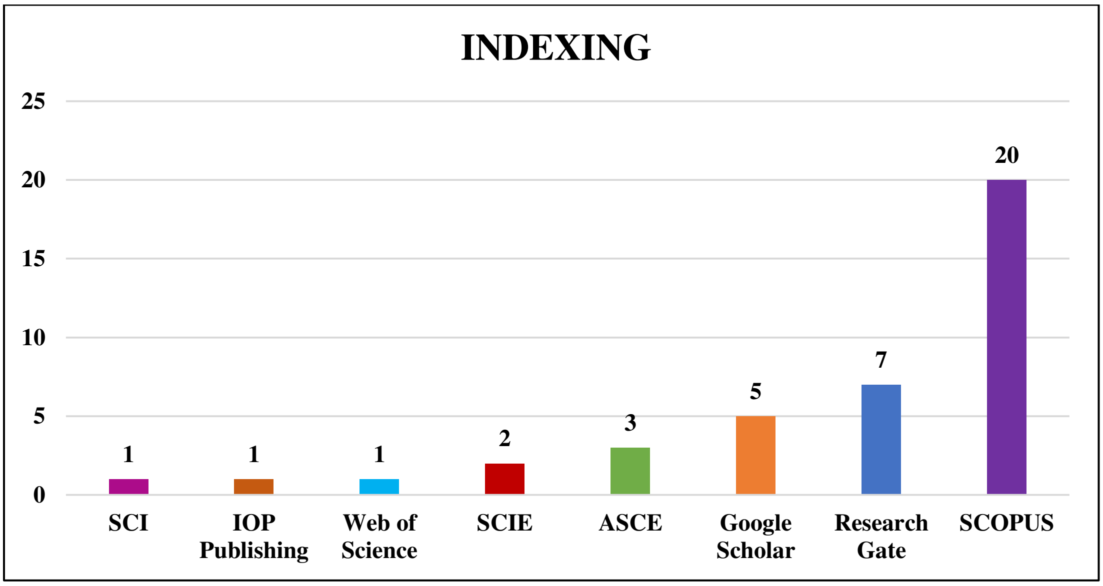

Figure 3: Indexing of paper between 2016 to 2023

4. **Methods:** Sections 1, 2, and 3 inform the discussion on various Sustainable Waste Management methods in construction presented below:

- **Waste Management Planning:** - Effective waste management should be a fundamental component of project development. Waste management approaches will be used to varied degrees by all of the project's primary players, including the Owner, their Architectural and Engineering (A/E) services, or Construction Management consultant, the Contractor, and the Subcontractors. The circular economy (CE) is a potent instrument for solving environmental issues and advancing sustainable development. A number of developed Asian and European nations have made progress in passing laws that encourage the CE in their cultures. The CE's goals cannot be met unless the waste treatment hierarchy established by the EU (Directive, 2008/98/EC) is followed. The waste hierarchy places less importance on recycling waste, recovering materials and energy, and disposing of waste[29].Regulations on the disposal of solid waste and national environmental standards apply to construction waste management (CWM). More specifically, the US, China, Korea, Japan, and the EU continue to abide by the 99/31/EC directive, which established a legal framework for landfills. Furthermore, CWM standards are now required by green building grading systems such as LEED (Leadership in Energy and Environmental Design) [30]. The three objectives for MSW—minimizing the harm that waste (waste treatment) causes to the environment and human health, protecting resources, and minimizing the amount of waste that is disposed of in landfills—were established by the EU and RS legislation, which provided the framework for the development of the scenarios [31].

- **Facility Design:** -The means, methods, techniques, sequences, and procedures of the construction, including the removal of waste, are under the control of the construction supervisor.

Information models must be incorporated into software. Evaluating an information model's compatibility with particular software goals and developer-friendliness continues to be a major area of interest for academics and professionals. In a market where work processes are flexible, information models must continuously assist software development efforts for high-performance apps. Keeping up with industry needs requires an information model to be developed and implemented quickly. Every information model functions as a computer-based representation of knowledge and has to follow accepted guidelines found in literature on ontology engineering the model's designers have the authority to determine which categories it should include. It is crucial to understand that each user must uphold this initial ontological commitment for the information model to be useful. Apart from ontological commitment, a data structure should enable human-user communication and ensuring that computers can efficiently process stored information, retrieve it quickly and seamlessly, and simply apply the information model using current technology are all critical components of any information model[32].The planning, design, operation/maintenance, and demolishing phases are the key themes of design strategies. They can be used as management methods later on, or as preventive measures in the early phases like planning and design. Assembly and disassembly as well as material optimization are two examples. According to the SLR selection criteria, these techniques are mostly considered in terms of planning and design. In order to optimize environmental advantages, it is crucial to prioritize preventive techniques, especially in the early stages of design, according to recent research [33].Conventional design techniques are based on the systematic layout planning (SLP) strategy, which prioritizes the initial arrangement of departments inside the plant site. The block arrangement that results attempts to maximize material handling across departments. Comparably, the same method can be used repeatedly within each department to arrange equipment, storage spaces, material handling tools, and other components. As a result, both design phases are included in the Facility Layout Planning (FLP).Since the flow patterns of traditional material handling systems, including those for forklifts and automated guided vehicles (AGV), must not cross over with facilities, material flow channels usually have to avoid obstacles like these [34].

- **Construction Contract Requirements:** -Companies have been increasingly interested in enhancing the management procedures on construction sites in an effort to successfully finish projects within the allocated time and budget in recent years. Because of this, the conditions of agreements have been viewed as a means of putting into reality efficient project management techniques and a fair distribution of project risks for a less confrontational approach between the two parties to the construction contract. [35].

Analyze the extent to which contractual clauses that are intended to reduce construction waste on building sites are integrated, and suggest ways to improve their effectiveness as well as ways to support and monitor their implementation. Furthermore, think about adding to contract paperwork to improve workflow and reduce waste of time and materials. Other recommendations also include, optimizing the reduction, reuse, and recycling of materials; Establishing contractual agreements between contractors and clients to determine penalties for individuals responsible for generating construction waste, as well as setting criteria for acceptable percentages of building material waste; Developing financial incentive plans aimed at reducing construction waste; Providing environmental education for workers; Offering client-provided incentives and tender premiums; Installing construction and demolition waste management facilities on-site; Implementing strategies to enhance labour productivity, such as utilizing the last planner system; Donating excess materials for beneficial purposes when feasible;

Implementing a waste-based management approach for construction site administration; Ensuring uniformity of design throughout the planning, designing, and estimating stages; and reducing the overall quantity of waste generated [36].

- **Jobsite Waste Reduction:** - The worldwide trend toward sustainability on building sites is becoming more and more important in reducing environmental problems brought on by subpar waste management techniques. Because recycling can reduce environmental damage and costs by repurposing or directly reusing resources, it is a highly effective method in the building industry. There are several advantages to this strategy, such as less need for new resources, less space in landfills, and a significant drop in the amount of solid trash generated, especially in cities like Manaus. Waste generation is a recurring issue during the construction process, from the initial setup of the site and preparation of the land to the project's completion and the disposal of finishing materials. Regretfully, Manaus does not currently have a proper waste management system or recycling facility, causing the environment to deteriorate and then offer solutions by developing a comprehensive trash management plan that prioritizes environmentally friendly methods [37].Proactive steps taken during the planning and design phases are the first step toward efficient waste management at construction sites. Following certain rules designed for project site waste reduction is crucial to reducing waste production and maximizing resource use [38].

A collection of prescriptive techniques does nothing more than dilute the distinctiveness of building projects and does not ensure the identification and reduction of all potential waste. In order to properly analyze the inefficiencies of on-site processes that result in waste generation and ideologies addressing waste minimization, investigations focusing on these concepts and techniques are required in the literature on C&D waste[39].

- **Education and Awareness:** - Establishing environmentally friendly waste management techniques in the building industry is crucial for protecting the environment. Initiatives to raise awareness and educate the public are important factors in encouraging waste reduction practices in the sector. Here are some important factors to think about:

i. Initiatives aimed at educating and training the public can increase awareness among the general public and students, motivating them to engage in environmental conservation, particularly with relation to waste management practices.

ii. Empowerment entails giving people access to chances for development and independence as well as motivation and awareness of their own potential. Self-sufficiency can be fostered by educating and empowering students and community members, such as those on a campus, through coaching.

iii. In order to raise awareness and encourage practical waste reduction techniques, it is essential to increase socialization and education initiatives centered on trash management. [40].

5. Challenges and future prospects of sustainable construction waste management

Construction waste management confronts a multitude of challenges that impede its effectiveness. One such challenge is the inadequacy of regulations governing waste management practices within the construction industry. Often, enforcement mechanisms are weak, and penalties for non-compliance are insufficient to deter improper waste disposal. This lax regulatory environment perpetuates unsustainable practices and undermines efforts to minimize waste generation and maximize recycling.Furthermore, a pervasive lack of awareness among stakeholders exacerbates the issue. Many individuals involved in construction activities remain ignorant of the importance of proper waste management and lack the necessary training to implement sustainable practices. Consequently, opportunities to reduce, reuse, and recycle construction waste are often overlooked, leading to increased environmental degradation and resource depletion.

Inefficient waste segregation poses another significant hurdle to sustainable construction waste management. Mixed waste streams hinder recycling efforts, making it challenging to separate recyclable materials from non-recyclable ones. Moreover, the distinction between hazardous and non-hazardous waste is often blurred, resulting in improper disposal practices that pose environmental and health risks.The limited recycling infrastructure further compounds these challenges. Insufficient facilities for processing and recycling construction waste, coupled with high transportation costs, impede the scalability of recycling initiatives. As a result, significant amounts of construction waste end up in landfills, exacerbating the burden on already limited landfill capacity and contributing to environmental pollution.

Despite these challenges, there are promising prospects for enhancing sustainable construction waste management. Advanced recycling techniques offer the potential to improve waste recovery rates and reduce reliance on landfill disposal. Technologies such as automated sorting systems and chemical recycling processes can facilitate the efficient separation and transformation of construction waste into valuable resources.

Moreover, digital tools for waste tracking and management hold considerable promise in enhancing transparency and accountability throughout the waste management lifecycle. Real-time monitoring platforms, integrated with GPS tracking and RFID technology, enable better traceability of waste streams, facilitating more effective waste management decision-making.

Innovative reuse practices, inspired by the principles of the circular economy, present additional avenues for sustainable waste management. Embracing concepts such as upcycling and repurposing of construction waste materials can not only minimize waste generation but also create economic opportunities and reduce the demand for virgin resources.In conclusion, addressing the challenges of sustainable construction waste management requires concerted efforts from stakeholders across the construction industry. By implementing effective regulations, raising awareness, improving waste segregation practices, and investing in recycling infrastructure and innovative technologies, the industry can transition towards a more sustainable and efficient waste management paradigm. Such endeavours are crucial for achieving environmental goals, conserving resources, and fostering long-term sustainability.

Discussion

In this comprehensive review, we have delved into the efficient strategies for sustainable construction and demolition waste management, highlighting key findings from the literature. Through our exploration, it is evident that construction waste remains a primary focus among researchers, emphasizing the critical need for sustainable waste management practices within this sector. Our analysis, as depicted in Figure 4, underscores the prevalent use of construction waste in research endeavors, reflecting its significance in the discourse surrounding sustainable waste management.

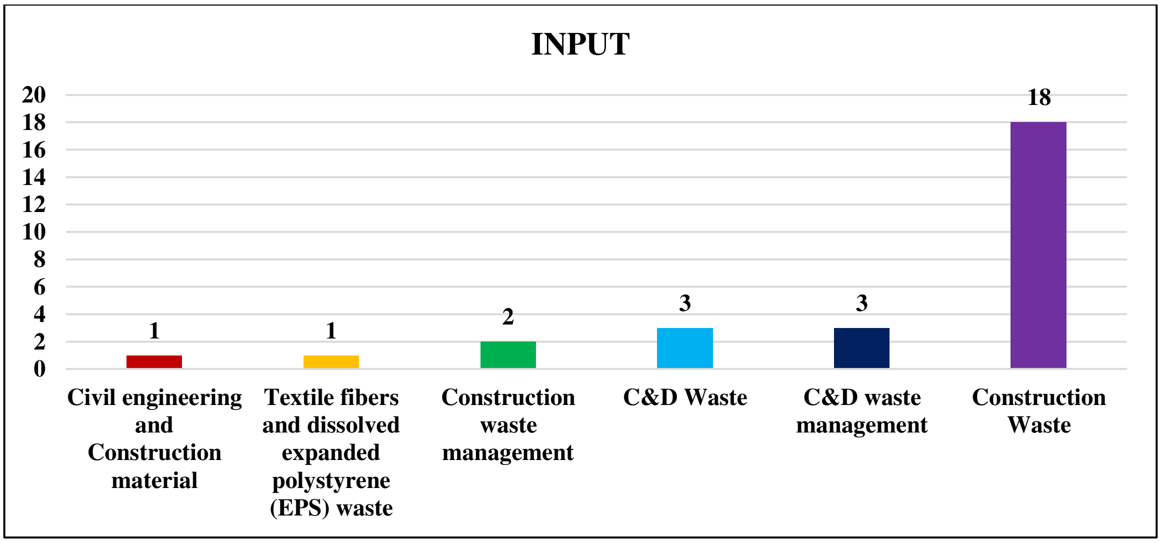

Figure 4: Various inputs used in Sustainable construction waste management

Furthermore, Figure 5 illustrates the various methodologies employed in this field, with a notable emphasis on data collection and analysis, indicative of the rigorous approach taken by researchers in addressing this complex issue.

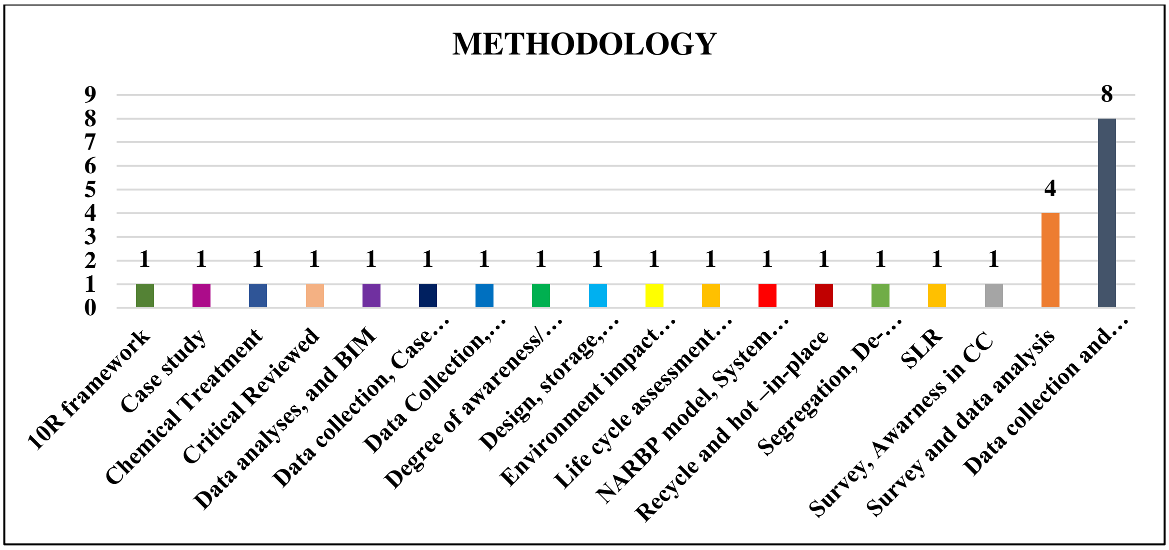

Figure 5: Various methodology used in Sustainable construction waste management

Moreover, our examination of Figure 6 reveals the diverse array of tools utilized to attain different outputs in sustainable waste management. Notably, building information modeling emerges as a prominent tool employed by researchers, highlighting its efficacy in generating valuable insights and facilitating informed decision-making processes.

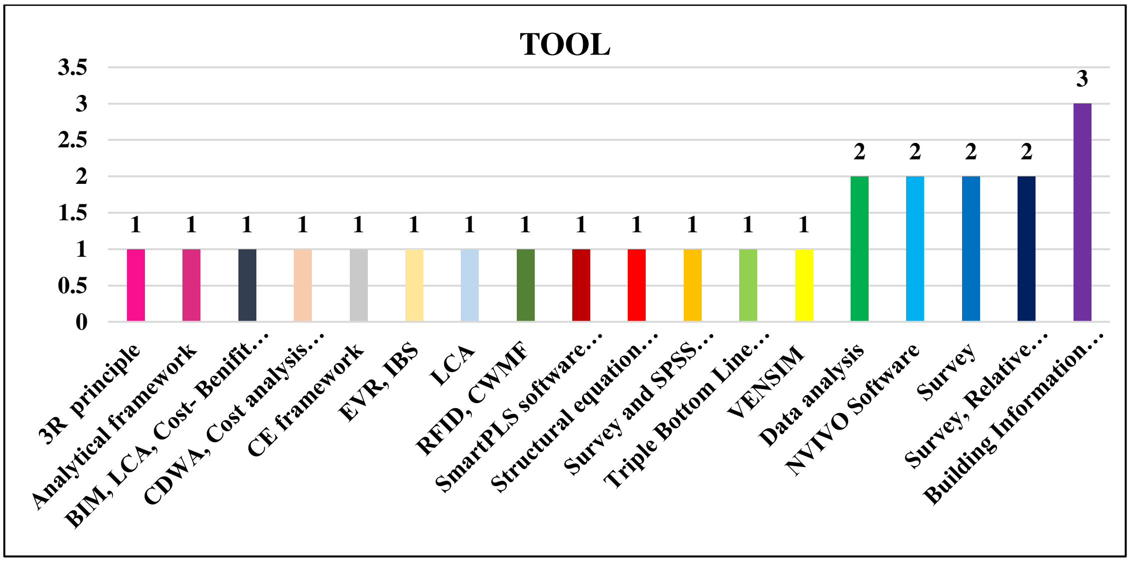

Figure 6: Various tools used in Sustainable construction waste management

Importantly, our findings culminate in Figure 7, which demonstrates a recurrent theme in the attainment of sustainable outputs – the adoption of circular economy principles. This underscores a paradigm shift towards holistic and regenerative approaches to waste management, emphasizing the importance of resource efficiency, recycling, and reutilization in achieving sustainability objectives.

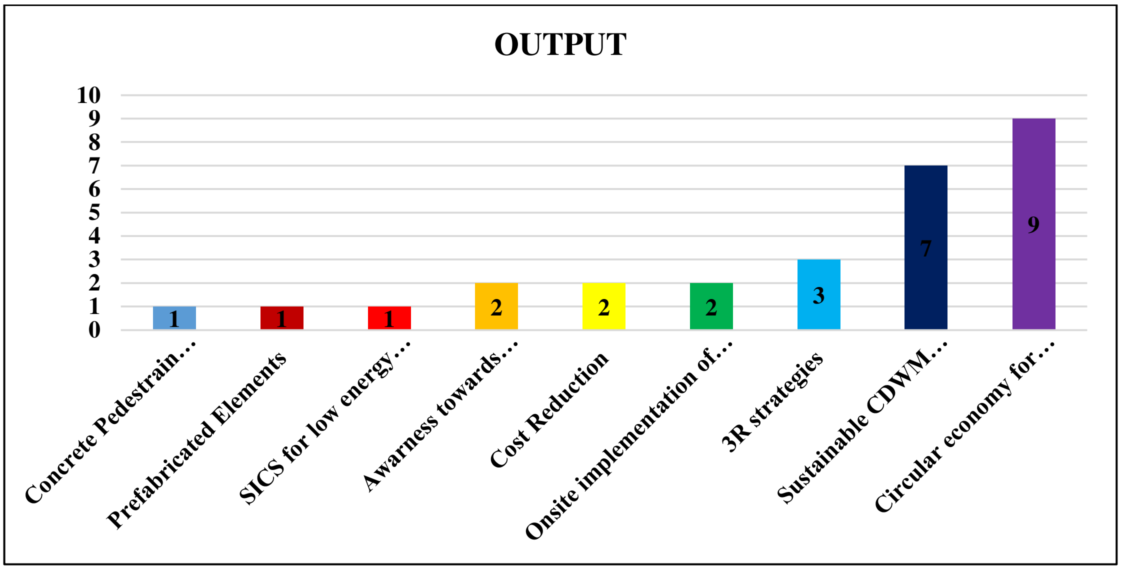

Figure 7: Various output comes in the field of Sustainable construction waste management

Conclusion and Future Work

Through the analysis of literature and visual representations such as Figures 4 to 7, key trends have been identified, highlighting the significance of construction waste utilization, data-driven methodologies, innovative tools such as building information modeling (BIM), and the adoption of circular economy principles.

The findings underscore the critical need for continued research and innovation to address existing challenges and capitalize on opportunities for improving sustainability within the construction industry. By leveraging efficient strategies, embracing technological advancements, and promoting stakeholder engagement, stakeholders can collectively work towards achieving the overarching goal of minimizing waste generation, optimizing resource utilization, and mitigating environmental impacts.

However, it is essential to acknowledge the persistent research gaps that remain within the field, including the optimization of waste management strategies, comprehensive lifecycle assessment methodologies, understanding behavioral aspects and stakeholder engagement, harnessing technological innovation, and enhancing policy and regulatory frameworks. Addressing these gaps will require interdisciplinary collaboration, concerted efforts from academia, industry, and policymakers, and a commitment to advancing knowledge and practice in sustainable construction and demolition waste management.

Despite the extensive focus on construction waste as a primary input and the prevalent use of data collection and analysis methodologies, there remains a gap in incorporating diverse stakeholder perspectives and interdisciplinary approaches in sustainable waste management research. While building information modeling (BIM) is widely utilized for generating outputs, there's a need to explore its integration with emerging technologies such as artificial intelligence and block chain for improved efficiency and transparency. Additionally, further investigation into the scalability and feasibility of circular economy models within various socio-economic contexts is required. Addressing these gaps can enhance the development of more inclusive and effective frameworks for sustainable waste management, advancing progress towards circular economy goals.

Data Availability

NA

Declaration of Competing Interest

The authors uphold that they have no current or past conflicts of interest in this study.

Declaration of Funding

This research did not receive any specific funding.

Acknowledgements

The authors wish to acknowledge the support of the National Institute of Technology, Arunachal Pradesh in this research.

Authors Contributions

Role of Yaiphaba Singh Y: Conceptualization, Formal analysis, and Writing – editing

Role of MoirangthemMomocha Singh: Investigation, Visualization, Reviewing and editing

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