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Review

Design Decision-Making for Construction Waste Minimisation: A Systematic Literature Review

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Abstract: The escalating pace of construction activities has triggered a concerning surge in waste accumulation, underscoring the urgent need for the construction industry to prioritise environmental sustainability and resource conservation. Research indicates that construction waste (CW) from a typical building project can comprise a substantial 30% of the total weight of materials transported to the site. Significantly, one-third of this waste could be avoided through judicious decision-making in the design phase. While waste management during construction has gained substantial attention in the existing literature, the domain of decision-making in the design stage remains relatively unexplored. This study addresses this gap by conducting a systematic literature review (SLR) of 59 articles from 2011 to 2022. The findings emphasise the crucial role of informed decision-making processes in minimising CW during building projects. A conceptual framework emerges from the analysis, highlighting the necessity of establishing a foundation for design decision-making to tackle CW issues effectively. Collaborative networks among stakeholders and an enhanced supply chain, bolstered by robust information sharing, are identified as pivotal factors in improving CW minimisation efforts. Consequently, this study advocates for further research to expand the knowledge base in this vital area, underscoring the imperative for collective efforts in advancing sustainable practices within the construction industry.

Keywords: buildings; construction waste; decision-making; design stage; information sharing; systematic review

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1. Introduction

The construction industry has experienced significant growth and complexity, resulting in a rise in the amount of construction waste (CW) being generated [1]. This poses a considerable challenge for the industry, as the large volume of waste produced contributes to 30–40% of the total solid waste in the world [2,3].

While the importance of reducing CW has been recognised, waste reduction activities are poorly adopted, as these are not reflected in a manner of cost-effectiveness, efficiency, and compatibility with key construction activities, even though stricter regulations and guidelines are in place [4]. Many studies focus on minimising CW during the construction phase, but there are now efforts to encourage practices that minimise waste overall [5,6]. It could be argued that efforts to minimise waste during the construction phase are inadequate if waste minimisation is not given priority in the design process, particularly considering that design activities have the potential to prevent up to 33% of CW in building projects [7]. Thus, the design stage is a critical phase, with significant implications for the project outcome [8]. It is, therefore, crucial to adopt a design-oriented approach to minimise CW, in addition to later-stage efforts, to achieve the most cost-effective measures for minimising waste resulting from construction activities. Adopting this approach would ensure that waste minimisation measures are integrated from the outset and have a greater potential to be successful. A study identified the requirement for a more comprehensive decision-making system to incorporate in the building design stage, considering multiple factors affecting the CW minimisation [9]. It was pointed out under future research directions that to improve CW minimisation at the design stage, systematically analysing the current empirical research is essential to identify what are the key areas that can support design stage CW minimisation strategies, and this would be a significant step in improving CW minimisation efforts [10]. Accordingly, the motivation of this research is to carry out a systematic literature review (SLR) to identify the key areas that can support CW minimisation strategies during the design decision-making process of building projects. This research aims to investigate and confirm a set of measures that can effectively minimise CW by having better design decision practices.

Consequently, this study has two objectives, namely:

(i). To identify and explore the key areas that can support CW minimisation strategies during the design decision-making process of building projects,
(ii). To determine the potential areas for further research in the field of study.

The underlying rationale for conducting this research is to establish the foundation of successful project delivery through a process for effective design decisions to minimise CW by proposing a conceptual framework and suggesting the prospective research directions. For the scope of this study, CW is considered as "the waste produced during the construction process of buildings", and 'waste minimisation' is defined as "the reduction of waste at source, by understanding and changing processes to reduce and prevent waste" [11]. Similarly, 'design waste' is defined as "the waste arising from construction sites owing directly or indirectly to the design process" [12]. The manuscript is structured as follows: Section 1 provides an overview of the study in the Introduction, followed by a detailed explanation of the screening and selection process for obtaining the necessary data for the systematic literature review and the article review process in Section 3. The organisation of the rest of the article is established through descriptive analysis and a further qualitative content analysis, directed towards highlighting the outcomes of the research findings. Subsequently, the results of the study are presented, consisting of the major topics identified in the research area, with a particular focus on the decision-making process. This is followed by a discussion of the results and their implications. The final sections of the paper detail the future research directions and conclusions, respectively.

2. Background

2.1. Origins of CW and the Building Design Stage

Prior to identifying ways to minimise CW, it is important to investigate the origins of CW and the various approaches for categorising the primary sources. CW materials have been classified into distinct groups, such as bricks and substitute materials, including blocks, mortar, dry lining, metal, timber, other types of special/hazardous waste, miscellaneous waste, and waste from material packaging [13]. Similar to that approach, there is another classification based on sources of CW according to the nature and technology of the materials used in building projects [14]. A further classification, based on the method of CW generation, which can be detailed as design, procurement, handling, operation, residual, and others, was also carried out [15]. In another study, the authors used a categorisation system to classify waste into three groups based on its characteristics: easily reusable or recyclable waste that has value, indirectly recyclable waste, and waste that poses challenges in terms of disposal, such as asbestos [16]. There have been various classification schemes used for different types of materials, such as asphalt, concrete, soil, tiles, bricks, and timber. Despite the variations in the classification models used, waste is typically measured either by the overall material weight obtained or as a percentage of the total material cost. This quantification approach has both financial and environmental implications [15].

Although the literature has identified multiple factors that contribute to the generation of CW throughout the project, starting from the design stage until the project's completion, research indicates that the design stage remains a significant known source of waste, contributing to the onsite waste generation [8]. This is an important aspect to consider, as some architects have argued that waste is only caused by activities during construction [17,18]. As well as the imperfections and intricacies in the design process, inaccurate selection of materials and modifications made to the design prior to or during onsite activities are also major contributors of CW [5,15]. It has been pointed out that insufficient information about the nature of CW during the design phase of a building has negatively impacted sustainable design efforts [18]. The authors have further stated that design errors are a significant source of CW, with design changes during construction and a lack of information on drawings being the most crucial contributors. There are other design-related causes of waste generation in building construction projects, such as the intricate nature of detailing, the use of substandard materials, and the lack of knowledge about alternative options [19]. Additionally, operational causes of waste can stem from errors made by workers, which might impact subsequent construction phases, and inadequate planning [20]. Material handling can also contribute to waste, with poor storage facilities and loose forms of supply being the primary concerns [21]. Furthermore, excessive ordering of building materials is a significant cause of waste related to procurement [22]. Waste can also occur due to incomplete or flawed design documents and drawings. It was identified that two phases contribute to the generation of CW: the pre-construction and construction stages [23]. It has been argued that waste is generated within the design process due to the complexity and non-clarity of tasks at the building design stage, coordination problems, and communication issues [24]. Therefore, it is crucial for decision-makers in building projects to understand the reasons behind design waste, make necessary changes in their processes and practices, and adopt a comprehensive approach to confront the issue considering the multidisciplinary nature of the design stage, which contributes to information variability and misinterpretation, leading to waste generation [25,26].

2.2. Building Design Process and Decision-Making

The primary goal of the building design stage is to create a design based on the initial concept [27]. The iterative design process in a building construction project is a crucial aspect of problem-solving that involves collaboration between all parties involved to gather and evaluate relevant information, devise a solution that addresses it, and repeat the process as necessary until a final solution is approved. Therefore, attention to information sharing is necessary because sufficient access to information on a product and the operations of other actors can enhance the material in a loop system [28]. The creation of drawings and visualisations is a tangible product of this process, serving as a tool to depict the evolving solution and to test it against a range of competing constraints until the development of a conclusive, well-pondered design solution with fewer contradictions [29]. The design process extends beyond the project outcome and is principally an aided decision-making process that leverages design thinking to determine the most fitting outcome for the site and the client's needs [30]. As identified through the existing literature, among design stage processes, decision-making plays a key role in generating the outcomes of this stage.

Decision-making is a central responsibility of the design team in any building construction project [31]. In a building project, decisions are typically made collaboratively, although sometimes they are made from the top down. This process involves discussing and negotiating the advantages and disadvantages of various alternatives, as well as determining the scope of work and associated costs. It requires defining the issue or the problem and identifying the factors related to it. These decisions play a key role in creating value throughout the project's life cycle and, therefore, they are critical for the project's success. However, most design teams do not consider nor draw attention to how they make decisions and what kind of project environment facilitates that. In general, the process of making a decision in a building project involves navigating through various pivotal decision points, commonly referred to as gateways, while the client evaluates the project's progress and determines whether it aligns with their strategic objectives, is affordable, value is being delivered, and that the risks are acceptable [32]. Recent research has brought attention to the significance of decision-making during the project design phase and its crucial role in minimising and preventing waste [33–35]. Considering the ample support from the literature, it is essential to examine and evaluate the correlation between design decision-making and CW minimisation, as it serves as a foundation for achieving a successful project delivery.

3. Research Methods

This paper employed a SLR as a research method to perform an evaluation of prevalent knowledge with a critical lens on the topic and, afterwards, to synthesise novel concepts. The search of the publications was performed in databases, and in this review study, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was followed as a guideline. PRISMA provides a structured approach to conducting systematic reviews in an impartial, clear, and transparent manner [36]. As a standard methodological approach for SLR, it is a widely accepted approach to enhance the comprehensiveness, quality, and accuracy and achieve the completeness of the review, with an aim to increase transparency [37]. The PRISMA method is often used for conducting SLRs [38–40]. This method involves qualitative analysis of the literature, which provides unique insights into the knowledge gained from previous research. It also enables the identification of literary trends and allows for a detailed examination of the data on a micro-level [41]. According to the PRISMA guidelines, the subsequent sections provide a comprehensive explanation of the steps of the method, in detail.

Phase 1: Planning and material collection

Firstly, the research purpose and boundary were established. Hence, the primary article search was limited to peer-reviewed journal papers during 2011–2022 to guarantee that up-to-date, quality information was captured, since the fortitude of this study is to investigate the novel topics and debates related to CW minimisation at the design stage of building projects and uncover less-researched issues. Most of the literature reviews carried out in the research domain have covered the publications for around a decade due to the emerging research directions in the construction management field [42,43]. The systematic search commenced by identifying the appropriate search engines and selecting the relevant keywords to conduct a search for scholarly articles. The search was conducted under six groups (A, B, C, D, E, and F) based on the criteria of title/keyword/abstract, each one representing a key area related to the design stage CW minimisation concept in building projects, as shown in Table 1.

Using the methodology of keyword search employed by the researchers as a basis for analysis, the chosen databases needed to be extensively available at most academic institutions [43,44]. Hence, Web of Science and Scopus were used to search for articles relevant to this study. The mentioned databases were chosen as they are among the most extensive and widely used search engine platforms, offering comprehensive access to academic content on both regional and global scales [45]. Compared to other databases, they include more recent scientific publications, a comprehensive range of articles, and literature reviews in the CW-related research fields [46]. It is suggested that using multiple search engines can effectively reduce bias and refine the search results among a broad range of articles [43]. These search engines are well-known for their extensive coverage and ease of accessibility and have previously been employed in systematic literature reviews [42,47–50]. The search strings used in this study incorporated multiple keywords, which were connected using Boolean connectors such as "OR" and "AND" to facilitate an advanced search. The search strings were devised using common phrases that encompassed the initial keywords (as outlined in Table 1) related to "building, design stage, decision-making, CW, and minimisation" in each stage, combined with other associated keywords, which were similar to the term "mechanisms". The inclusion criteria of the study were not limited to certain countries or regions in the world. Similarly, previous SLR studies have attempted to extract papers from different countries and regions to improve those studies by allowing a detailed descriptive and content analysis.

Table 1. Keyword search.

Group 'A'		Group 'B'		Group 'C'		Group 'D'		Group 'E'		Group 'F'	
A1	Building OR Building project? AND	B1	Design OR Design stage OR Initial stage OR Early stage OR Design Process AND	C1	Decision making OR Decision? AND	D1	"Construction Waste" OR CW AND	E1	Reduc* OR Minimis* OR Prevent* OR Avoid* OR Eliminat* AND	F1	Technolog* OR Tool* OR measure*
										F2	Database* OR Prototype*
										F3	Model* OR Framework* OR Strateg*
										F4	Architecture OR Platform
										F5	Practic* OR Method? OR Approach*
										F6	System? OR way?
										F7	Overview OR Review
										F8	Perspective?

The process of retrieving relevant articles from the specified search engines was completed in 2022. When the searches were carried out, the obtained articles were from 2011 to 2022, including publications at both ends of the selected literature sample. In the realm of design stage CW minimisation, there has been a general upsurge in research outputs, particularly in recent times, suggesting a heightened interest among researchers in decision-making processes at the design stage concerning CW minimisation, which may soon lead to more successful waste minimisation. As a result, 960 articles were obtained through the aforementioned searches and subsequently subjected to a process of refinement.

Phase 2: Practical Screening

The practical screening process consisted of the refinement criteria graphically illustrated in Figure 1. Initial search results yielded 960 publications (Web of Science: 403 and Scopus: 557), but the articles that fell outside the predetermined boundary or were not aligned with the keywords (irrelevant subject areas, such as manufacturing/automobile industry and waste management/minimisation in infrastructure projects) were not considered. In addition, during the process of article selection, certain duplicate articles were excluded. Later, the publication title and the content available in the abstract were selected as a method of filtering related papers. Accordingly, 456 records were rejected based on their nature (i.e., literature review papers, non-peer-reviewed papers, languages other than English, dissertations/thesis/reports/books). For the next step, the remaining 121 papers were closely examined based on their full-text content and relevance to the topic under study. From this, 29 papers were found indirectly connected to the domain under study, and instead, their primary emphasis was on the management of solid waste generated by municipalities, feasible precast concrete technologies, soil and bearing capacity upon landfill waste, global warming potential and waste, building energy efficiency, and CW and the ecological issues related to CW management. Additionally, two articles were inaccessible. Upon examination of particular sections, such as the introduction, of the articles that were not accessible, it was ascertained that they did not make a noteworthy contribution to the advancement of the literature in the field under investigation. Although the remaining articles were centred on minimising waste during the design stage, the quality of 38 papers was questionable due to a lack of comprehensive explanations regarding the research method used, as well as a failure to include information on design decisions or decision-making in building projects. Following the rejection of 33 articles, considering the quality of the content, 2 articles were selected as relevant to the study by cross-referencing citations. Subsequently, a thorough reading, and review of the complete articles was conducted to ascertain their suitability for the research context. The articles' quality was subjected to a critical evaluation based on their coherence with the research topic, methodology, findings, and significance. After this quality screening, the final review included 59 peer-reviewed articles for the analysis.

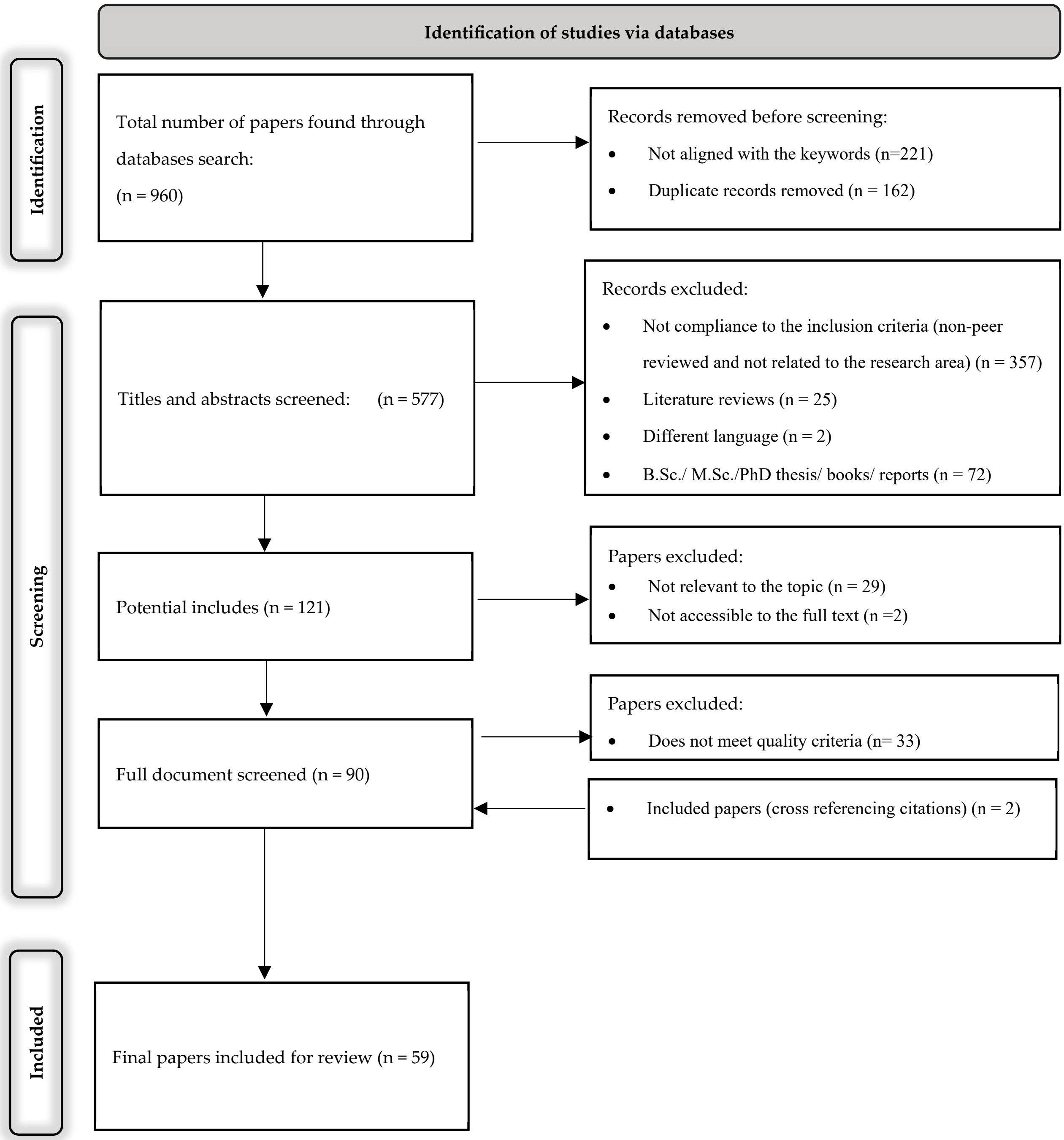

Figure 1. PRISMA flow diagram for the systematic reviews.

Phase 3: Analysis, evaluation, and documenting the review

The chosen articles underwent two distinct forms of analysis: descriptive and content analysis. The descriptive analysis was carried out considering the research context, the year of publication, and the scope [51]. On the other hand, the content analysis involved a comprehensive evaluation and examination of the literature, establishing a strong foundation for further investigation [52]. While delineating research domains related to CW minimisation in the set of papers undergoing content analysis, an inductive approach was applied.

4. Results from the Descriptive Analysis

A descriptive analysis was conducted to establish a foundation for the content analysis. In this step, the bibliographic details of the articles were presented. This involved compiling a table of the articles categorised by their publication year and source [48].

Literature Development

Figure 2 presents an illustration of the distribution of publications pertaining to three distinct concepts during the time frame from 2011 to 2022: publications up to 2015, publications from 2015 to 2018, and publications after 2018, as further discussed below. The discourse surrounding the identified concepts exhibited notable fluctuations over the years. The CW minimisation concept gradually increased in the first four years and had a fluctuating trend thereafter, but there was an increment of the publications. The highest number of publications was observed in 2017, as indicated in Figure 2.

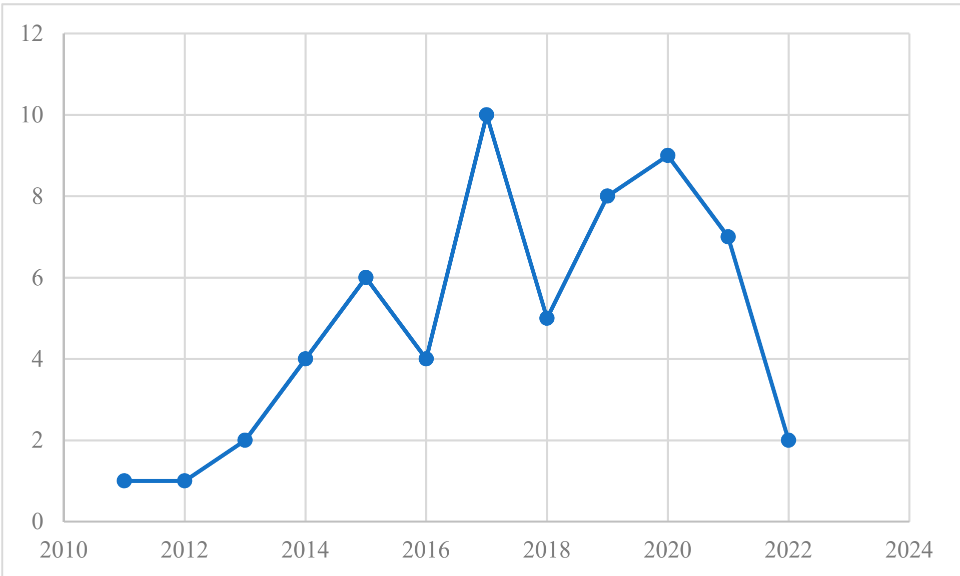

Figure 2. Yearly publications.

CW minimisation and management have been studied since the late 20th century, with publications examining the reuse and recycling of materials, acknowledging the amount of waste sent to landfills and damages to the environment. Publications have also discussed the role of material control in reducing building waste and assessing building design based on the calculated amounts of waste quantities. The application of recycling systems as an effective strategy to reduce both the cost and environmental impact was an emerging research area two decades ago. Before 2015, most of the publications were on quantifying and strategising waste management related to life cycle analysis (LCA) and analysing waste management practices, sustainable methods for waste minimisation, sources of waste, the impact of design decisions towards waste generation, and prevention concepts [24,53–55].

In more recent years(after 2015), there has been an increasing number of publications related to the application of building information modelling (BIM) and its role in CW minimisation strategies [56]. BIM is a process—often mentioned as an enabler of various benefits within architecture–engineering–construction—of creating and managing information for a built asset [57]. Therefore, BIM technology has been used not only in designing-out CW but also in evaluating waste-efficient building designs [58]. The research trends after 2018 show a focus on the feasibility and impact of existing early-stage waste minimisation mechanisms [30,59,60]. Similarly, a significant amount of scholarly inquiry has been devoted to offsite construction in the construction industry in past decades in relation to waste minimisation, along with the growing body of knowledge on construction methods. It is interesting to note that most of the studies related to early-stage waste minimisation began to grow in recent years after the rapid advancement of emergent technologies and distinct directions, such as BIM and big data [56,61–64].

The distribution of publications across the top-tier academic journals is illustrated in Figure 3.

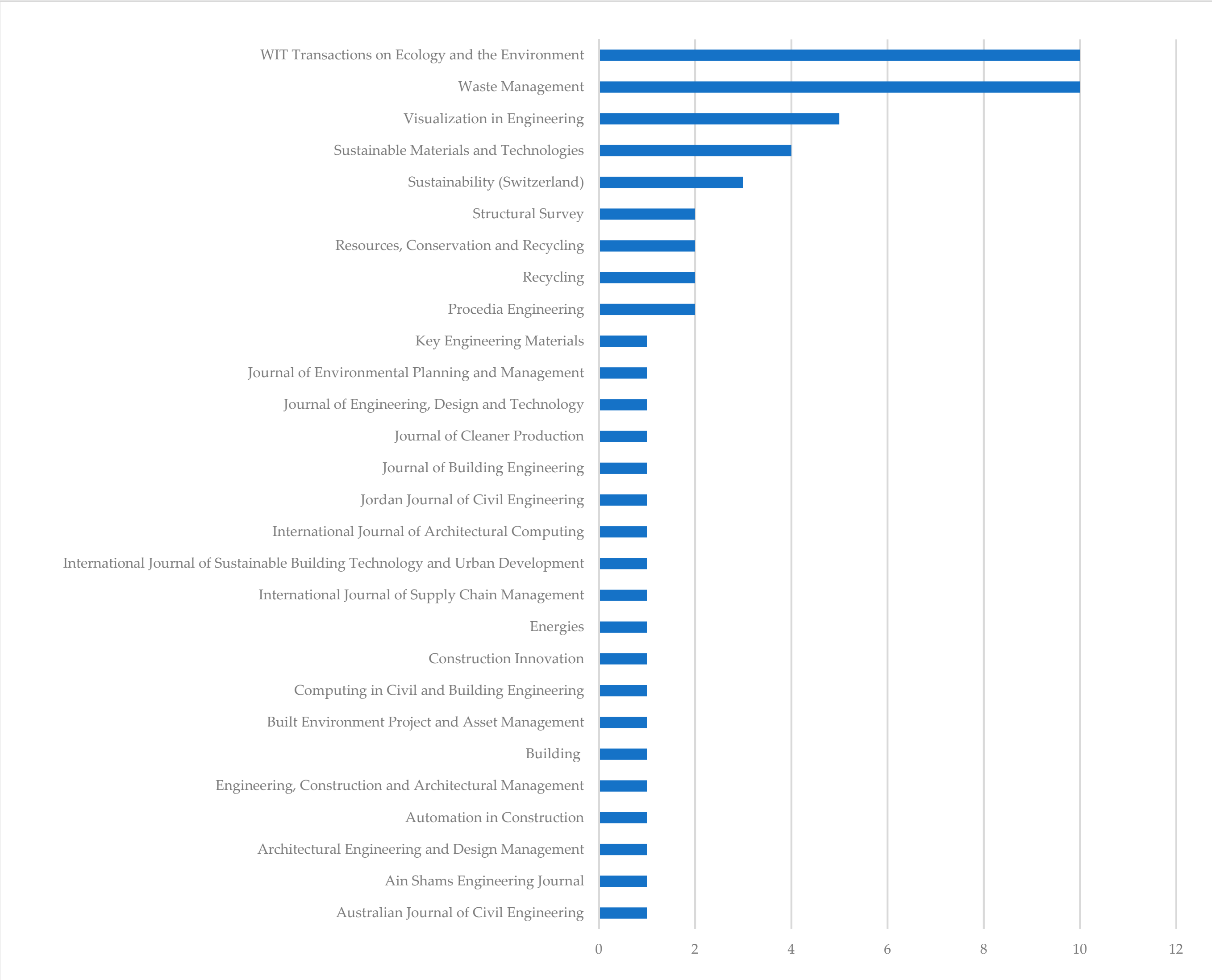

Figure 3. Mainstream journals in the domain of design-stage CW.

The chosen publications were sourced from over 25 distinct academic journals, thus exemplifying the diverse range of perspectives examined within the parameters of the present investigation. From Figure 3, it is also appreciated that the main journals contributing to this topic are *Waste Management* and the *Journal of Cleaner Production*. The credibility of the sources associated with the publication inspires confidence in the overall excellence and potential influence of the current SLR concerning the existing literature on practices for CW minimisation practices in the building design stage. It has been posited that well-established academic journals play a crucial role in assessing the quality of contemporary literature used in research analysis [65].

The interdisciplinary nature of CW's domain can be understood as covering a range of subjects, including project management, construction management, civil engineering, environmental science, and social sciences. Researchers may use varying methods, such as a literature review or methods as case studies and interviews, depending on their research aims [66–68].

5. Findings from the Content Analysis

The section discusses significant findings obtained from the content analysis process, which involved scrutinising and categorising articles to identify prevalent research areas. The analysis highlighted the need for more attention to emerging research areas in minimising CW, particularly in the design stage of building projects. The finalised papers were examined, focusing on topics related to CW minimisation and decision-making processes during the design stage, including the influencing factors.

5.1. Estimation/Quantification of CW Generation

The literature emphasises the importance of estimating and quantifying CW generation in all project phases: design, construction, and operation. However, there is a lack of established frameworks and methods for accurately measuring CW generation, necessitating the establishment of benchmarking criteria. A study was conducted to develop a statistical approach to assess waste production in high-rise building construction. This approach analysed the impact of both the design process and the material fabrication system, which are commonly recognised as the main sources of waste in building construction projects [69]. Other methods of data analytics were attempted, such as enterprise resource planning, to improve the estimation approaches of CW generation [70]. An analysis of how the design of multi-storey buildings and certain construction processes impact the generation of CW indices was conducted [71]. This approach to CW generation indices represents an improvement over the conventional approach, as it reduces estimation errors. This study serves as a reference, with its CW generation indices for stakeholders interested in estimating the volumes of CW. Therefore, multiple methodologies have been employed to determine the amount of CW, such as statistical methods, data mining, and modelling approaches. Regression analysis has been used to estimate CW by considering design and product systems as separate factors to estimate CW, achieving an accuracy rate of nearly 70% [69]. Additional factors that impact waste generation have also been examined, including building design and structure codes [72]. Further, advanced information technology or automation have been used to assist in waste estimation. A CW estimation system based on big data was created that involves stakeholders, providing them with a practical opportunity to predict and eliminate waste in the design process [73]. These studies emphasise the crucial role of high-quality, reliable databases in developing and validating waste estimation methods. The authors stress the significance of factors such as database quality, size, and reliability in this process. Designers can create waste-efficient buildings by employing effective design strategies, careful material selection, and procurement methods. Continuous modifications to building designs are essential to achieve optimal and eco-friendly outcomes while minimising waste.

However, recent research indicates insufficient knowledge about the extent and composition of CW, making accurate estimation challenging. To enhance waste generation databases, it is vital to incorporate elements such as geographical location and waste type into the estimation model [56,73,74]. Additionally, comparing and contrasting primary and secondary data on waste generation can also aid in enhancing these databases and categorising building types as either newly constructed or renovated.

5.2. Human Factors in CW Diversion Practice

It is evident that, since 2011, there has been a growing interest among researchers on the role of human factors in minimising CW. Scholars have posited that the most prevalent causes of CW generation can be mitigated by altering people's attitudes [17], underscoring the importance of considering human factors in CW management [75]. Additionally, scholars have found that comprehending attitudes and behaviours towards waste management is critical in effectively managing CW [76,77]. Moreover, some scholars have suggested that changing attitudes, rather than technologies, is a more effective approach to CW management [34].

In the context of CW minimisation practices, it is necessary to investigate human factors, such as perceptions, attitudes, behaviours, and expectations. This can be performed in both organisational and local contexts. However, research on the involvement of multiple stakeholders, including clients, engineers, contractors, and facilities managers, is needed [78]. These stakeholders must collaborate and be dedicated to identifying and reducing waste generation [34]. Although architects may not be experts in waste generation factors, they should still have the ability to gather and comprehend project specifications and communicate them effectively to the construction team [17]. The participation of suppliers in waste reduction measures, including waste-efficient bills of quantity, is also important [21]. To improve the effectiveness of CW mitigation practices, it is essential to address both technical and human aspects. Specifically, the focus should be on those who make significant decisions during the design stage of the project, where the most significant impact can be achieved.

The role of human factors in minimising CW should not be overlooked when making decisions [54]. Designers play a critical role in construction projects by demonstrating their cognitive abilities and knowledge when choosing materials, methods, and equipment. It is essential for them to effectively communicate the project requirements to the construction teams. Precise documentation and specifications are vital to ensure that construction aligns with the initial plans and supports waste prevention efforts that stem from the design stage [8].

5.3. Emerging Technologies, Concepts, and Management Practices

Recent advances in digital technologies and data analytics, particularly big data, have been the subject of investigation for their potential applications in waste control, project management, and quantification. One of these emerging digital technologies, BIM, has been explored for its capacity to aid in waste management, such as waste generation estimation during the design phase [62]. As BIM heavily relies on the storage and processing of large datasets, it is particularly compatible with big data technologies [56]. The integration of big data with BIM for waste estimation in CW management is still in its early stages. Currently, novel digital technologies for waste regulation are not widely implemented. There is potential to use BIM to assist designers in the early architectural phases, enhancing decision-making by providing insights into waste generation from specific materials or construction methods. This knowledge could help designers explore alternatives and enhance construction feasibility [79]. However, this necessitates designers to possess practical construction knowledge [80]. It has been noted that combining BIM visualisation capabilities and visual interactive methods for data analysis with human expertise, intuition, and creativity can lead to the discovery of novel approaches to support efficient decision-making [56]. By affirming the benefits of BIM, a firm academic foundation for acknowledging its usage and application in architectural design was established [81]. This study contributes to the growing body of knowledge surrounding BIM's potential to support designers, especially in terms of making informed decisions during the crucial initial stages of the design process. However, not all designers may have the same objectives or views regarding CW. It is important to establish an unambiguous management approach that guarantees timely access to pertinent information, enabling responsible parties to make well-informed decisions. BIM is recognised as a potentially valuable resource in achieving this objective.

5.4. Design Stage Decision-Making and CW Minimisation

Existing studies have explored the integration of CW minimisation measures within the design phases, planning, and tendering stages [58,82]. Research was carried out that concentrated on the design stage's pivotal role in reducing waste in construction projects [8]. The authors used structural equation modelling to identify important design practices for reducing waste in construction projects. Their findings highlighted that documenting waste-efficient design is crucial for minimising waste. Additionally, effective communication and early collaboration during the design phase play significant roles in CW efforts in building projects.

It was advocated for increased use of improved communication, standardisation, and enhanced collaboration to reduce waste generation [83]. The study highlights the importance of collaborative procurement and contractual provisions to adoptive commitments to minimise CW, which could be employed among the parties involved in a project [8]. The study further revealed that designers often avoid collaborating with other team members during the early stages of building projects, believing that waste management is the responsibility of contractors. However, evidence suggests that involving contractors and stakeholders early can improve the project quality, information flow, and overall performance. To enhance decision-making, it is crucial to understand the reasons behind this reluctance and find solutions. The study emphasises the need for better collaboration among construction professionals, as inadequate collaboration can lead to poor coordination, responsibility issues, reworks, and increased waste generation [8].

5.5. Stages of Design Stage Decision-Making towards Minimising CW

Designing a building project encounters many challenges in the practical execution [34]. Acquiring and representing knowledge to assess the degree to which constructability principles are applied in design solutions is a significant challenge that needs to be overcome, especially in selecting the most suitable strategy for minimising CW [69]. Research highlights the ineffectiveness of the currently prevailing design decision-making tools for building projects available to support a successful CW minimisation evaluation and implementation over the entire design stage [64]. Although the benefits of implementing constructability principles in the construction industry have been widely recognised by owners, contractors, and designers, the practical application process is often hindered by defects in the decision-making process [8]. This decision-making process requires effective coordination and communication among the design team to finalise the best strategy for minimising CW [64]. Therefore, a collaborative decision-making mechanism is needed for a better building design process.

Within the groups of participants involved at each decision point, each decision is a result of the negotiations and information sharing that underpin the process [8]. It is often observed that design adheres to a consistent approach involving project definition and CW minimisation priorities, followed by the development of a progressively refined solution. During this procedure, it is essential to identify the project's stakeholders and their duties and responsibilities and remain focused on meeting those needs. Additionally, the design process entails a complicated equilibrium of retaining close oversight while avoiding premature elimination of potential solutions. However, the decision-making tools to minimise CW, which support the design process, are rare, but making decisions on CW minimisation strategies during the initial phase of a project is crucial since the project is still in its early stage and subject to modifications [84].

While the literature includes very few references on the design decision-making process when targeting CW minimisation, the generic stages of this process have been identified. These tasks have been described in different terms, so this section attempts to present a unified version of this process. The initial task involves gathering all input data (CW priorities of the projects, allocated budget, ultimate project goals, and time frames assigned for CW implementations), which are to be mainly collected through design documentation analysis and information gathering from the project brief and other documents [74]. Hence, the initial phase is termed the "project familiarisation and information gathering phase", which also includes becoming familiar with the project context, the planning, and problem definition. Additionally, it consists of team formation, becoming familiar with the nature of the project, and planning subsequent stages [85]. In this stage, it is important to determine what information is needed, the best sources of information, and how to obtain it before accessing or gathering information, as incorrect information negatively affects the quality of making informed decisions [86]. As such, in terms of selecting a strategy to quantify CW, consideration for comprehensive material data and factors contributing to waste generation are very important in the first stage but have not been assigned adequate value [87]. The subsequent stage of the decision-making process is to generate a substantial number of ideas and potential solutions. Once all the information is collected, the next phase can be recognised as "identifying different solutions". In this stage, it is required to provide the necessary functionality and meet the CW minimisation objectives, which requires creativity and open thinking [34]. This includes diverse techniques for stimulating creativity and motivation to generate alternative ideas related to designing project components while considering CW minimisation. This is the step that engineering professionals often find the most challenging, as the feasibility of the different options is not recognised [80]. There exist numerous established techniques for innovative problem-solving, such as brainstorming, which is one of the most widely used [88].

The next phase is "evaluation of the alternative solutions". This phase considers aspects such as the effectiveness and applicability of the proposed solutions, as well as cost estimation and risk analysis [74]. In this phase, each of the technical ideas generated is assessed against the required criteria, mainly considering the CW minimisation priorities, to create a shortlist. It can be relatively simple to eliminate unsuitable solutions based on factors such as cost or feasibility in certain cases. However, in other cases, a comprehensive analysis might be required to accurately evaluate the prospective solutions. Weighing the alternatives and evaluating how effective they might be in addressing the criteria is important in this stage. The result of this process is a concise list of potential solutions, accompanied by documented evidence that supports their inclusion or exclusion from the list.

In the fourth step, the "shortlisted solutions are examined" in more detail [34]. Usually, one would typically need to conduct further analysis to fully comprehend the advantages and drawbacks of each option, along with other considerations. It would not be an effective allocation of resources to carry out an extensive analysis of all potential solutions at once, and it may be necessary to undergo multiple rounds of screening and more in-depth investigation [89]. Examining the shortlisted solutions based on CW minimisation priorities is important, and this helps to ensure a systematic and consistent assessment of the shortlisted solutions. The required quantitative and qualitative examination involves assessing the potential waste reduction benefits of each solution, such as the anticipated reduction in material waste, energy consumption, or carbon emissions as quantitative aspects. Qualitative analysis considers factors such as feasibility, practicality, cost-effectiveness, and compatibility with project constraints [90]. The process involves applying LCA techniques to comprehensively assess the environmental impact of selected solutions. LCA analyses the entire life cycle of a design, from raw material extraction to construction, use, and end-of-life stages. It identifies environmental hotspots and enables a comparative analysis of various design options. Expert involvement is crucial in this phase to conduct a thorough analysis. Simultaneously, evaluating risks and challenges is essential to assess the technical and practical aspects of solution implementation [85]. This outlines a crucial phase in building construction, focusing on regulatory compliance and market acceptance. It involves analysing suitable options based on environmental impact, feasibility, cost, and risks. The chosen solutions form the basis for implementing waste reduction strategies in the construction project, effectively guiding the design process.

After analysing the shortlisted solutions, "selecting and identifying the best solution and making recommendations" is the next step [91]. After identifying several potential solutions, a process of shortlisting one or more rounds is applied to gradually narrow them down to a preferred option or potentially a small set of equally viable alternatives.

The outcome of this step is the description of the preferred solution or solutions [92]. Considering the overall environmental impact, the potential of CW minimisation, cost-effectiveness, stakeholder feedback on the solution, and the potential of risk mitigation are the basis of finding the best solution. The decision-making on CW minimisation in a building construction project ends with documenting the decision-making process and the rationale behind selecting the chosen solution. Though these steps have been designed in the practical context, practising these processes requires a proper design decision-making mechanism [93].

5.6. Factors Affecting Design Stage Waste Minimisation Practices: Integrated Supply Chain, Stakeholder Collaboration, and Information Sharing

It is clear that the design stage has the potential to reduce a significant amount of CW, and waste can be generated from various activities throughout the entire project delivery process, which can be avoided by making appropriate design decisions [94]. Thus, it is crucial to adopt a comprehensive strategy for mitigating CW and assess the consequences of design choices throughout the entire life cycle of a project, from the construction phase to operation, maintenance, renovation, and demolition [95]. Within this decision-making process, it is particularly important to identify the factors that affect decision-making at the project design stage. Among them, the supply chain significantly impacts the decision-making process when focusing on minimising CW during the building design stage [96]. Enhancing the "integration within the supply chain" can result in a variety of benefits, including the reduction of unnecessary material allocations, the strategies to promote the efficient and effective usage of resources, introducing mechanisms for the prevention of CW by implementing environmentally conscious building designs, and supporting to reuse, recycle, or recover waste [96]. In every supply chain, regardless of the sector, managing information is crucial to ensure it is used to the fullest degree, as it can be efficiently upscaled for delivering waste-conscious building designs [70]. In this sense, design information pertains to any data that are generated by architects, engineers, contractors, or other suppliers during the design process, and such information serves the purpose of conveying or advancing the design, aiding in decision-making, and enabling the construction process [60]. The act of disseminating information is an essential component of integrating supply chains, and it holds a vital position in improving the efficacy and productivity of supply chain operations [97]. The success of waste minimisation strategies is heavily dependent on the efficient and effective "exchange of pivotal information" across various stages within the supply chain [98]. While various definitions of information sharing exist, in this context, it refers to the transfer of valuable information among systems, individuals, or organisations involved in the supply chain [84]. The term "crucial information" refers to a well-structured collection of facts or insights that are used to make informed judgments and direct actions. In conventional construction projects, stakeholders usually make decisions independently to benefit themselves, resulting in various issues, such as conflicts, uncertainty in cost and time, inefficiency, and hazards. The root cause of these problems is the absence of effective communication and cooperation among the involved parties [99]. Ineffective communication, inadequate scope definition, and the diverse technical backgrounds of stakeholders are the major problems in the pre-design phase of a project, which makes a complex decision environment for the design team [70,100]. Nevertheless, as advocated by a study carried out by the researchers, the best-practice measures for CW minimisation include the "collaboration of stakeholders" [14]. Henceforth, in addition to existing trends and considerations, the need to highlight the numerous challenges encompassing design, supply chain dynamics, uncertainty, collaborative efforts among stakeholders, and the comprehension of knowledge is essential for proper early-stage decision-making [101].

5.7. Requirement of an Effective Design Decision-Making Process towards CW Minimisation

Based on the content analysis carried out, it was evident that, during the early stages of design, it is important to create effective decision-making processes to minimise any negative impacts that design changes may have on CW. Poor decision-making during design could also lead to the selection of inappropriate materials due to a lack of knowledge about other options, resulting in even more CW generation [70]. Other factors that could contribute to CW include a lack of familiarity with standard material sizes and dimensions [8], errors in contract documents and drawings, and industry-related cultural factors [80].

As an effective decision-making process to minimise CW at the building design stage, it is important to have clearly set CW minimisation goals and priorities for the project, which specifically define the CW minimisation outcomes directly communicated to the design team of the project [61]. Additionally, it is important to have a collaborative decision-making process that comprises fostering collaboration and open communication among all the parties involved in the design stage [59], involving all the parties of the design team in decision-making discussions to ensure that waste reduction strategies are considered from multiple perspectives and that all parties are committed to CW minimisation. By following this effective design decision-making process, designers can proactively address CW issues while integrating waste management principles such as reuse and recycling into the building design. This approach not only minimises waste generation but also promotes resource efficiency, cost savings, and the overall sustainability of the project [74].

Although it is commonly known that making sound decisions during the design stage can help minimise CW, the current tools available for CW management are not fully integrated into the design process. Despite the use of certain CW strategies during the design stage, they are not incorporated into the design software used by architects and engineers [56]. In the design stage, the effectiveness of waste minimisation strategies is often hindered by the limited awareness and knowledge of design team members. This lack of understanding can negatively impact decision-making, leading to missed opportunities for waste reduction. Certain strategies, such as estimation tools, further complicate the process due to a lack of coordination among team members, resulting in suboptimal design decisions. Additionally, designers often face challenges accessing comprehensive and accurate data on materials, supply chains, and project information, further impeding successful waste minimisation efforts [102]. Without such data and information, it becomes challenging to make informed decisions to achieve the CW goals and priorities. Cost constraints and budget limitations are also a factor when introducing an advanced tool or platform to a building project for the purpose of CW minimisation. For these reasons, investors usually show a reluctance to invest in them upfront, despite that waste minimisation may have long-term cost benefits. Moreover, even though researchers have come up with complex and advanced models that use technologies such as BIM to apply in the building design stage with the purpose of minimising CW, without clear guidelines or financial incentives, designers may not prioritise the models, considering them as optional rather than essential. Despite the emergence of various information and communication technology (ICT) tools that can assist stakeholders in managing CW in the construction industry, these tools are still not integrated into the design process and can only be employed after the design stage [103].

This work provides greater insight into how to improve CW minimisation processes and design decision-making, particularly considering the unique challenges faced across building construction projects. The findings suggest that an interactive decision support platform, which enables waste prediction and benchmarking, design optimisation, and the setting of waste reduction targets, could be effective in CW minimisation. Further, increased education and awareness would be necessary to facilitate informed decision-making in this regard.

6. Conceptual Framework

This section synthesises the results in a methodical manner following the completion of the content analysis of the literature findings. The results are presented in a conceptual framework, which is illustrated in Figure 4. One of the functions of a conceptual framework is to provide a foundation for solving new and emerging practical problems [104]. In view of this, the conceptual framework leverages previous work to establish interrelationships and discern emerging patterns, and reviews can be developed based on theory and existing literature. This research established a foundation to address the persistent problem of improving CW minimisation practices by emphasising the importance of effective decision-making during the building design stage to overcome existing barriers. In addition, it helps define the stages of the process, which makes it easier to make decisions.

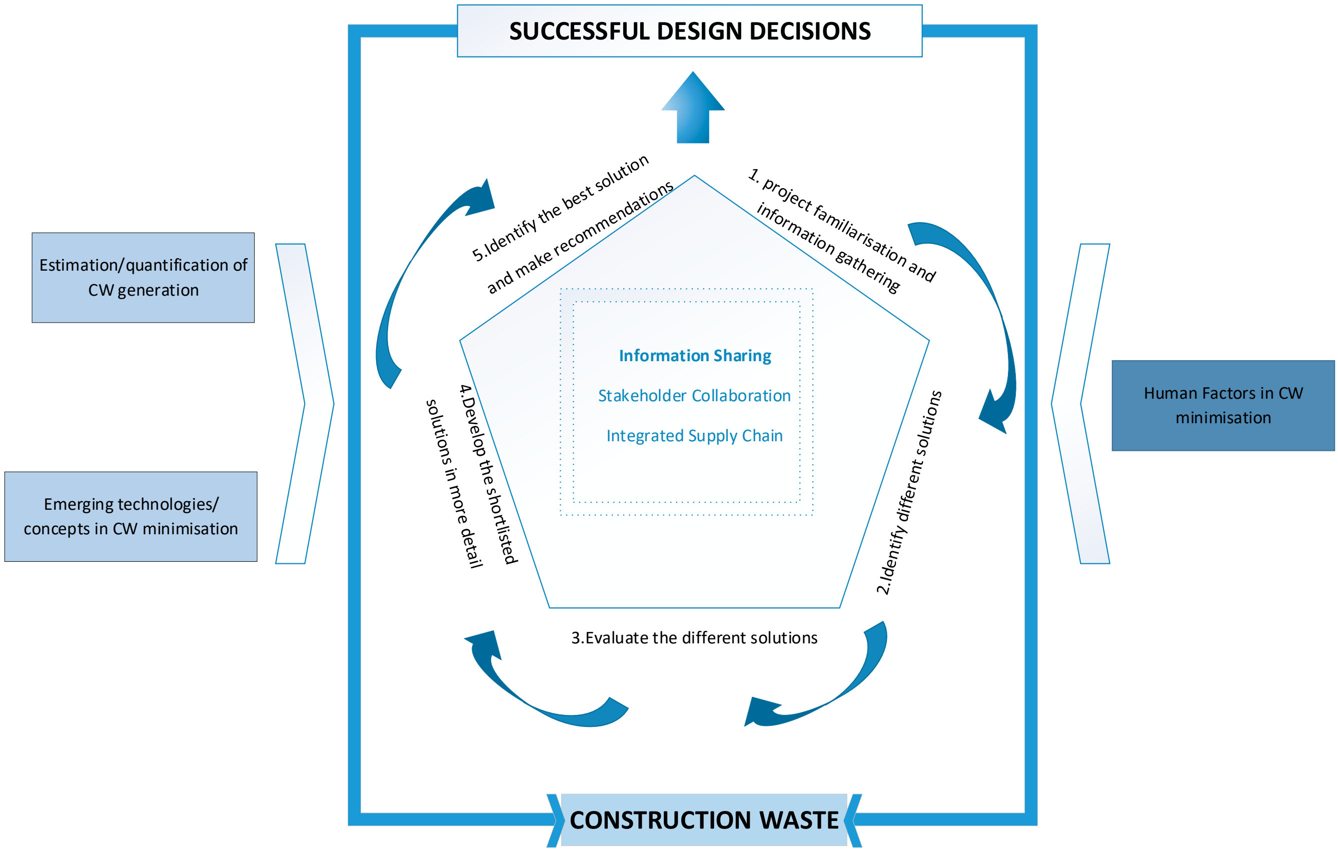

Figure 4. Conceptual framework.

While conducting the literature review, it was identified that the key themes within the domain of CW minimisation in building projects are primarily centred around the quantification or estimation of CW generation and the emergence of technologies such as BIM or big data, with human factors emerging as a prominent theme. This highlights the significance of decision-making in this context. During the design phase, it is imperative to ensure that the decisions made are both informative and precise to minimise waste to the greatest extent possible. Therefore, waste reduction should be considered a crucial factor in attaining project value while making decisions during the initial phases of design [105]. By identifying and exploring a proper decision-making process during the building design stage to minimise CW, it is possible to maximise the effectiveness of the decisions made during this stage. In this review, the decision-making steps have been identified as project familiarisation information gathering, identifying different solutions, evaluating the solutions, developing and shortlisting solutions in more detail, and finally, identifying the best solution and making recommendations accordingly. Regarding synthesising decision-making steps in building design, this review identified the factors affecting the effective and successful implementation of the decision-making process. The factors are information sharing, stakeholder collaboration, and supply chain integration. It has been discussed within the paper that by addressing these factors, the decision-making process at the building design stage towards CW minimisation can be improved. As identified in the literature, for an effective decision-making process, integration of the supply chain plays a key role and, therefore, studies have underscored the significance of integrating the supply chain to make informed decisions [43,70]. In research on supply chain transactions in the construction industry, it was found that information management is crucial [106]. Effective information exchange is key to efficient management of the construction supply chain, and this highlights the importance of exploring the intersection of the supply chain and information sharing in the design decision-making process. Design and detailing errors due to a lack of information are also crucial causes of waste generation. The use of design details serves to delineate the interconnection between building components and materials. These details are typically used in conjunction with construction specifications to assemble components and materials. If there are errors in the detailing process, this can lead to undefined, incomplete, and misleading information, which could pose challenges during construction. To avoid such errors, the design team must provide clear and comprehensive details and specifications that can be easily understood and implemented by construction professionals. Extensive research indicates that errors in detailing, specifications, and design significantly contribute to construction-related issues, particularly in terms of information sharing. Should a team fail to guarantee that all members receive adequate information and have equal input in decision-making, the potential for a small group to dominate and overlook crucial information exists. Moreover, it has been noted that decision-making in building design projects can be complex due to various factors, such as the technical backgrounds of stakeholders, their differing priorities and expectations for the final project outcomes, the need to fulfil multiple objectives, managing numerous criteria and alternatives, justifying decisions, and understanding the problems. This complexity may potentially impede effective communication among project stakeholders prior to the design phase, leading to uncertainty. Additionally, studies have identified a correlation between the complexities in the pre-design phase and the generation of CW [100]. Moreover, separated responsibilities for design and construction may potentially lead to a deficiency in information exchange and knowledge transfer among the various project stakeholders [74].

In alignment with these findings, it was highlighted that proper decision-making processes are important to facilitate a successful project delivery with effective CW minimisation. To establish an effective decision-making mechanism for minimising CW, it is necessary to have a collaborative network that can overcome challenges, such as user-friendliness and practicality. The SLR revealed that specific factors exert an influence on CW minimisation practices during the design phase of building construction projects. Consequently, a conceptual framework was devised based on these identified factors and research directions for CW minimisation. This framework serves as a condensed representation of the various stages involved in building design, possessing the potential to increase project outcomes. By furnishing a robust foundation for decision-making pertaining to CW minimisation during the design phase, this framework represents an initial noteworthy contribution to the domain.

7. Further Research Directions

The findings emphasised that the construction industry must do more than seek methods to reduce waste. A streamlined process is needed during the project design phase to ensure efficient delivery that meets waste reduction requirements. The significance of investigating this topic is underscored by the areas of concern that have been identified. It is essential to establish a sound decision-making mechanism to address current waste issues in construction. Moreover, conducting a quantitative analysis of these reviewed papers is crucial. Such analysis offers a statistically valid and quantitatively illustrative insight into the current research directions, particularly concerning decision-making processes during the building design stage for minimising CW. Further, to achieve this, a thorough analysis of research topics related to CW and their impact on decision-making during the design phase is crucial. Table 2 provides a summary of the identified research areas and offers insights for future directions of study.

Table 2. Research directions on design stage decision-making.

Current Research Approaches	Supportive Sources	Research Areas	Future Research Directions Identified in Analysed Literature on Design Stage Decision-Making
Quantifying/estimating waste at the design stage. Reuse and recycling plans for materials to reduce waste based on waste estimation models. Design, modelling, simulation, and validation of waste generation.	[69–72]	CW quantification and planning for waste diversion.	Developing models with the data and information from waste estimations and quantifications, to make informed decisions towards enhancing the collaboration among stakeholders and improving the supply chain.
Behaviour/perceptions and attitudes of construction employees/professionals for waste minimisation.	[24,34,75]	Human factors in CW management and minimisation.	Identification and investigation of decision-making mechanisms to assist design team members in collaborative efforts, with the goal of minimising CW. Quantitatively analysing behaviour/perceptions and attitudes of design team members towards CW at the building design stage.
BIM/digital construction/industry 4.0/artificial intelligence relating to the project design process for waste minimisation. Prefabrication/offsite construction and modular construction. System thinking/automation of design and waste minimisation. Lean concepts for waste reduction at the design stage/reverse logistics/disaster management. Reducing CW during the design process with management concepts. Construction stage onsite waste minimisation.	[56,81,107]	BIM/emerging technologies- or concepts-based CW minimisation. Designing out waste. Management practices.	The integration of emerging technologies, such as BIM and big data, VM, and lean concepts, aiming to improve information sharing among design team members and contribute to decision-making during the design stage.

Quantification and estimation aspects in terms of predicting CW at the building design stage play a key role in waste minimisation [53]. Even though different research avenues can be explored, the foundation is laid on proper decision-making at the building design stage to predict the amount of CW more precisely [83]. Therefore, it is important to explore research directions for developing models using data and information from waste estimations and quantifications. This will enable informed decision-making and assist design team members in collaborative efforts to minimise CW. Moreover, the design team members are the key contributors who can influence the strategies to minimise CW at the design stage with their decisions [53]. Based on that critique, the identification and investigation of decision-making mechanisms to assist design team members with the goal of minimising CW has become important in today's context. Similarly, focusing on carrying out a quantitative analysis of the behaviour/perceptions and attitudes of design team members towards CW at the building design stage is important to capture the generalised version of design team members' perceptions. Modern research trends have led to significant progress in academic research on the theoretical applications of BIM in minimising CW. This progress can be achieved by enhancing the efficiency and effectiveness of information sharing through innovative platforms. Nevertheless, the CW minimisation process is a complex project environment that encompasses a variety of dynamic activities, including but not limited to recycling, reusing, sorting, and transporting. These processes require a dynamic assessment of all influential variables and their interrelationships [61]. Therefore, the integration of emerging technologies (e.g., BIM and big data) and the identification of ways in which they can contribute to design stage decision-making while enhancing collaboration among design team members is vital. These findings encourage the researchers to focus on the decision-making process at the building design stage, which will be a crucial direction in the construction management research field.

8. Conclusions

This review study aimed to integrate the existing literature to identify and explore the key areas that can support CW minimisation strategies during the design decision-making process of building projects and to determine the potential areas for further research in the field of study. A systematic literature review was conducted following the PRISMA guidelines. The articles were sorted and subjected to a descriptive analysis based on their publication years and sources.

After conducting the descriptive analysis for the selected period and publications, it became clear that there were three distinct concepts that the publications focused on. Prior to 2015, most research focused primarily on the reuse and recycling of materials, addressing the volume of waste sent to landfills and the associated environmental damage. From 2015 to 2018, publications delved into sustainable methods for waste minimisation, sources of waste, and the impact of design decisions on waste generation and prevention concepts. Research conducted after 2018 placed significant emphasis on assessing the feasibility and impact of early-stage construction waste minimisation mechanisms in the building construction industry.

Following the descriptive analysis, a content analysis was conducted to identify research themes in relation to CW minimisation and decision-making processes during the design stage. Additionally, a discussion on the factors affecting design stage waste minimisation practices was presented, followed by a further analysis of the decision-making process for minimising CW. This analysis involved identifying the significant steps in the decision-making process with the intention of establishing a basis to develop a systematic process. Accordingly, the identified steps were: (1) project familiarisation and information gathering, (2) identify different solutions, (3) evaluate the different solutions, (4) develop the shortlisted solutions in more detail, and (5) identify the best solution and make recommendations.

This SLR holds great significance in that it provides solid groundwork for reducing CW through strategic design choices, while also offering guidance on the key factors that influence this decision-making process. The research has shown that effective information sharing is a crucial component in enhancing the decision-making process, acting as a unifying factor. Moreover, the interconnectivity of other factors, such as supply chain integration and stakeholder collaboration, cannot be overlooked as they too play an important role.

The essence of the literature review findings is presented in a conceptual framework illustrated in Figure 4. This framework provides valuable guidance on how to implement the enablers introduced to improve decision-making during the design phase. By carefully selecting strategies that minimise CW, design team members, such as architects, engineers, and quantity surveyors, can make informed choices about design and buildability aspects, leading to better project outcomes. This study extends the theoretical landscape by offering a nuanced understanding of the interplay between design decision-making processes and CW minimisation. The conceptual framework contributes to the emerging discourse on sustainable design practices, thereby bridging a significant gap in the existing literature and advocating for a paradigmatic shift within the built environment research community.

In summary, this study outlined the urgent need for more robust decision-making processes and improved information exchange to reduce CW in building design. Although this area has received little attention from researchers in the built environment, the findings suggest that improving building design processes should be a top priority for reducing CW. This underscores the critical role of architects, engineers, and quantity surveyors in achieving these goals. Consequently, this study not only fills a significant gap in the research landscape but also underscores the pressing need for improved design processes and information sharing to effectively minimise CW. The enriched understanding provided by this study indicates a concerted effort from both academia and industry to foster a more sustainable and waste-efficient design ethos in building construction projects.

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References

1. Salman, S.; Tayyab, M.; Peter, W.; Malik, K.; Rebecca, Y. Green Construction and Construction and Demolition Waste Management in Australia. In Proceedings of the 43rd AUBEA Conference: Built to Thrive: Creating Buildings and Cities That Support Individual Well-Being and Community Prosperity, Noosa, Australia, 6–8 November 2019; pp. 1–9.
2. Ghafourian, K.; Mohamed, Z.; Ismail, S.; Malakute, R.; Abolghasemi, M. Current status of the research on construction and demolition waste management. *Indian J. Sci. Technol.* **2016**, *9*, 1–9. [CrossRef]
3. López Ruiz, L.A.; Roca Ramón, X.; Gassó Domingo, S. The circular economy in the construction and demolition waste sector—A review and an integrative model approach. *J. Clean. Prod.* **2020**, *248*, 119238. [CrossRef]
4. Bølviken, T.; Koskela, L. Why Hasn't Waste Reduction Conquered Construction? In Proceedings of the 24th Annual Conference of the International Group for Lean Construction, Boston, MA, USA, 18–24 July 2016.
5. Osmani, M. Construction Waste Minimization in the UK: Current Pressures for Change and Approaches. *Procedia—Soc. Behav. Sci.* **2012**, *40*, 37–40. [CrossRef]
6. Ajayi, S.O.; Oyedele, L.O.; Akinade, O.O.; Bilal, M.; Alaka, H.A.; Owolabi, H.A.; Kadiri, K.O. Attributes of design for construction waste minimization: A case study of waste-to-energy project. *Renew. Sustain. Energy Rev.* **2017**, *73*, 1333–1341. [CrossRef]
7. Innes, S. Developing tools for designing out waste pre-site and on-site. In *Proceedings of the Minimising Construction Waste Conference: Developing Resource Efficiency and Waste Minimisation in Design and Construction*; New Civil Engineer: London, UK, 2004.
8. Ajayi, S.O.; Oyedele, L.O. Critical design factors for minimising waste in construction projects: A structural equation modelling approach. *Resour. Conserv. Recycl.* **2018**, *137*, 302–313. [CrossRef]
9. Jin, R.; Zou, Y.; Gidado, K.; Ashton, P.; Painting, N. Scientometric analysis of BIM-based research in construction engineering and management. *Eng. Constr. Archit. Manag.* **2019**, *26*, 1750–1776. [CrossRef]
10. Wang, J.; Li, Z.; Tam, V.W.Y. Critical factors in effective construction waste minimization at the design stage: A Shenzhen case study, China. *Resour. Conserv. Recycl.* **2014**, *82*, 1–7. [CrossRef]
11. Osmani, M.; Glass, J.; Price, A.D.F. Architects' perspectives on construction waste reduction by design. *Waste Manag.* **2008**, *28*, 1147–1158. [CrossRef]
12. Mohamed, A.-M.O.; El Gamal, M.M.; Hameedi, S.M.; Paleologos, E.K. Chapter 1—Emerging carbon-based waste management sustainable practices. In *Sustainable Utilization of Carbon Dioxide in Waste Management*; Mohamed, A.-M.O., El Gamal, M.M., Hameedi, S.M., Paleologos, E.K., Eds.; Elsevier: Amsterdam, The Netherlands, 2023; pp. 1–66. Available online: https://www.sciencedirect.com/science/article/pii/B9780128234181000159 (accessed on 1 January 2023).
13. Coventry, S.; Shorter, B.; Kingsley, M. *Demonstrating Waste Minimisation Benefits in Construction*; Construction Industry Research and Information Association: London, UK, 2001.
14. Osmani, M.; Villoria-Sáez, P. Current and Emerging Construction Waste Management Status, Trends and Approaches. In *Waste*; Elsevier: Amsterdam, The Netherlands, 2019; pp. 365–380.
15. Ekanayake, L.L.; Ofori, G. Building waste assessment score: Design-based tool. *Build. Environ.* **2004**, *39*, 851–861. [CrossRef]
16. Silva, R.V.; de Brito, J.; Dhir, R.K. Availability and processing of recycled aggregates within the construction and demolition supply chain: A review. *J. Clean. Prod.* **2017**, *143*, 598–614. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85008158197&doi=10.1016%2Fj.jclepro.2016.12.070&partnerID=40&md5=5b68ec360dc339f1036d56af9a0c4bdf (accessed on 5 December 2022). [CrossRef]

17. Osmani, M.; Glass, J.; Price, A.D.F. An investigation of design waste causes in construction. *WIT Trans. Ecol. Environ.* **2008**, *109*, 491–498. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-58849139680&doi=10.2495%2FWM080501&partnerID=40&md5=ce3d63a0f676a93924c51ed3d8b40dc8 (accessed on 2 February 2023).
18. Soto-Paz, J.; Arroyo, O.; Torres-Guevara, L.E.; Parra-Orobio, B.A.; Casallas-Ojeda, M. The circular economy in the construction and demolition waste management: A comparative analysis in emerging and developed countries. *J. Build. Eng.* **2023**, *78*, 107724. [CrossRef]
19. Spišáková, M.; Mandičák, T.; Mésároš, P.; Špak, M. Waste Management in a Sustainable Circular Economy as a Part of Design of Construction. *Appl. Sci.* **2022**, *12*, 4553. [CrossRef]
20. Nikmehr, B.; Hosseini, M.R.; Oraee, M.; Chileshe, N. Major Factors Affecting Waste Generation on Construction Sites in Iran. In Proceedings of the 6th International Conference on Engineering, Project, and Production Management, Gold Coast, Australia, 2–4 September 2015; pp. 528–536.
21. Luangcharoenrat, C.; Intrachooto, S.; Peansupap, V.; Sutthinarakorn, W. Factors influencing construction waste generation in building construction: Thailand's perspective. *Sustainability* **2019**, *11*, 3638. [CrossRef]
22. Chen, X.F.; Jiao, C.J. A photocatalytic mortar prepared by tourmaline and TiO2 treated recycled aggregates and its air-purifying performance. *Case Stud. Constr. Mater.* **2022**, *16*, e01073. [CrossRef]
23. Greeno, R. An Overview of the Building Delivery Process. In *Principles of Construction*; Birkhäuser: Basel, Switzerland, 2014; pp. 1–31.
24. Baldwin, A.N.; Shen, L.Y.; Poon, C.S.; Austin, S.A.; Wong, I. Modelling design information to evaluate pre-fabricated and pre-cast design solutions for reducing construction waste in high rise residential buildings. *Autom. Constr.* **2008**, *17*, 333–341. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-37549009171&doi=10.1016%2Fj.autcon.2007.05.013&partnerID=40&md5=826e6ca6632ec9afef4bfc11380722b6 (accessed on 11 March 2023). [CrossRef]
25. Osmani, M. Design waste mapping: A project life cycle approach. *Proc. Inst. Civ. Eng. Waste Resour. Manag.* **2013**, *166*, 114–127. [CrossRef]
26. Osmani, M. Integration of Waste Minimisation Strategies into the Design Process of Buildings. 2015. Available online: https://dspace.lboro.ac.uk/2134/21775 (accessed on 11 September 2022).
27. State Library New South Wales Understanding the Building Design and Construction Phases. Available online: https://www.sl.nsw.gov.au/public-library-services/people-places/understanding-building-design-and-construction-phases (accessed on 24 April 2023).
28. Oluleye, B.I.; Chan, D.W.M.; Olawumi, T.O.; Saka, A.B. Assessment of symmetries and asymmetries on barriers to circular economy adoption in the construction industry towards zero waste: A survey of international experts. *Build. Environ.* **2023**, *228*, 109885. [CrossRef]
29. Wynn, D.C.; Clarkson, P.J. Process models in design and development. *Res. Eng. Des.* **2018**, *29*, 161–202. [CrossRef]
30. Doust, K.; Battista, G.; Rundle, P. Front-end construction waste minimization strategies. *Aust. J. Civ. Eng.* **2020**, *19*, 1–11. [CrossRef]
31. Islam, M.S.; Islam, M.M.; Shihab, S.R.; Skitmore, M.; Nepal, M.P. Nonconformity Assessment in Building Construction Projects: A Fuzzy Group Decision-Making Approach. *J. Perform. Constr. Facil.* **2023**, *37*, 04022075. [CrossRef]
32. Olanrewaju, S.D.; Ogunmakinde, O.E. Waste minimisation strategies at the design phase: Architects' response. *Waste Manag.* **2020**, *118*, 323–330. [CrossRef]
33. Alshboul, A.A.; Ghazaleh, S.A. Consequences of design decisions on material waste during construction survey of architects' point of view, The case of Jordan. *Jordan J. Civ. Eng.* **2014**, *8*, 363–374.
34. Udawatta, N.; Zuo, J.; Chiveralls, K.; Zillante, G. Improving waste management in construction projects: An Australian study. *Resour. Conserv. Recycl.* **2015**, *101*, 73–83. [CrossRef]
35. de Magalhães, R.F.; Danilevicz, Â.d.M.F.; Saurin, T.A. Reducing construction waste: A study of urban infrastructure projects. *Waste Manag.* **2017**, *67*, 265–277. [CrossRef]
36. Moher, D.; Liberati, A.; Tetzlaff, J.; Altman, D.G.; Group, T.P. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med.* **2009**, *6*, e1000097. [CrossRef]
37. Moher, D.; Shamseer, L.; Clarke, M.; Ghersi, D.; Liberati, A.; Petticrew, M.; Shekelle, P.; Stewart, L.A.; Estarli, M.; Barrera, E.S.A.; et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Rev. Esp. Nutr. Humana y Diet.* **2016**, *20*, 148–160. [CrossRef]
38. Oluleye, B.I.; Chan, D.W.M.; Olawumi, T.O. Barriers to circular economy adoption and concomitant implementation strategies in building construction and demolition waste management: A PRISMA and interpretive structural modeling approach. *Habitat Int.* **2022**, *126*, 102615. [CrossRef]
39. Regona, M.; Yigitcanlar, T.; Xia, B.; Li, R.Y.M. Opportunities and Adoption Challenges of AI in the Construction Industry: A PRISMA Review. *J. Open Innov. Technol. Mark. Complex.* **2022**, *8*, 45. [CrossRef]
40. Radzi, A.R.; Rahman, R.A.; Doh, S.I. Decision making in highway construction: A systematic review and future directions. *J. Eng. Des. Technol.* **2021**, *21*, 1083–1106. [CrossRef]
41. Vaismoradi, M.; Jones, J.; Turunen, H.; Snelgrove, S. Theme development in qualitative content analysis and thematic analysis. *J. Nurs. Educ. Pract.* **2016**, *6*, 100–110. [CrossRef]

42. Jin, R.; Yuan, H.; Chen, Q. Science mapping approach to assisting the review of construction and demolition waste management research published between 2009 and 2018. *Resour. Conserv. Recycl.* **2019**, *140*, 175–188. [CrossRef]
43. Ali, A.; Mahfouz, A.; Arisha, A. Analysing supply chain resilience: Integrating the constructs in a concept mapping framework via a systematic literature review. *Supply Chain Manag. Int. J.* **2017**, *22*, 16–39. [CrossRef]
44. Elmualim, A.; Mostafa, S.; Chileshe, N.; Rameezdeen, R. Construction and the Circular Economy: Smart and Industrialised Prefabrication. In *Unmaking Waste in Production and Consumption: Towards the Circular Economy*; Crocker, R., Saint, C., Chen, G., Tong, Y., Eds.; Emerald Publishing Limited: Bingley, UK, 2018; pp. 323–336. [CrossRef]
45. Aghaei Chadegani, A.; Salehi, H.; Md Yunus, M.M.; Farhadi, H.; Fooladi, M.; Farhadi, M.; Ale Ebrahim, N. A comparison between two main academic literature collections: Web of science and scopus databases. *Asian Soc. Sci.* **2013**, *9*, 18–26. [CrossRef]
46. Kabirifar, K.; Mojtahedi, M.; Wang, C.C. A Systematic Review of Construction and Demolition Waste Management in Australia: Current Practices and Challenges. *Recycling* **2021**, *6*, 34. Available online: https://www.mdpi.com/2313-4321/6/2/34 (accessed on 10 January 2023). [CrossRef]
47. Wu, H.; Zuo, J.; Yuan, H.; Zillante, G.; Wang, J. A review of performance assessment methods for construction and demolition waste management. *Resour. Conserv. Recycl.* **2019**, *150*, 104407. [CrossRef]
48. Wijewickrama, M.K.C.S.; Chileshe, N.; Rameezdeen, R.; Ochoa, J.J. Quality assurance in reverse logistics supply chain of demolition waste: A systematic literature review. *Waste Manag. Res.* **2021**, *39*, 3–24. [CrossRef]
49. Wijewickrama, M.K.C.S.; Chileshe, N.; Rameezdeen, R.; Ochoa, J.J. Information sharing in reverse logistics supply chain of demolition waste: A systematic literature review. *J. Clean. Prod.* **2021**, *280*, 124359. [CrossRef]
50. Yin, X.; Liu, H.; Chen, Y.; Al-Hussein, M. Building information modelling for off-site construction: Review and future directions. *Autom. Constr.* **2019**, *101*, 72–91. [CrossRef]
51. Stone, J.M.; Gardiner, T.A.; Teuben, P.; Hawley, J.F.; Simon, J.B. Athena: A New Code for Astrophysical MHD. *Astrophys. J. Suppl. Ser.* **2008**, *178*, 137–177. [CrossRef]
52. Fereday, J.; Muir-Cochrane, E. Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *Int. J. Qual. Methods* **2006**, *5*, 80–92. [CrossRef]
53. Llatas, C. A model for quantifying construction waste in projects according to the European waste list. *Waste Manag.* **2011**, *31*, 1261–1276. [CrossRef] [PubMed]
54. Yates, J.K. Sustainable methods for waste minimisation in construction. *Constr. Innov.* **2013**, *13*, 281–301. [CrossRef]
55. Jayamathan, J.; Rameezdeen, R. Influence of labour arrangement on construction material waste generation. *Struct. Surv.* **2014**, *32*, 76–88. [CrossRef]
56. Bilal, M.; Oyedele, L.O.; Qadir, J.; Munir, K.; Akinade, O.O.; Ajayi, S.O.; Alaka, H.A.; Owolabi, H.A. Analysis of critical features and evaluation of BIM software: Towards a plug-in for construction waste minimization using big data. *Int. J. Sustain. Build. Technol. Urban Dev.* **2015**, *6*, 211–228. [CrossRef]
57. Olofsson Hallén, K.; Forsman, M.; Eriksson, A. Interactions between Human, Technology and Organization in Building Information Modelling (BIM)—A scoping review of critical factors for the individual user. *Int. J. Ind. Ergon.* **2023**, *97*, 103480. [CrossRef]
58. Akinade, O.O.; Oyedele, L.O.; Ajayi, S.O.; Bilal, M.; Alaka, H.A.; Owolabi, H.A.; Arawomo, O.O. Designing out construction waste using BIM technology: Stakeholders' expectations for industry deployment. *J. Clean. Prod.* **2018**, *180*, 375–385. [CrossRef]
59. Murtagh, N.; Scott, L.; Fan, J. Sustainable and resilient construction: Current status and future challenges. *J. Clean. Prod.* **2020**, *268*, 122264. [CrossRef]
60. Haruna, A.; Shafiq, N.; Montasir, O.A. Building information modelling application for developing sustainable building (Multi criteria decision making approach). *Ain Shams Eng. J.* **2021**, *12*, 293–302. [CrossRef]
61. Zoghi, M.; Kim, S. Dynamic modeling for life cycle cost analysis of BIM-based construction waste management. *Sustainability* **2020**, *12*, 2483. [CrossRef]
62. Won, J.; Cheng, J.C.P.; Lee, G. Quantification of construction waste prevented by BIM-based design validation: Case studies in South Korea. *Waste Manag.* **2016**, *49*, 170–180. [CrossRef] [PubMed]
63. Ge, X.J.; Livesey, P.; Wang, J.; Huang, S.; He, X.; Zhang, C. Deconstruction waste management through 3d reconstruction and bim: A case study. *Vis. Eng.* **2017**, *5*, 13. [CrossRef]
64. Liu, Z.; Osmani, M.; Demian, P.; Baldwin, A. A BIM-aided construction waste minimisation framework. *Autom. Constr.* **2015**, *59*, 1–23. [CrossRef]
65. Akbari, M.; Ha, N. Impact of additive manufacturing on the Vietnamese transportation industry: An exploratory study. *Asian J. Shipp. Logist.* **2020**, *36*, 78–88. [CrossRef]
66. Akbarieh, A.; Jayasinghe, L.B.; Waldmann, D.; Teferle, F.N. BIM-based end-of-lifecycle decision making and digital deconstruction: Literature review. *Sustainability* **2020**, *12*, 2670. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85083586987&doi=10.3390%2Fsu12072670&partnerID=40&md5=5ed311256e00c1ac9530d42c97d8c201 (accessed on 12 December 2022). [CrossRef]
67. Bosch-Sijtsema, P.; Buser, M. Construction and demolition waste management on the building site: A literature review. In Proceedings of the Association of Researchers in Construction Management ARCOM—33rd Annual ARCOM Conference 2017, Cambridge, UK, 4–6 September 2017; pp. 269–278.

68. Chanki, N.M.; Pitroda, J. A Critical Literature Review on Construction Waste Management. *Int. J. Adv. Eng. Res. Dev.* **2018**, *5*, 434–439.
69. Parisi Kern, A.; Ferreira Dias, M.; Piva Kulakowski, M.; Paulo Gomes, L. Waste generated in high-rise buildings construction: A quantification model based on statistical multiple regression. *Waste Manag.* **2015**, *39*, 35–44. [CrossRef]
70. Akinade, O.O.; Oyedele, L.O. Integrating construction supply chains within a circular economy: An ANFIS-based waste analytics system (A-WAS). *J. Clean. Prod.* **2019**, *229*, 863–873. [CrossRef]
71. Angulo, S.C.; Gulo, T.; Quattrone, M. Building design and construction process influence in construction waste generation. *Key Eng. Mater.* **2016**, *668*, 297–303. [CrossRef]
72. Ding, Z.; Liu, R.; Wang, Y.; Tam, V.W.; Ma, M. An agent-based model approach for urban demolition waste quantification and a management framework for stakeholders. *J. Clean. Prod.* **2021**, *285*, 124897. [CrossRef]
73. Bilal, M.; Oyedele, L.O.; Qadir, J.; Munir, K.; Ajayi, S.O.; Akinade, O.O.; Owolabi, H.A.; Alaka, H.A.; Pasha, M. Big Data in the construction industry: A review of present status, opportunities, and future trends. *Adv. Eng. Inform.* **2016**, *30*, 500–521. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84978529080&doi=10.1016%2Fj.aei.2016.07.001&partnerID=40&md5=2e3c4aa24b24f44b04d3ef411258aa75 (accessed on 15 January 2023). [CrossRef]
74. Llatas, C.; Osmani, M. Development and validation of a building design waste reduction model. *Waste Manag.* **2016**, *56*, 318–336. [CrossRef] [PubMed]
75. Yuan, H.; Shen, L. Trend of the research on construction and demolition waste management. *Waste Manag.* **2011**, *31*, 670–679. [CrossRef]
76. Begum, R.A.; Siwar, C.; Pereira, J.J.; Jaafar, A.H. Implementation of waste management and minimisation in the construction industry of Malaysia. *Resour. Conserv. Recycl.* **2007**, *51*, 190–202. [CrossRef]
77. Zaman, A.U.; Lehmann, S. Challenges and Opportunities in Transforming a City into a "Zero Waste City". *Challenges* **2011**, *2*, 73–93. [CrossRef]
78. Wu, H.; Zuo, J.; Zillante, G.; Wang, J.; Yuan, H. Status quo and future directions of construction and demolition waste research: A critical review. *J. Clean. Prod.* **2019**, *240*, 118163. [CrossRef]
79. Lam, T.T.; Mahdjoubi, L.; Mason, J. A framework to assist in the analysis of risks and rewards of adopting BIM for SMEs in the UK. *J. Civ. Eng. Manag.* **2017**, *23*, 740–752. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85019174694&doi=10.3846%2F13923730.2017.1281840&partnerID=40&md5=3e2cef4a7ba279ed73af8f97e2176c0d (accessed on 19 January 2023). [CrossRef]
80. Ajayi, S.O.; Oyedele, L.O.; Kadiri, K.O.; Akinade, O.O.; Bilal, M.; Owolabi, H.A.; Alaka, H.A. Competency-based measures for designing out construction waste: Task and contextual attributes. *Eng. Constr. Archit. Manag.* **2016**, *23*, 464–490. [CrossRef]
81. Çavuşoğlu, Ö.H.; Çağdaş, G. Enhancing decision making processes in early design stages: Opportunities of bim to achieve energy efficient design solutions. *A/Z ITU J. Fac. Archit.* **2018**, *15*, 53–64. [CrossRef]
82. Baldwin, A.; Poon, C.-S.; Shen, L.-Y.; Austin, S.; Wong, I. Designing out waste in high-rise residential buildings: Analysis of precasting methods and traditional construction. *Renew. Energy* **2009**, *34*, 2067–2073. [CrossRef]
83. Ajayi, S.O.; Oyedele, L.O.; Bilal, M.; Akinade, O.O.; Alaka, H.A.; Owolabi, H.A. Critical management practices influencing on-site waste minimization in construction projects. *Waste Manag.* **2017**, *59*, 330–339. [CrossRef] [PubMed]
84. Schade, J.; Olofsson, T.; Schreyer, M. Decision-making in a model-based design process. *Constr. Manag. Econ.* **2011**, *29*, 371–382. [CrossRef]
85. Laovisutthichai, V.; Lu, W.; Bao, Z. Design for construction waste minimization: Guidelines and practice. *Archit. Eng. Des. Manag.* **2020**, *18*, 279–298. [CrossRef]
86. Ghose, A.; Pizzol, M.; McLaren, S.J. Consequential LCA modelling of building refurbishment in New Zealand- an evaluation of resource and waste management scenarios. *J. Clean. Prod.* **2017**, *165*, 119–133. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85028356604&doi=10.1016%2Fj.jclepro.2017.07.099&partnerID=40&md5=c6b31b8133757ac0d3c32a2c3e24cd6f (accessed on 21 January 2023). [CrossRef]
87. Akinade, O.O.; Oyedele, L.O.; Munir, K.; Bilal, M.; Ajayi, S.O.; Owolabi, H.A.; Alaka, H.A.; Bello, S.A. Evaluation criteria for construction waste management tools: Towards a holistic BIM framework. *Int. J. Sustain. Build. Technol. Urban Dev.* **2016**, *7*, 3–21. [CrossRef]
88. Othman, A.A.E.; Abdelrahim, S.M. Achieving sustainability through reducing construction waste during the design process: A value management perspective. *J. Eng. Des. Technol.* **2019**, *18*, 362–377. [CrossRef]
89. Liu, J.; Yi, Y.; Wang, X. Exploring factors influencing construction waste reduction: A structural equation modeling approach. *J. Clean. Prod.* **2020**, *276*, 123185. [CrossRef]
90. Hossain, M.U.; Wu, Z.; Poon, C.S. Comparative environmental evaluation of construction waste management through different waste sorting systems in Hong Kong. *Waste Manag.* **2017**, *69*, 325–335. [CrossRef]
91. Arif, M.; Bendi, D.; Toma-Sabbagh, T.; Sutrisna, M. Construction waste management in India: An exploratory study. *Constr. Innov.* **2012**, *12*, 133–155. [CrossRef]
92. Liu, H.; Sydora, C.; Altaf, M.S.; Han, S.H.; Al-Hussein, M. Towards sustainable construction: BIM-enabled design and planning of roof sheathing installation for prefabricated buildings. *J. Clean. Prod.* **2019**, *235*, 1189–1201. [CrossRef]
93. Pirzadeh, P.; Lingard, H.; Blismas, N. Effective communication in the context of safe design decision making. *Saf. Sci.* **2020**, *131*, 104913. [CrossRef]

94. Wu, Z.; Yu, A.T.W.; Shen, L.; Liu, G. Quantifying construction and demolition waste: An analytical review. *Waste Manag.* **2014**, *34*, 1683–1692. Available online: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84905591201&doi=10.1016%2Fj.wasman.2014.05.010&partnerID=40&md5=ecd3d219e4b614f1f3ec3c0d010d0b53 (accessed on 22 January 2023). [CrossRef]
95. Hassanain, M.A.; Adewale, B.; Al-Hammad, A.M.; Sanni-Anibire, M.O. Factors affecting building services' coordination during the design development and review stages. *Built Environ. Proj. Asset Manag.* **2018**, *8*, 64–77. [CrossRef]
96. Akdag, H.C.; Beldek, T. Waste management in green building operations using GSCM. *Int. J. Supply Chain Manag.* **2017**, *6*, 174–180.
97. Nakandala, D.; Samaranayake, P.; Lau, H.; Ramanathan, K. Modelling information flow and sharing matrix for fresh food supply chains. *Bus. Process Manag. J.* **2017**, *23*, 108–129. [CrossRef]
98. Olorunniwo, F.O.; Li, X. Information sharing and collaboration practices in reverse logistics. *Supply Chain Manag. Int. J.* **2010**, *15*, 454–462. [CrossRef]
99. Lotfi, S.; Deja, J.; Rem, P.; Mróz, R.; van Roekel, E.; van der Stelt, H. Mechanical recycling of EOL concrete into high-grade aggregates. *Resour. Conserv. Recycl.* **2014**, *87*, 117–125. Available online: https://www.sciencedirect.com/science/article/pii/S0921344914000688 (accessed on 11 January 2023). [CrossRef]
100. Domingo, N. Assessment of the impact of complex healthcare features on construction waste generation. *Buildings* **2015**, *5*, 860–879. [CrossRef]
101. Hossain, M.U.; Ng, S.T.; Antwi-Afari, P.; Amor, B. Circular economy and the construction industry: Existing trends, challenges and prospective framework for sustainable construction. *Renew. Sustain. Energy Rev.* **2020**, *130*, 109948. [CrossRef]
102. Bilal, M.; Oyedele, L.O.; Munir, K.; Ajayi, S.O.; Akinade, O.O.; Owolabi, H.A.; Alaka, H.A. The application of web of data technologies in building materials information modelling for construction waste analytics. *Sustain. Mater. Technol.* **2017**, *11*, 28–37. [CrossRef]
103. Alwan, Z.; Jones, P.; Holgate, P. Strategic sustainable development in the UK construction industry, through the framework for strategic sustainable development, using Building Information Modelling. *J. Clean. Prod.* **2017**, *140*, 349–358. [CrossRef]
104. Passey, D. Theories, theoretical and conceptual frameworks, models and constructs: Limiting research outcomes through misconceptions and misunderstandings. *Stud. Technol. Enhanc. Learn.* **2020**, *1*, 95–114. [CrossRef]
105. Nagapan, S.; Rahman, I.A.; Asmi, A.; Memon, A.H.; Latif, I. Issues on construction waste: The need for sustainable waste management. In Proceedings of the CHUSER 2012—2012 IEEE Colloquium on Humanities, Science and Engineering, Kota Kinabalu, Malaysia, 3–4 December 2012; pp. 325–330.
106. Punith Maharshi, Y.R.; Guptha, C.K.N. Importance of Information Sharing in Construction Supply Chain Management: A Review. In Proceedings of the Tenth AIMS International Conference on Management, Bangalore, India, 6–9 January 2013; pp. 3719–3722.
107. Won, J.; Cheng, J.C.P. Identifying potential opportunities of building information modeling for construction and demolition waste management and minimization. *Autom. Constr.* **2017**, *79*, 3–18. [CrossRef]