buildings

MDPI

Article

Developing Critical Success Factors for Implementing Circular Economy in Building Construction Projects

Abdulaziz AlJaber [1,2,*], **Pedro Martinez-Vazquez** [1] and **Charalampos Baniotopoulos** [1,*]

[1] Department of Civil Engineering, School of Engineering, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK; p.vazquez@bham.ac.uk
[2] Department of Civil and Construction Engineering, College of Engineering, Imam Abdulrahman Bin Faisal University, Dammam 31451, Saudi Arabia
* Correspondence: asaljaber@iau.edu.sa (A.A.); c.baniotopoulos@bham.ac.uk (C.B.)

Abstract: The construction industry continues to play a significant role in the economic development of most nations in the world. However, the construction sector still follows the 'linear' 'take–make–dispose' industrial model that, having benefited development, plays a major factor in the depletion of resources, environmental deterioration, and the generation of waste and pollution. In this regard, the adoption of a circular economy (CE) presents a compelling opportunity to address the challenges derived from the traditional linear economic model. This study attempts to scrutinise the critical success factors (CSFs) for implementing a CE via a mixed-method approach that combines both focus groups and an online survey. The adopted approach ensures a comprehensive identification and prioritisation of CSFs for implementing CE principles in building construction projects. The focus groups consisted of 20 key stakeholders drawn from prominent construction firms which included clients, consultants, contractors and designers. The outcomes from these focused groups led to the dentification of 43 CSFs, later categorised across different dimensions. Subsequently, an online survey was conducted to establish a priority list of the identified CSFs, using responses from 82 stakeholders to rate their level of importance. The top five significant CSFs include ensuring the use of standardised and warranted secondary materials, maintaining cost equivalence between a CE and linear approach, maintenance and operation cost minimisation, assessment of life cycle cost (LCC), and the enforcement of robust government regulations and policies that prioritise a CE. The Relative Importance Index (RII) was used to rank the identified CSFs following results obtained using the Statistical Package for Social Sciences (SPSS 27) and Excel for Microsoft 365. The findings of this study can inform the creation of decision support systems that could progress a CE across the construction project life cycle.

Keywords: circular economy; critical success factors; building construction projects; building sector

check for updates

Citation: AlJaber, A.; Martinez-Vazquez, P.; Baniotopoulos, C. Developing Critical Success Factors for Implementing Circular Economy in Building Construction Projects. *Buildings* **2024**, *14*, 2319. https://doi.org/10.3390/buildings14082319

Academic Editor: Paulo Santos

Received: 25 June 2024
Revised: 16 July 2024
Accepted: 22 July 2024
Published: 26 July 2024

1. Introduction

The building sector plays a pivotal role in the global economy, contributing to a substantial 13% of the world's gross domestic product (GDP) [1]. However, it is also responsible for the emission of greenhouse gases (GHGs) and a significant share of resource consumption, waste generation, and further environmental impacts [2]. The traditional linear model of construction, characterised by extraction–production–use–disposal, has led to resource depletion and environmental degradation [3,4]. This adverse environmental impact is demonstrably evident throughout the building's life cycle, particularly during the operation and end-of-life stages [5].

The concept of a circular economy (CE) has emerged as a critical strategy for addressing resource depletion, waste generation, and environmental challenges, offering a promising path towards a more sustainable future [6,7]. A CE offers a feasible alternative to the traditional linear economy through principles guided by the so-called 9Rs framework, which aims at minimising material consumption and waste generation [8]. The detailed strategy includes R0 (Refuse), R1 (Rethink), R2 (Reduce), R3 (Reuse), R4 (Repair), R5 (Refurbish), R6 (Remanufacture), R7 (Repurpose), R8 (Recycle), and R9 (Recover). According to Hysa et al. [9], a CE develops under the assumption that Earth has finite resources and operates as a closed system in which the economy and environment should coexist harmoniously. The Ellen Macarthur Foundation [6] defined a CE as "*An industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models*". Essentially, a CE aims to intentionally restore or regenerate the system rather than solely disposing of products at the end of their life cycle. Likewise, Stahel [10] argues that the CE model is a compelling approach to achieving economic growth alongside environmental benefits.

Implementing CE practices in building construction projects yields both environmental and economic benefits [11]. A CE advocates for maintaining building components and materials within a closed-loop system, emphasising their ongoing utilisation, reuse, recycle, and repair throughout their lifecycle. This approach effectively eliminates waste and prevents CO_2 emissions [12]. According to Kubbinga et al. [13], a circular building can be defined as "*A building that is developed, used and reused without unnecessary resource depletion, environmental pollution and ecosystem degradation. It is constructed in an economically responsible way and contributes to the wellbeing of people and the biosphere. Here and there, now and later. Technical elements are demountable and reusable, and biological elements can also be brought back into the biological cycle*". Pomponi and Moncaster [14] stated that circular principles offer a robust approach to significantly mitigating the environmental footprint of buildings. However, the full potential of a CE in the construction of buildings cannot be achieved without integrating its principles throughout all stages of a building's life cycle [15].

The construction industry has been perceived as conservative and little innovative compared to other sectors [16,17]. The effective implementation of CE practices in the construction industry is complicated and faces several challenges [18–24]. These obstacles include a low interest in a CE, regulatory constraints, insufficient standardised practices, cost-related issues, limited awareness and knowledge, and a lack of guidelines for project teams to integrate CE principles into their project [25–27]. Without clear frameworks in place, stakeholders and project teams encounter difficulties in navigating the complexities of CE implementation. This ambiguity not only leads to confusion but also hinders progress towards adopting more circular practices in building construction projects. In this context, the identification of critical success factors (CSFs) becomes paramount for the successful integration of CE principles.

CSFs are fundamental for achieving imperative outcomes for an organisation to achieve its goals [28]. They provide guidelines for strategic and tactical project execution, ensuring the establishment of a successful delivery system [29]. In this regard, Gan et al. [30] emphasise the importance of CSFs for effectively incorporating sustainability into project management practices. According to Boynton and Zmud [31], CSFs are "*those few things that must go well to ensure success for a manager or organization and therefore, they represent those managerial or enterprise areas that must be given special and continual attention to bring about high-performance*". Koc et al. [32] highlighted the significance of identifying CSFs as an essential step in the adoption process for any modern technology or approach.

Wuni and Shen [33] argue that CSFs stand as a powerful tool for enhancing success and reducing failure in project management. Consequently, the development of CSFs has led to considerable research interest within the construction management field. In the context of a CE, the CSFs play a significant role in determining the effectiveness and outcome of CE initiatives, influencing their commencement, progress, and eventual success [34]. By studying these factors and developing a robust framework of CSFs, we can significantly contribute to facilitating the transition towards a CE model and guide project teams in minimising risks associated with circular construction projects [35]. Koc et al. [32] added that investigating CSFs for adopting circularity in the construction sector can significantly smoothen the path to its successful implementation.

Although there is limited literature focusing on the CSFs for managing and implementing circular buildings, there are some studies that document the CSFs for implementing a CE in the broader construction industry. Akinade et al. [36] identified and ranked 38 CSFs needed for effective material recovery through design for deconstruction and claimed that most CSFs are stringent legislation and policy, along with the design process and competency for deconstruction. Wuni and Shen [35] highlighted 23 CSFs for managing circular modular construction in Hong Kong and found the top three significant CSFs were early design completion and freezing, early understanding and commitment of the client, and effective leadership and support of a specialist contractor. Ma et al. [37] identified eight CSFs essential for advancing CE practices in construction and demolition waste management. Among these factors, two emerged as particularly pivotal: improving the quality and value of secondary materials and providing incentives for their utilisation. However, according to Aloini et al. [34], there is a need for more context-specific research to develop CSFs for the adoption of CE.

The primary objective of this study is to identify, categorise, and rank the CSFs required to promote CE practices based on their significance and relevance to the successful implementation of CE principles. This study intends to shed light on the prioritised CSFs as perceived by each stakeholder group, providing valuable insights into key considerations essential for advancing a CE in the building sector. This investigation also aims to enhance the limited body of knowledge on the CSFs for the adoption of CE practices in the building sector. The results of this study would offer stakeholders valuable guidance on key considerations essential for advancing CE adoption in building construction projects. This information could also inform strategic decision-making, project planning and execution for the successful implementation of CE principles.

To address the project objectives, we establish the following research questions:

1. What CSFs are essential for effectively implementing the CE concept within building construction projects?
2. How do different stakeholders perceive CSFs and prioritise their importance for CE adoption in the building sector?
3. At which stages of a project lifecycle could these CSFs be implemented?

2. Methods

2.1. Research Strategy

This study employed a mixed method approach, incorporating both qualitative and quantitative data collected through focus groups and online questionnaire surveys. This method facilitates the exploration of our research questions, leveraging the diverse strengths of both quantitative and qualitative analyses [38,39]. As highlighted by DeCuir et al. [40], mixed methods research is particularly well-suited for examining complex problems within a study due to the evidence triangulation, which involves using multiple data sources or methods to corroborate findings. According to Denzin [41], using mixed methods can be a valuable way to increase the validity and reliability of research findings. Therefore, we believe that utilising a mixed methods approach is the most appropriate way to achieve the study's objectives. Figure 1 demonstrates the research methodology for this study.

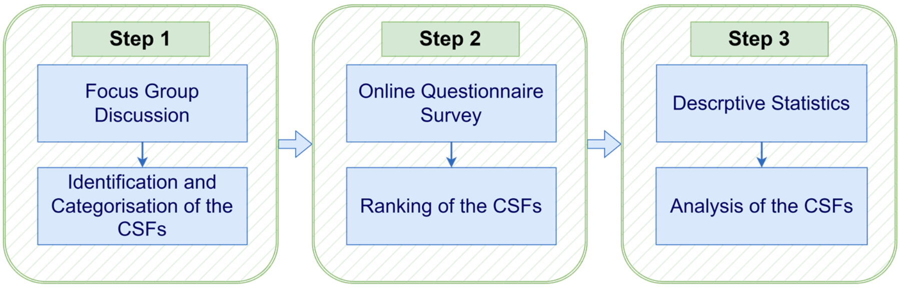

Figure 1. The research framework for the study.

2.1.1. Qualitative Research Design

Focus groups emerged as a popular technique for gathering qualitative data employed by researchers globally [42]. According to Morgan [43], it can be defined as "a research technique that collects data through group interaction on a topic determined by the researcher". There is a range of perspectives around optimal focus group sizes. Guest et al. [44] suggest a size between six and twelve people, while Krueger [45] argues that smaller groups of five to seven participants might be more suitable for fostering in-depth conversations. The dynamics of focus groups reveal both the similarities and differences of opinion among participants [45,46]. Kaplowitz and Hoehn [47] argued that the dynamics within focus groups often foster a tendency for participants to speculate about information. According to Freitas et al. [42], focus groups enable depth and flexibility in data collection that is typically not attained when collecting information on an individual basis. This approach has, therefore, been selected to identify and develop CSFs for enforcing CE in building construction projects.

2.1.2. Quantitative Research Design

Quantitative research involves a methodical and organised approach to investigating phenomena by gathering and analysing numerical data [48]. A fundamental objective in quantitative research is to establish precise and reliable measurements that facilitate statistical analysis [49]. According to Roopa and Rani [50], a questionnaire survey is the primary method of gathering quantitative data. This study used the survey's quantitative data to determine the importance level of the identified CSFs among building stakeholders in Saudi Arabia's building sector. The choice of an online questionnaire survey offers a convenient and accessible method for data collection, which allowed us to reach a broad and diverse sample of respondents.

2.2. Data Collection

2.2.1. Qualitative Data Collection

Focus groups were conducted with 20 participants representing four stakeholder groups, namely, clients, contractors, consultants, and designers. The participants were provided with a topic and instructions one week before the meeting to ensure a common understanding and knowledge base. A purposive sampling, which is largely based on subjective, personal judgment, was used for the qualitative part of this study. The main reason for using this technique is to capture a particular group of interest in a population that best enables the researcher to answer the research questions.

The focus group discussions, structured into three sessions, extended over a duration of four hours. Session 1 lasted for one hour, Session 2 lasted two hours and thirty minutes, and Session 3 lasted for thirty minutes.

In the first session, each participant (individually) was asked to write down their thoughts about the following question:

- What are the CSFs that are essential for establishing an effective implementation of the CE concept within the building construction project?

This approach did capture individual perspectives before facilitating collaborative analysis and discussion, providing a rich qualitative exploration of the CSFs and potential actions for promoting CE practices in building construction projects. In session 2, the focus then shifted to a group analysis where all identified CSFs were discussed, categorised, and ranked collectively by each stakeholder group. This process also involved refining the CSFs by eliminating duplicates. For a factor to be included as a CSF, it needed to achieve a threshold of 75% agreement among the participants.

In the final session of the focus groups, participants engaged in discussions regarding the implementation of the identified CSFs across various stages of the project life cycle. The CSFs were presented on a smart board projector, and the participants were asked to indicate the project life cycle phase they believed each CSF was most relevant or contributed significantly to. This interactive exercise facilitated a comprehensive understanding of how these factors impact different phases of the project life cycle through collaborative discussion.

2.2.2. Quantitative Data Collection

The questionnaire was efficiently distributed using a web-based format through Google Forms. Following a pilot survey, the final questionnaire was refined to ensure clarity and effectiveness. The link to the online survey remained accessible for completion over a two-month period. To ensure participants had a foundational understanding of CE principles in the building sector, a brief overview was provided at the beginning of the questionnaire. This introductory section was to familiarise respondents with key concepts related to a CE. The next sections in the questionnaire were divided as follows: section I requested demographic details from the respondents, while section II requested respondents to assess the importance of the forty-three CSFs. The questionnaire utilised the Likert scale technique, which employs a five-point rating scale ranging from ‘1’ (lowest weight) to ‘5’ (highest weight). This design facilitated a straightforward analysis of the results through closed-ended questions that provided valuable insights into participant perceptions.

The size of the interview sample was defined through a random sampling technique, and included stakeholders in six semi-governmental and private organisations. This study employed Yamane’s [51] simplified formula, a widely utilised method for calculating sample size in studies involving large populations [52]. This formula takes into account both the total population size and the desired level of precision, as demonstrated in Equation (1):

$$n = \frac{N}{1 + N(e)^2} = \frac{120}{1 + 120(0.05)^2} = 92 \ participants \tag{1}$$

where:

- n: sample size;
- N: represents the overall population size;
- e: symbolises the desired precision level.

The study obtained 82 valid responses from the 120 surveys distributed, resulting in a final response rate of 68.3%. This aligns well with previous research, such as Fincham [53], which suggests that the response rate is at 60% at least, whereas, according to Nulty [54], achieving response rates above 70% is often challenging.

2.3. Data Analysis

2.3.1. Thematic Analysis

Thematic analysis is a flexible and widely used qualitative research method that focuses on identifying, analysing, and reporting patterns (themes) within a data set [55]. It is commonly used due to its ability to address a wide variety of research questions and topics [56]. This method allows researchers to delve deeply into the views and experiences of different participants, providing rich and detailed insights [55]. The six main stages of the analysis include familiarisation with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report [57].

A thematic analysis was employed to analyse the data gathered from the focus group discussions. The researchers transcribed the audio recordings of these discussions into Word documents for detailed examination to then search for recurring patterns and themes in the participants’ responses. To ensure accuracy in the transcriptions, the audio recordings were played many times, which also increased the possibility of identifying extra themes while correcting mistakes made during the transcribing. This material was key to identifying similarities and differences among the participants’ perspectives and provided deep insights into the CSFs based on their experiences.

2.3.2. Relative Importance Index (RII)

This study employed the RII analysis to rank the CSFs associated to the implementation of CE principles in building construction projects. This analysis helps to prioritise factors based on their perceived influence, offering valuable insights into stakeholders' perceptions regarding these factors. The feedback from respondents was analysed using Microsoft Excel, and the RII was then applied using Formula (2).

$$\frac{\sum w}{A \times N} = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{A \times N}\ ; \qquad (0\ \leq\ \text{RII}\ \leq\ 1) \tag{2}$$

where:

w = The weighting given to each factor by the respondent, ranging from 1 to 5 where n_5 is "Very important" and n_1 is "Not important";
A = Highest weight (in this study: 5);
N = Overall number of respondents (in this study: 82).

2.3.3. Reliability and Validity

The reliability of a research instrument assesses how consistent research findings are when its analysis procedures are subject to multiple iterations to the same population [58]. Reliability is commonly evaluated in the form of internal consistency reliability [58]. To this end, we used Cronbach's alpha coefficient as it is the most used technique for evaluating internal consistency [59,60]. The alpha coefficient was estimated for each CSF category by feeding the first and second-order statistics listed in Table 1 in Cronbach's alpha (α) formula [61], which is reproduced below:

$$\alpha = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum_i V_i}{V_t}\right) \tag{3}$$

where:

n = Number of items;
V_t = Variance of test scores;
V_i = Total variance of the scale.

Table 1. Reliability analysis of the CSFs.

CSFs Category	M	SD	No. of Items	Cronbach's Alpha
Contractual	3.868	1.135	5	0.847
Supply Chain	4.031	0.838	6	0.808
Stakeholders and Organisational	4.099	0.952	9	0.948
Technical	4.151	0.899	5	0.770
Strategic	3.890	0.944	8	0.866
Regulations and Policies	4.179	0.945	3	0.707
Economic	4.296	0.906	4	0.790
Technological	3.846	1.034	3	0.702

The results obtained reveal a level of internal consistency ranging from 0.7 to 0.9, indicating good-to-excellent reliability [62,63]. This demonstrates the extent to which this study captures qualitative information and produces accurate results. Content validity was established through direct consultations with subject matter experts. The questionnaire was also assessed a priori before its wider distribution through a pilot study completed that included a smaller sample of 10 respondents with ample experience in construction projects. Based on the feedback from the pilot study, the questionnaire was refined to ensure its effectiveness during the main survey. After that point, statistical validation was completed using SPSS 27 and Excel for Microsoft 365 to confirm the validity and reliability of the research database.

3. Results and Discussion

3.1. Overview

The following five sub-sections present the findings of focus group discussions and online questionnaires employed in this study. Section 1 presents the demographic details of participants within the focus group. Section 2 presents the participant's opinions about CSFs including how they weigh their importance. Section 3 provides the participants' views on the CSFs throughout different stages of building construction project life cycles. Finally, Section 4 provides the overall ranking of the CSFs based on the data collected through the online questionnaire survey.

3.2. Focus Groups Demographic Details

Table 2 provides details of the twenty participants involved in the focus groups. This includes participant names (coded), type of stakeholder, positions within their organisations, and years of experience in the building sector. These illustrate the diverse range of perspectives represented in the focus groups.

Table 2. Participants' demographic details.

No.	ID	Type	Position	Years of Experience
1	C1	Client	Chief Executive Officer	31
2	C2	Client	Sustainability Manager	19
3	C3	Client	Quality and Quantity Surveyor Engineer	15
4	C4	Client	Project Director	29
5	C5	Client	Developer	20
6	CT1	Contractor	Project Manager	31
7	CT2	Contractor	Project Manager	37
8	CT3	Contractor	Procurement Manager	25
9	CT4	Contractor	Site Engineer	13
10	CT5	Contractor	Environmental Engineer	11
11	CN1	Consultant	Risk Manager	26
12	CN2	Consultant	Structural Engineer	18
13	CN3	Consultant	Project Manager	33
14	CN4	Consultant	Project Manager	29
15	CN5	Consultant	Environmental Manager	21
16	D1	Designer	Sustainability Engineer	15
17	D2	Designer	Architect	18
18	D3	Designer	Structural Engineer	10
19	D4	Designer	Senior Designer	22
20	D5	Designer	Senior Designer	28

3.3. Identification of Circular Economy's CSFs

3.3.1. Clients' Perspective Responses

The client group identified 22 CSFs that were primarily categorised into contractual, stakeholder, and organisational and economic factors, as shown in Table 3. Among these factors, the top four deemed most crucial: (1) "Ensure that the CE approach maintains cost equivalence with the current linear approach"; (2) "Conduct life cycle cost (LCC) to assess the economic feasibility and long-term financial viability of CE practices"; (3) "Governmental financial support"; and (4) "Enforce adherence to circular business models through clear contractual terms within project contracts".

The client group recognised the critical role of a circular approach to maintaining cost equivalence with respect to the traditional linear approach. This emphasis on economic equivalence is essential for stability and the subsequent popularisation of circular practices throughout the industry. Cost remains a major deciding factor for clients and developers when choosing construction methods. C5 stated, "*as a developer, being able to demonstrate that a circular approach can be achieved at a similar cost to the traditional linear method strengthens the business case for circularity. This is because it will be easier to source for funds as well as get support for the implementation of CE projects hence wider implementation*". C4 provided another opinion that shows how cost-equivalent matters for a stable transition: "*this means we can consider using more circular materials and strategies in our projects as long as the cost will not be an issue, thereby offering projects that are both economically feasible and environmentally friendly*".

The LCC provides the overall perspective of the costs involved in the implementation of CE practices throughout the life cycle of the project. It provides a valuable method for evaluating the feasibility of CE projects in economic terms. This information can inform the planning for the financial needs of a project. C3 described how LCC benefits stakeholders, given the induced understanding of financial outcomes associated with CE in the long run. C3 stated, "*conducting LCC is crucial because it uncovers hidden financial benefits of CE practices and aids the decision-makers in comprehending the financial implications of CE and its potential for cost optimization*". Similarly, C1 commented, "*conducting LCC to evaluate the return of investment of any project is critical. This ensures that the adopted circular approach make financial sense for our organisation*".

Financial assistance by the government was also mentioned as an important element that can enhance the implementation of CE construction projects. C1 further said, "*This is because financial incentives from the government are important for encouraging businesses adopt CE practices. Therefore, I would prioritise CE principles knowing that it would help offset some of the initial costs and risks associated with transitioning to CE practices*". Furthermore, C5 added, "*government incentives in terms of tax exemptions can therefore be a major boost to circular construction projects. These incentives can allow us to better cover the initial expenses related to circular activities, which will make such initiatives more appealing to investors and developers. These financial instruments enable us to eliminate financial challenges and enhance the economic feasibility of circular construction solutions*".

The client group also stressed that for a solid legal framework to be put in place for the participating parties in the project, it is essential to include clear contractual provisions. This framework also ensures that every aspect of the circular principles is legally well articulated, recognised and adhered to. Effective contracts help to ensure that all the stakeholders know what is expected of them, which enhances the performance of the construction process. This can help minimise ambiguity and promote consistency throughout the circular project life cycle. In this regard, C2 commented, "*it is necessary to consider noting specific conditions of reuse, recycling, and resource efficiency in contracts. This leads to the ability to manage expectations and performance in delivery of circularity strategies with stakeholders*". C1 similarly added, "*commitment is built with all stakeholders involved in projects when contracts establish clear expectations and performance metrics for delivering circularity commitments. This ensures successful implementation of CE goals throughout the project life cycle*".

Table 3. Synthesis of the identified CSFs.

Category	ID	Circular Economy's CSFs	Client	Contractor	Consultant	Designer
Contractual	CSF1	Ensure adherence to circular business models through clear contractual terms within project contracts.	✓			
	CSF2	Use incentive-based contracts to reward contractors and suppliers for meeting CE objectives.	✓			
	CSF3	Set specific waste diversion and reusing/recycling targets in project contracts for construction and demolition activities.	✓			
	CSF4	Incorporate assurances of CE principles performance within project contracts.	✓		✓	
	CSF5	Include provisions for contractors to report on their adherence to circularity targets.	✓			
Supply Chain	CSF6	Ensure adequate data and information about circular materials and products.		✓	✓	✓
	CSF7	Ensure the availability of secondary materials market.		✓		✓
	CSF8	Adopt green procurement policies that prioritise circular materials and components.		✓		
	CSF9	Encourage dealing with local contractors and suppliers.			✓	
	CSF10	Prioritise and build long-term partnerships with suppliers and contractors committed to CE principles.	✓		✓	
	CSF11	Use just-in-time (JIT) delivery for supply chain management.		✓		
Stakeholders and Organisational	CSF12	Client commitment and leadership toward CE objectives.	✓	✓	✓	✓
	CSF13	Collaborate extensively with all stakeholders to establish robust circular business models.	✓		✓	
	CSF14	Present comprehensive evidence to decision-makers about the financial and environmental benefits of the CE approach.	✓			
	CSF15	Foster strong collaboration and communication among stakeholders at every stage of the project lifecycle.	✓	✓	✓	✓
	CSF16	Promote awareness and acceptance of CE principles among stakeholders.	✓	✓	✓	✓
	CSF17	Provide training programs and capacity-building initiatives for the project team to enhance the team's proficiency in circular construction practices.		✓	✓	✓
	CSF18	Introduce new roles within the project team dedicated to CE implementation.	✓			
	CSF19	Ensure that the project team possesses substantial knowledge and experience in executing CE construction projects.		✓	✓	✓
	CSF20	Embed CE principles into the organisation's culture, values and vision.	✓			
Technical	CSF21	Ensure the use of standardised, certified, and warranted secondary materials.	✓	✓	✓	✓
	CSF22	Design with the aim of obtaining green building certifications.				✓
	CSF23	Embed design for longevity, durability, and disassembly.				✓

Table 3. *Cont.*

Category	ID	Circular Economy's CSFs	Client	Contractor	Consultant	Designer
Technical	CSF24	Design using materials with significant value that can undergo further reuse or recycling.				✓
	CSF25	Provide technical guidelines to facilitate the integration of CE principles into construction projects.		✓		✓
Strategic	CSF26	Establish rigorous waste management protocols and plans from the early stage of the building life cycle.		✓		
	CSF27	Develop comprehensive risk management strategies to mitigate potential risks associated with CE approaches.	✓	✓	✓	
	CSF28	Implement proactive maintenance programs to extend the lifespan of building components and systems.		✓		
	CSF29	Establish waste reduction and recycling programs for building occupants.		✓		
	CSF30	Evaluate the performance, durability, and lifecycle impacts of different material options using life cycle assessment (LCA).			✓	✓
	CSF31	Develop key performance indicators (KPIs) and metrics to assess the effectiveness and impact of CE strategies on project outcomes.	✓		✓	
	CSF32	Develop early detailed plans for material reuse with detailed restoration and deconstruction strategies.		✓		✓
	CSF33	Promote the practice of pre-demolition auditing to enhance materials recovery.		✓		✓
Regulations and Policies	CSF34	Strong government regulations, legislations, and policies toward CE.	✓	✓	✓	✓
	CSF35	Ensure strict adherence to circular practices in compliance with building codes and standards.		✓	✓	✓
	CSF36	Governmental financial support.	✓			
Economic	CSF37	Ensure that the CE approach maintains cost equivalence with the current linear approach.	✓		✓	✓
	CSF38	Conduct life cycle cost to assess the economic feasibility and long-term financial viability of CE practices.	✓		✓	
	CSF39	Ensure minimisation of maintenance and operation costs.	✓			
	CSF40	Identify wider value of project opportunities for cost savings through CE approaches.	✓			
Technological	CSF41	Leverage BIM and digital tools effectively to optimise circularity practices throughout the project life cycle.				✓
	CSF42	Embrace innovative technologies such as 3D printing, prefabrication, and digital fabrication.		✓		✓
	CSF43	Maintain digital detailed project records for material passports.				✓

3.3.2. Contractors' Perspective Results

The group of contractors identified 20 CSFs, which are shown in Table 3. Among these factors, the top four deemed most important are as follows: (1) "Client commitment and leadership toward CE objectives"; (2) "Ensure that the project team possesses substantial knowledge and experience in executing CE construction projects"; (3) "Develop comprehensive risk management strategies to mitigate potential risks associated with CE approaches"; and (4) "Ensure the use of standardised, certified, and warranted secondary materials".

According to this group, commitment from the client and, especially, leadership play a major role in setting the pace and the mood of the project. The participants all admitted that the client has the ultimate responsibility of prioritising CE objectives since they inform project stakeholders that these goals are important. CT2 elaborated on this as follows: "*when clients drive the CE initiatives and set out the agenda of work, it empowers everyone to make the right choices that are consistent with the goals of CE*". CT4 demonstrated how client commitment directly affects construction practices by stating, "*client who is committed to CE usually have high expectation in terms of compliance with sustainability standards and regulation and as a site engineer, I have to ensure that construction activities do not deviate from these expectations*". Moreover, CT5 acknowledged the fact that commitment towards a CE is vital as this will enable the development of measures and standards for evaluating the environmental performance of the project.

There is a clear need for contractors to have knowledge and experience in CE principles to ensure the delivery of circular outcomes throughout the project execution. In this regard, CT1 said, "*if I do not possess knowledge in CE principles, I will be lacking the experience in managing the project, which, in turn, could leading to inefficiencies, missed opportunities for circular practices, and potentially negative impacts on the environment and economic project outcomes*". Likewise, CT2 expanded on the idea by stating, "*projects that incorporate CE principles require innovative approaches and careful consideration of materials lifecycle impacts. Without proper knowledge, there is a higher risk of project failure, cost overruns, and delays*".

The group of contractors further highlighted the need to properly manage risk when using CE approaches. These strategies help organisations manage risks associated with circularity and provide them with plans on how to deal with uncertainties arising from circular practices. CT1 stated, "*circular construction projects entail risks, including uncertainties over the availability and cost of reused/recycled materials, the market prices of circular products, and changes in regulation, all of which can affect project outcomes. Therefore, we need to identify and manage circular construction risks, and make sensible decisions on how to minimise their impact*". Moreover, CT3 commented, "*a solid risk management plan is crucial to have. It provides us the way and means of identifying and managing the financial risks that are likely to be incurred on procurement so that costs are controlled and kept within the budget and avoid unexpected expenses*".

The participants had a consensus on the key factors, including standardisation of processes, certification, and warranties for the secondary materials used in the projects. As with any construction project, they state that it is fundamental to ensure that the secondary materials meet consistent quality standards. This is due to the fact that the reliability and performance of the material used are critical in any construction project. CT3 focused on the materials standardisation and certification as follows: "*It assists us in setting quality standards of the materials that we use. This provides confidence that we are investing in materials that will be durable and efficient*". In addition, the focus group emphasised that warranties for secondary materials are crucial factors in risk management. Such risks may be covered through warranties, for example, those addressing the durability of the construction materials. For example, CT1 has said, "*As a project manager, I would only use materials with warranties as they provide safety net against actual defects or failure. Without warranties, we risk unexpected costs because of the unreliable performance*".

3.3.3. Consultants' Perspective Results

The group of consultants identified 18 CSFs, which are shown in Table 3. The top four factors were (1) "Strong government regulations, legislations, and policies toward CE"; (2) "Client commitment and leadership toward CE objectives"; (3) "Ensure strict adherence to circular practices in compliance with building codes and standards"; and (4) "Identify wider value of project opportunities for cost savings through CE approaches".

The group generally regarded CE regulations and policies as key factors for succeeding in the implementation of a CE. They noted that there is no current legislation governing a CE within the building sector. For instance, CN3 commented, "*we need clear regulations outlining the requirements for circular practices. This will reduce ambiguity and enable us (organisations) to make informed decisions and investments aligned with CE principles*". CN1 added, "*without the implementation of adequate policies and legislation, it would be challenging to rival the linear model*". Moreover, CN2 argued, "*government policies might require us to conduct lifecycle assessments (LCAs) of buildings to evaluate their environmental impact. They may also set requirements for using reused or recycled materials, or for designing buildings for disassembly that may require us to rethink of the traditional design approaches*".

These participants have a common understanding of the need for the client's commitment and leadership to achieve the CE goals. According to this, clients have the critical role of setting up the general goals and objectives of any project, hence ensuring alignment with CE principles. CN2 claimed, "*client leadership sets the tone for the entire project team since they decide on matters such as materials to use, approaches to adopt while designing, and the project goals to achieve*". CN4 further said, "*client commitment to CE objectives influences design decisions and project outcomes at every stage of the project life cycle, motivating stakeholders to complete the project within the CE paradigm*". CN5 highlighted the significance of the commitment of the clients in achieving and sustaining the outcomes within the construction projects. He pointed out, "*as an environmental manager, I believe that client commitment forms the basis of environmental aspects within the project work, because by prioritizing circularity, the client sets the tone for responsible environmental decision-making about project objectives and the work of stakeholders, thus guiding project implementation with the goal of minimizing their negative impact on the environment*".

In this context, building codes are essential to set the rules to guarantee the safety, durability, and functionality of buildings. CN1, CN3, and CN4 stressed how important it was to comply with these codes and standards to mitigate risks during the project development, construction, and operation. CN4 indicated, "*it is important that any adopted CE approach is complied with the building codes and standards. This is because adhering to the building codes increases the chances of project success and decreases encountering project setbacks, delays, or disruptions due to regulatory non-compliance, legal challenges, or safety issues*". CN2 highlighted, "*it is essential to ensure that any innovative design incorporating reused/recycled materials or circular design still meets the legal requirements. It is critical to verify that these materials and designs meet the performance criteria outlined in building codes*". Similarly, CN3 emphasised the importance of using reused/recycled materials that complained with building codes and standards by saying, "*I would reject the utilising of reused/recycled materials that do not comply with applicable building codes and standards. These materials may have unknown properties or may not meet the same standards as conventional construction materials, posing potential risks to the building's performance*".

The focus group highlighted the significance of assessing the financial viability and return on the investment of CE practices, as these factors are critical considerations for the client. They emphasised the necessity of evaluating whether the anticipated benefits of adopting circular practices outweigh the associated costs and if the project aligns with the client's financial objectives. CN1 commented, "*as risk manager, it's important to communicate the expected financial benefits and risks associated with implementation of CE practises. Demonstrating a positive return on investment and a clear understanding of financial implications increase the confidence in the client and fosters trust in the project's ability to deliver value*". CN2 and CN3 shared the view that if CE practices incur higher costs compared to traditional methods without showcasing tangible financial benefits, it becomes challenging to persuade the client to embrace them.

3.3.4. The Perspective of Designers

This group identified 21 CSFs, as outlined in Table 3. The top four deemed most important were as follows: (1) "Ensure the use of standardised, certified, and warranted secondary materials"; (2) "Ensure that the project team possesses substantial knowledge and experience in executing CE construction projects"; (3) "Leverage BIM and digital tools effectively to optimise circularity practices throughout the project life cycle"; and (4) "Promote awareness and acceptance of CE principles".

Standardised materials come with predetermined specifications and quality standards to ensure consistency and reliability in performance. The assurance of these standards supports the predictability of construction project outcomes by increasing efficiency while reducing risk. D4 commented, "*I recognize the significant CE benefits of incorporating reused materials in construction projects. However, for me to feel comfortable using them, there needs to be a clear system for ensuring quality, performance, and compatibility of these materials*". Furthermore, D3 discussed the importance of using standardised circular materials. He stated, "*I have responsibility to provide quality and high performing projects and standardised materials give the required assurance in this endeavour*". D5 added, "*the adoption of standardised material in our design eliminates the complexities of regulation compliance and also minimises legal and liability risks. The absence of standardisation in our design adds legal and liability issues and complicate the regulation compliance process*".

The group agreed with the need for the project team to hold significant knowledge and practical experience in carrying out CE construction projects. Knowledgeable and experienced project teams are crucial in implementing successful CE principles into construction projects. With such knowledge, the team can identify opportunities and evaluate the suitability and feasibility of different materials and methods for the project. Drawing on their experience from past projects and industry best practices, they can make informed decisions that contribute to the success of the project. D1 commented, "*having experienced team members in how to execute circular construction projects can seamlessly translate CE design concepts into reality. This makes sure that the project do not only look positive on papers but also deliver environmental and economic promises*". D2 added, "*with a project team member being knowledgeable in CE, it is possible to achieve CE innovative solutions and going beyond the conventional design, which differentiates our approach and helps us to deliver a significant circular projects*".

The importance of an effective implementation of a BIM was raised by all the interviewees. D4 said, "*I strongly believe that it is critical to integrate BIM into our design processes because, by creating building models and simulating components, we can consider different materials, their environmental impacts, and make circularity choices*". Furthermore, D5 described how a BIM could be effectively implemented in circular construction projects as well. He said, "*it is beneficial in every phase of project life cycle. BIM provides detailed data regarding materials used in buildings such as their composition, current condition, maintenance needs, disassembly/deconstruction guidelines, and traceability information*". Additionally, D1 added, "*in my opinion, the use of BIM definitely enhances circular decision-making processes. It keeps all the project information that promotes efficient storage and exchange of data. This makes it possible for all the stakeholders to have access to relevant information thus enhancing the transparency and circular decision-making*".

Awareness and acceptance of CE principles by stakeholders became the fourth key element for the implementation of CE practices in this group, as they create a common understanding of the purpose and expected outcomes of CE transition for all involved parties. In this regard, D5 stated, "*It is important to promote to CE awareness to overcome the resistance to embrace a new way of construction projects. It is critical to show where and how the CE principles can be applied to improve environmental and economic aspects of the project. Showing that circular projects can be cost-effective enhance their acceptance and thus increase their adoption*". Furthermore, D4 presented his thoughts on how understanding CE principles can affect the design of CE. He commented, "*being aware of CE encourages designers to rethink of the linear design practices and consider the entire lifecycle of materials. Designers can play an important role in enlightening clients about the benefits of CE design strategies and the potential long-term cost savings associated with it. This is important to enhance the client acceptance toward CE*".

3.4. Interaction between the CSFs in Different Categories

The multiple interactions identified amongst CSFs are shown in Figure 2. The chain components have been heuristically ordered to provide a logic sequence. For instance, governmental financial support (CSF36) can balance the upfront investment costs of CE initiatives, ensuring that the CE approach maintains cost equivalence with the current linear approach (CSF37). This financial support is crucial for promoting the awareness and acceptance of CE principles among stakeholders (CSF16). The awareness of CE principles encourages the adoption of practices such as designing for longevity, durability, and disassembly (CSF23). This adoption leads to the development of early, detailed plans for material reuse, incorporating detailed restoration and deconstruction strategies (CSF32). These strategies necessitate maintaining digital, detailed project records for material passports (CSF43), which in turn facilitate the practice of pre-demolition auditing to enhance materials recovery (CSF33).

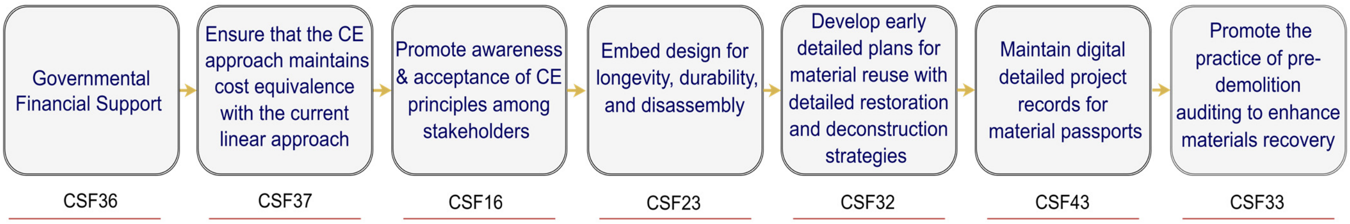

Figure 2. Interaction between the CSFs in different categories.

3.5. CSFs Throughout Building Construction Project Life Cycle Stages

The life cycle of a construction project can be divided into seven stages: initiation, planning, design, procurement, construction, operation and maintenance, and end of life. Each of these stages presents a unique opportunity for integrating CE principles, for example to minimise waste, extend the lifespan of buildings, and promote resource conservation. This section explores how CSFs can be effectively applied throughout the construction project life cycle, highlighting key factors that contribute to successful CE implementation at each stage.

3.5.1. Initiation Stage

The main objective of this stage is to conduct feasibility studies encompassing multiple scenarios to determine the form, time, and amount of investment. The feasibility assessment must resolve uncertainties around the viability of integrating CE practices, resource availability, regulatory compliance, and focalised financial concerns. Within this stage, nine CSFs are highlighted, including one supply chain factor, five stakeholders and organisational factors, two regulations and policies factors, and one economic factor, as demonstrated in Table 4.

Table 4. CSFs related to the initiation stage.

ID	Initiation Stage CSFs
CSF6	Ensure adequate data and information about circular materials and products.
CSF12	Client commitment and leadership toward CE objectives.
CSF13	Collaborate extensively with all stakeholders to establish robust circular business models.
CSF14	Present comprehensive evidence to decision-makers about the financial and environmental benefits of the CE approach.
CSF16	Promote awareness and acceptance of CE principles.

Table 4. *Cont.*

ID	Initiation Stage CSFs
CSF20	Embed CE principles into the organisation's culture, values and vision.
CSF34	Strong government regulations, legislations, and policies toward CE.
CSF36	Governmental financial support
CSF38	Conduct life cycle cost (LCC) to assess the economic feasibility and long-term financial viability of CE practices.

3.5.2. Planning Stage

The planning stage of a construction project involves detailed preparation to ensure that the project is well-organised and aligned with the client's goals in terms of scope, schedule, and budget. This mobilises various teams focused on management, procurement planning, quality management, resource allocation, and risk management. According to Wuni [64], circular decisions and operations are most critical in the early stages of the project lifecycle. Within this stage, thirteen CSFs are highlighted, including two supply chain factors, six stakeholders and organisational factors, and three strategic factors and two economic factors, as presented in Table 5.

Table 5. CSFs related to the planning stage.

ID	Planning Stage CSFs
CSF9	Encourage dealing with local contractors and suppliers.
CSF10	Prioritise and build long-term partnerships with suppliers and contractors committed to CE principles.
CSF12	Client commitment and leadership toward CE objectives.
CSF15	Foster strong collaboration and communication among stakeholders at every stage of the project lifecycle.
CSF16	Promote awareness and acceptance of CE principles among stakeholders.
CSF17	Provide training programs and capacity-building initiatives for the project team to enhance the team's proficiency in circular construction practices.
CSF18	Introduce new roles within the project team dedicated to CE implementation.
CSF19	Ensure that the project team possesses substantial knowledge and experience in executing CE construction projects.
CSF26	Establish rigorous waste management protocols and plans from the early stage of the project life cycle.
CSF27	Develop comprehensive risk management strategies to mitigate potential risks associated with CE approaches.
CSF31	Develop key performance indicators (KPIs) and metrics to assess the effectiveness and impact of CE strategies on project outcomes.
CSF37	Ensure that the CE approach maintains cost equivalence with the current linear approach.
CSF40	Identify wider value of project opportunities for cost savings through CE approaches.

3.5.3. Design Stage

The design stage within a construction project is mostly divided into conceptual design, technical design and shop-drawing design. The design stage lays the groundwork for the entire project. This stage offers a prime opportunity for the successful integration of CE practices. Design decisions made during this stage have significant implications for material selection, resource efficiency, and waste reduction throughout the project lifecycle. Moreover, the design stage serves as a strategic opportunity to optimise project value while minimising environmental impact. By identifying opportunities to reduce costs, improve resource efficiency, and enhance building performance, projects can achieve their circular objectives more effectively. Within this stage, fourteen CSFs are identified, including two stakeholders and organisational factors, five technical factors, two strategic factors, one regulations and policies factor, one economic factor, and three technological factors, as shown in Table 6.

Table 6. CSFs related to the design stage.

ID	Design Stage CSFs
CSF15	Foster strong collaboration and communication among stakeholders at every stage of the project lifecycle.
CSF16	Promote awareness and acceptance of CE principles.
CSF21	Ensure the use of standardised, certified, and warranted secondary materials.
CSF22	Design with the aim of obtaining green building certifications.
CSF23	Embed design for longevity, durability, disassembly and deconstruction.
CSF24	Design using materials with significant value that can undergo further reuse or recycling.
CSF25	Provide technical guidelines to facilitate the integration of CE principles into construction projects.
CSF30	Evaluate the performance, durability, and lifecycle impacts of different material options using life cycle assessment (LCA).
CSF32	Develop early detailed plans for material reuse with detailed restoration and deconstruction strategies.
CSF35	Ensure strict adherence to circular practices in compliance with building codes and standards.
CSF39	Ensure minimisation of maintenance and operation costs.
CSF41	Leverage BIM and digital tools effectively to optimise circularity practices throughout the project life cycle.
CSF42	Embrace innovative technologies such as 3D printing, prefabrication, and digital fabrication.
CSF43	Maintain digital detailed project records for material passports.

3.5.4. Procurement Stage

This phase connects the design and construction stages. During this stage, the project owner is responsible for undertaking the essential tasks of acquiring the necessary resources, services, and materials required to bring the project execution, which involves key activities such as reviewing bids, selecting contractors, and finalising contracts. In this study, we identified five contractual factors and three supply chain factors, as presented in Table 7.

Table 7. CSFs related to the procurement stage.

ID	Procurement Stage CSFs
CSF1	Ensure adherence to circular business models through clear contractual terms within project contracts
CSF2	Use incentive-based contracts to reward contractors and suppliers for meeting CE objectives.
CSF3	Set specific waste diversion and reusing/recycling targets in project contracts for construction and demolition activities.

Table 7. *Cont.*

ID	Procurement Stage CSFs
CSF4	Incorporate assurances of CE principles performance within project contracts.
CSF5	Include provisions for contractors to report on their adherence to circularity targets.
CSF8	Implement green procurement policies and guidelines that prioritise the procurement of circular materials and components.
CSF9	Encourage dealing with local contractors and suppliers.
CSF11	Use just-in-time (JIT) delivery for supply chain management

3.5.5. Construction Stage

In this stage, design plans are transformed into reality for construction, which implies the utilisation of various resources, including financial resources, equipment, materials, and human resources. These tasks involve designers, contractors, suppliers, consultants, and subcontractors and impose significant challenges to project managers to coordinate and manage these diverse stakeholders to achieve common goals. During construction, numerous physical activities take place, each potentially generating waste, pollution, and other environmental impacts. Effectively managing these activities is essential to minimise negative effects and ensure the circular project's success. Table 8 lists the CFs identified within this stage. These refer to one supply chain factor, two stakeholders and organisational factors, one strategic factor, one regulations and policies factor, and one technological factor.

Table 8. CSFs related to the construction stage.

ID	Construction Stage CSFs
CSF11	Use just-in-time (JIT) delivery for supply chain management
CSF15	Foster strong collaboration and communication among stakeholders at every stage of the project lifecycle.
CSF16	Promote awareness and acceptance of CE principles.
CSF21	Ensure the use of standardised, certified, and warranted secondary materials.
CSF25	Provide technical guidelines to facilitate the integration of CE principles into construction projects.
CSF26	Establish rigorous waste management protocols and plans from the early stage of the building life cycle.
CSF34	Ensure strict adherence to circular practices in compliance with building codes and standards.
CSF42	Embrace innovative technologies such as 3D printing, prefabrication, and digital fabrication.

3.5.6. Operation and Maintenance Stage

The operation stage has major effects on a project's CE performance. The operation stage focuses on the active use and management of the building. During this phase, the building is fully occupied and functional, with ongoing activities aimed at maintaining its performance, efficiency, and circularity. The operation stage is typically regarded as the longest phase in the building's lifecycle [65], and the majority of a building's overall energy consumption is attributed to it [66]. Key activities in this stage include regular maintenance, energy management, and ensuring occupant comfort and safety. Within this stage, five CSFs are identified, including two stakeholder and organisational factors, two strategic factors, and one technological factor, as presented in Table 9.

Table 9. CSFs related to the operation and maintenance stage.

ID	Operation and Maintenance Stage CSFs
CSF15	Foster strong collaboration and communication among stakeholders at every stage of the project lifecycle.
CSF16	Promote awareness and acceptance of CE principles.
CSF28	Implement proactive maintenance programs to extend the lifespan of building components and systems.
CSF29	Establish waste reduction and recycling programs for building occupants.
CSF41	Leverage BIM and digital tools effectively to optimise circularity practices throughout the project life cycle.

3.5.7. End-of-Life Stage

The end-of-life stage of a construction project marks the final phase of a building's life cycle. In this stage, the focus on operations shifts to dismantling and material recovery. The aim here is to keep materials in circulation, hence extending their lifecycle and supporting circular practices in the construction industry. This goal can be achieved by opting for deconstruction as opposed to demolition to maximise the reuse and recycling of materials rather than sending them to landfills. According to Lei et al. [67], the environmental benefits of circular design are greatly enhanced by effective reuse and recycling during this stage. Therefore, it is important to design buildings for deconstruction and enforce the 3Rs "reduce–reuse–recycle" concept in the end-of-life stage [68]. Within this stage, eight CSFs are highlighted by participants as follows: five stakeholder and organisational factors, two strategic factors, and one technological factor, as presented in Table 10.

Table 10. CSFs related to the end-of-life stage.

ID	End of Life Stage CSFs
CSF12	Client commitment and leadership toward CE objectives.
CSF15	Foster strong collaboration and communication among stakeholders at every stage of the project lifecycle.
CSF16	Promote awareness and acceptance of CE principles.
CSF30	Evaluate the performance, durability, and lifecycle impacts of different material options using life cycle assessment (LCA).
CSF32	Develop early detailed plans for material reuse with detailed restoration and deconstruction strategies.
CSF33	Promote the practice of pre-demolition auditing to enhance materials recovery.
CSF41	Leverage BIM and digital tools effectively to optimise circularity practices throughout the project life cycle.
CSF43	Maintain digital detailed project records for material passports.

3.6. Survey Results

This section presents the results of the online survey conducted to let building sector stakeholders rank the CSFs. The initiative captured demographic details of the participants, such as their expertise and the types of organisations they represent. Through this survey, we established the ranking of 42 CSFs based on the factors deemed most pivotal by the participants.

3.6.1. Demographic Details

Figure 3 illustrates the distribution of experience amongst participants. The majority (55%) hold between 6 and 15 years of experience, with 33% reporting 6–10 years and 22% having 11–15 years. The remaining participants, who were located at the tails of the sample, were clustered into two groups, namely, those with lower experience (17% with 2–5 years) and those with higher experience (28% with over 15 years).

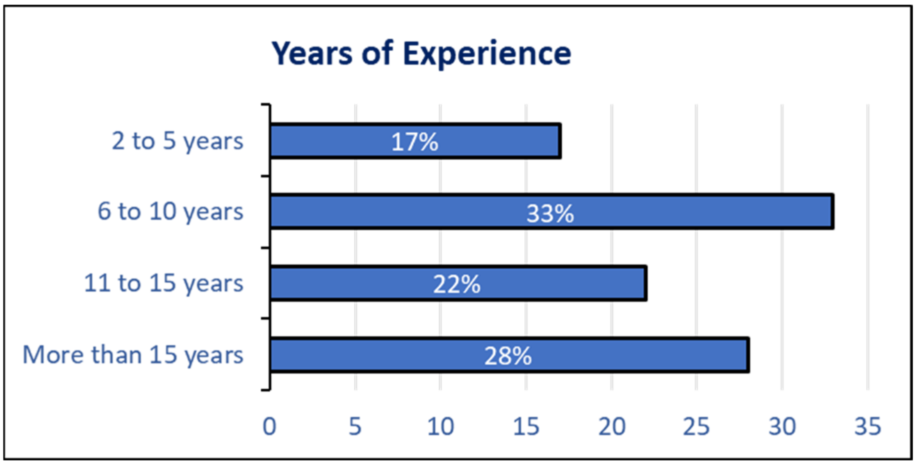

Figure 3. Participants' years of experience in the building sector.

This study captures the views and opinions of the four main types of profiles within construction organisations: clients, consultants, contractors, and designers (see Figure 4). Participants from client organisations were the most represented group, comprising 37% of respondents. Those from contractor and consultant organisations also played significant roles, with 20% and 18%, respectively. Participants from designer organisations accounted for 10% of the respondents. Additionally, 13% of respondents were from academia, whose research-based knowledge enriches the understanding of circular building practices. This variety of backgrounds demonstrates that the study incorporates the perspectives and expertise of key stakeholders.

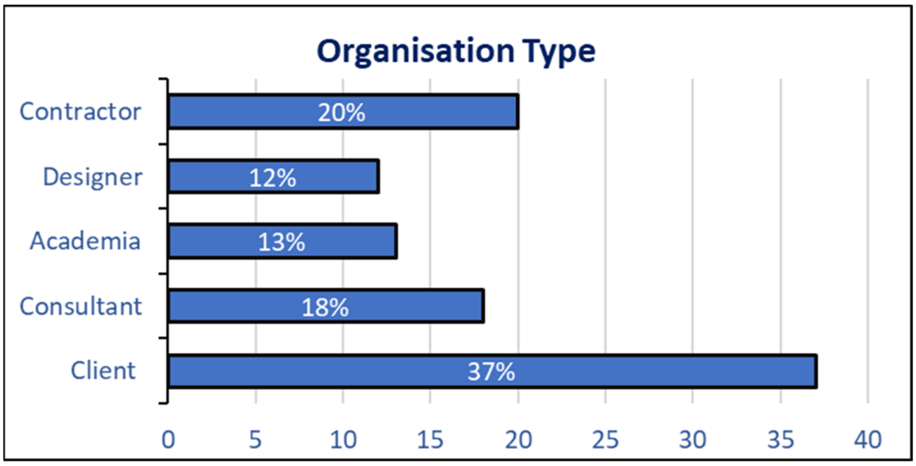

Figure 4. Participants' organisational type.

As illustrated in Figure 5, the sample displayed a diverse range of educational backgrounds. Over half of the respondents (51%) reported holding a bachelor's degree as their highest level of education, while 34% held a master's degree, indicating a higher level of specialisation. Additionally, 15% of the respondents possessed a doctoral degree, highlighting their advanced expertise in research.

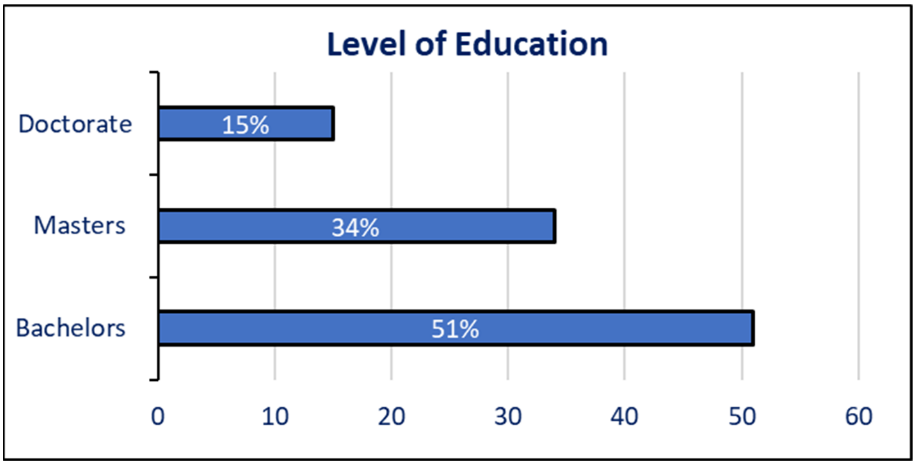

Figure 5. Participants' level of education.

3.6.2. CSF Relative Importance Index

As stated above, this study utilised the Relative Importance Index (RII) to rank the CSFs based on their impact on the successful implementation of CE construction projects. The top five CSFs moving from highest to lowest were as follows: (CSF21) Ensure the use of standardised, certified, and warranted secondary materials (RII = 0.8927); (CSF37) Ensure that the CE approach maintains cost equivalence with the current linear approach Ensure (RII = 0.8805); (CSF39) Ensure minimisation of maintenance and operation costs. (RII = 0.8585); (CSF38) Conduct life cycle cost to assess the economic feasibility and long-term financial viability of CE practices (RII = 0.8561), and (CSF34) Strong government regulations, legislations, and policies toward CE (RII 0.8415).

The RII value can be divided into five levels [69]: High (H) ($0.8 \leq \text{RII} \leq 1$); High-Medium (H–M) ($0.6 \leq \text{RII} < 0.8$); Medium (M) ($0.4 \leq \text{RII} < 0.6$); Medium-Low (M-L) ($0.2 \leq \text{RII} < 0.4$); and Low (L) ($0 \leq \text{RII} < 0.2$). Notably, all CSFs in this study were ranked as high or high–medium importance, emphasising the industry's strong perception of their critical role in integrating CE practices. Table 11 summarises the findings, highlighting the respondents' perspectives on the significance of each CSF in facilitating CE adoption within construction projects.

Table 11. Ranking of the CSFs.

Category	ID	Circular Economy's CSFs	RII	Ranking Across Constructs	Overall Rank	Importance Level
Contractual	CSF1	Ensure adherence to circular business models through clear contractual terms within project contracts.	0.776	4	**37**	H-M
	CSF2	Use incentive-based contracts to reward contractors and suppliers for meeting CE objectives.	0.720	5	**42**	H-M
	CSF3	Set specific waste diversion and reusing/recycling targets in project contracts for construction and demolition activities.	0.802	1	**29**	H
	CSF4	Incorporate assurances of CE principles performance within project contracts.	0.793	2	**33**	H-M
	CSF5	Include provisions for contractors to report on their adherence to circularity targets.	0.778	3	**36**	H-M

Table 11. *Cont.*

Category	ID	Circular Economy's CSFs	RII	Ranking Across Constructs	Overall Rank	Importance Level
Supply Chain	CSF6	Ensure adequate data and information about circular materials and products.	0.763	5	**38**	H-M
	CSF7	Ensure the availability of secondary materials market.	0.837	1	**9**	H
	CSF8	Adopt green procurement policies that prioritize circular materials and components	0.800	4	**30**	H
	CSF9	Encourage dealing with local contractors and suppliers.	0.829	2	**14**	H
	CSF10	Prioritise and build long-term partnerships with suppliers and contractors committed to CE principles.	0.824	3	**17**	H
	CSF11	Use just-in-time (JIT) delivery for supply chain management.	0.759	6	**40**	H-M
Stakeholders and Organisational	CSF12	Client commitment and leadership toward CE objectives.	0.834	3	**12**	H
	CSF13	Collaborate extensively with all stakeholders to establish robust circular business models.	0.810	8	**27**	H
	CSF14	Present comprehensive evidence to decision-makers about the financial and environmental benefits of the CE approach.	0.820	6	**22**	H
	CSF15	Foster strong collaboration and communication among stakeholders and project team at every stage of the project lifecycle.	0.839	1	**7**	H
	CSF16	Promote awareness and acceptance of CE principles among stakeholders.	0.817	7	**25**	H
	CSF17	Provide training programs and capacity-building initiatives for project team to enhance the team's proficiency in circular construction practices.	0.822	5	**18**	H
	CSF18	Introduce new roles within the project team dedicated to CE implementation.	0.690	9	**43**	H-M
	CSF19	Ensure that the project team possesses substantial knowledge and experience in executing CE construction projects.	0.839	1	**7**	H
	CSF20	Embed CE principles into the organisation's culture, values and vision.	0.829	4	**14**	H
Technical	CSF21	Ensure the use of standardised, certified, and warranted secondary materials.	0.893	1	**1**	H
	CSF22	Design with the aim of obtaining green building certifications.	0.822	3	**18**	H
	CSF23	Embed design for longevity, durability, and disassembly.	0.832	2	**13**	H

Table 11. *Cont.*

Category	ID	Circular Economy's CSFs	RII	Ranking Across Constructs	Overall Rank	Importance Level
Technical	CSF24	Design using materials with significant value that can undergo further reuse or recycling.	0.805	4	**28**	H
	CSF25	Provide technical guidelines to facilitate the integration of CE principles into construction projects.	0.800	5	**30**	H
Strategic	CSF26	Establish rigorous waste management protocols and plans from the early stage of the building life cycle.	0.820	3	**22**	H
	CSF27	Develop comprehensive risk management strategies to mitigate potential risks associated with CE approaches.	0.822	2	**18**	H
	CSF28	Implement proactive maintenance programs to extend the lifespan of building components and systems.	0.837	1	**9**	H
	CSF29	Establish waste reduction and recycling programs for building occupants.	0.822	2	**18**	H
	CSF30	Evaluate the performance, durability, and lifecycle impacts of different material options using life cycle assessment (LCA).	0.788	5	**34**	H-M
	CSF31	Develop key performance indicators (KPIs) and metrics to assess the effectiveness and impact of CE strategies on project outcomes.	0.785	6	**35**	H-M
	CSF32	Develop early detailed plans for material reuse with detailed restoration and deconstruction strategies.	0.817	4	**25**	H
	CSF33	Promote the practice of pre-demolition auditing to enhance materials recovery.	0.761	7	**39**	H-M
Regulations and Policies	CSF34	Strong government regulations, legislations, and policies toward CE.	0.842	1	**5**	H
	CSF35	Ensure strict adherence to circular practices in compliance with building codes and standards.	0.829	3	**14**	H
	CSF36	Governmental financial support.	0.837	2	**9**	H
Economic	CSF37	Ensure that the CE approach maintains cost equivalence with the current linear approach.	0.881	1	**2**	H
	CSF38	Conduct life cycle cost to assess the economic feasibility and long-term financial viability of CE practices.	0.856	3	**4**	H
	CSF39	Ensure minimisation of maintenance and operation costs.	0.859	2	**3**	H
	CSF40	Identify the wider value of project opportunities for cost savings through CE approaches.	0.840	4	**6**	H

Table 11. *Cont.*

Category	ID	Circular Economy's CSFs	RII	Ranking Across Constructs	Overall Rank	Importance Level
Technological	CSF41	Leverage BIM and digital tools effectively to optimise circularity practices throughout the project life cycle.	0.820	1	**22**	H
	CSF42	Embrace innovative technologies such as 3D printing, prefabrication, and digital fabrication.	0.798	2	**32**	H-M
	CSF43	Maintain digital detailed project records for material passports.	0.759	3	**40**	H-M

The prioritisation of CSFs for construction projects reflects the practical and strategic considerations that stakeholders find most significant. As demonstrated in Table 10, three of the top five CSFs were economic-related factors. This highlights the significant emphasis stakeholders place on the importance of the economic viability of CE construction projects. This result underscores the importance of ensuring that CE approaches are not only sustainable but also economically advantageous.

The highest CSF rank is the use of standardised, certified, and warranted secondary materials. This CSF is crucial as it ensures quality, reliability, and regulatory compliance. In this way, stakeholders prioritise the mitigation of risks associated with low-quality materials, which can lead to increased maintenance costs and safety issues. Ensuring the performance and longevity of materials is vital to enhance confidence among all parties involved, including investors, contractors, and end-users.

According to the analysis of the information, it became evident how important cost equivalence between a CE and the current linear approach is, not just for promoting its adoption in the construction industry but also since cost equivalence ensures that initial feasibility studies can confidently incorporate CE practices without increasing project costs. This makes it easier to gain support from decision-makers and secure funding. It also empowers the project team, such as architects and engineers, to freely explore circular design options and materials, knowing these choices will not escalate project costs. This allows for better cost control and monitoring without the unexpected financial pressures associated with adopting CE practices. In addition, investors and developers are inclined to embrace CE approaches in their construction projects when they perceive clear cost benefits and when they do not pose additional financial burdens compared to traditional methods. This assurance of financial viability stands as a significant factor in the widespread adoption of CE principles within construction projects.

The minimisation of maintenance and operation costs was ranked the third highest among stakeholders because it is crucial for a project's economic sustainability. The operation phase is typically regarded as the longest phase in the building's lifecycle, as it demands most of the energy and water consumption. Buildings designed with CE principles must incorporate resource-efficient systems and durable materials to lower operational expenses, improve building performance, and reduce lifecycle environmental impact. The focus on long-term financial viability, which could be achieved through reduced energy and water consumption and maintenance needs, should translate into higher profitability and a better investment return. These cost reductions through circular practices help offset any upfront investments in CE implementation, which contributes to long-term financial sustainability.

The LCC assessments are necessary to determine the complete financial impacts of a construction project throughout its life cycle. It gives the ultimate picture of the total costs incurred in construction projects from the design phase till the end-of-life phase. This analysis enables stakeholders to understand the long-term benefits and costs associated with CE practices. Furthermore, the LCC evaluation plays a role in determining the financial implications and potential risks that might end up in unanticipated costs at the time of the implementation of CE projects and requires taking some advanced measures to prevent them. This allows the project's stakeholders to anticipate long-term costs and even budget for additional expenses that may arise later and cause instability in the project's finances. Additionally, the LCC evaluation offers the necessary data which may be required to demonstrate that a project is both financially sound and capable of producing long-term economic benefits. The LCC evaluation is unavoidable for CE construction projects to attract investment and secure funding.

The role of governments is crucial in the wider adoption of circular practices through each stage of the construction project. Strong governmental regulations and policies are important for providing a clear framework, standards, and guidelines that mandate compliance with CE principles. This ensures that all stakeholders in the construction industry adhere to CE practices, making it easier for them to align their strategies with CE principles. For instance, updated building codes that reflect CE principles can guide architects and engineers to design buildings that are easier to disassemble and reuse. In addition, having clear waste management policies can encourage and facilitate the reusing, recycling, and repurposing of materials, diverting construction waste from landfills and into the circular resource system. This ensures the end-of-life phase aligns with CE principles.

4. Conclusions

This study intends to fill in some of the knowledge gaps regarding the CSFs for implementing CE principles in building construction projects. This is performed by addressing three research questions: (1) What CSFs are essential for effectively implementing the CE concept within building construction projects? (2) How do different stakeholders perceive CSFs and prioritise their importance for CE adoption in the building sector? (3) At which stages of a project lifecycle could these CSFs be implemented?

This study has developed the CSFs through a mixed-method approach via focus groups (qualitative) and an online questionnaire survey (quantitative). The focus groups included 20 participants from among key stakeholder groups: clients, contractors, consultants, and designers. The discussions held in those groups resulted in the identification of 43 CSFs and their categorisation into eight distinct groups: contractual, supply chain, stakeholders and organisational, technical, strategic, regulations and policies, economic, and technological. This study discusses the implementation of each factor within each project life cycle stage, including initiation, planning, procurement, construction, operation and maintenance, and end-of-life.

On the other hand, the online questionnaire captured 82 responses that were analysed using mean, standard deviation, and relative importance index to rank the referred CSFs. The top five most significant CSFs are "Ensure the use of standardised, certified, and warranted secondary materials"; "Ensure that the CE approach maintains cost equivalence with the current linear approach"; "Minimise maintenance and operation costs"; "Conduct life cycle cost assessments and evaluate the economic feasibility and long-term financial viability of CE practices", and "Strong government regulations, legislation, and policies toward CE".

The study revealed notable differences in the emphasis that stakeholders in different focus groups put on the relevance of CSFs. The client group prioritised having a strong business case for CE principles and securing governmental financial support. Contractors and consultants emphasised the importance of client commitment and leadership toward CE objectives, as well as ensuring compliance with building codes when implementing CE approaches. The designer group focused more on the technical and technological factors, such as the assurance of building structural performance and the utilisation of BIM and digital tools throughout the project life cycle.

Notably, all the groups agreed on the importance of having strong regulations and policies toward CE, as these enforce compliance with CE objectives from all stakeholders. They also agreed on the critical role of client commitment, collaboration and communication between all stakeholders throughout the project life cycle, as well as increasing the awareness and acceptance of CE applications for wider successful adoption. There was also agreement regarding the importance of having standardised secondary materials. According to the participants, material quality plays a fundamental role in promoting the use of reused/recycled materials within construction. Without such standardisation, their adoption would pose considerable challenges.

The findings of this study aim to provide practical insights for managing CE practices at the project level. These insights can be applied to enhance the planning and execution of circular construction projects, ensuring that CE principles are integrated effectively from inception to completion. By identifying and prioritising CSFs, this research provides a robust framework that empowers building sector stakeholders to develop more effective strategies for successfully adopting CE principles in the project life cycle. The research outcomes are useful for shaping pathways toward more circular construction projects, contributing to long-term environmental and economic benefits. The findings serve as a practical decision-making tool for construction managers, project planners, designers, developers, and investors, enabling them to focus on the most impactful factors to achieve CE goals.

Nonetheless, it is important to acknowledge the limitations of this study. The ranked CSFs are based on stakeholders' perspectives without the support of case studies. It is also essential to acknowledge that the findings may not fully represent the entire construction industry. Future research should aim to improve the generalisability of findings by incorporating expert opinions from diverse geographic regions.

Finally, this study found that the use of different methods, such as LCA, LCC, and BIM, can facilitate the implementation of circularity in building projects. These methods can be further investigated to show their relationships, limitations, and the processes required for more integration.

Author Contributions: Conceptualisation, A.A., C.B. and P.M.-V.; Data curation, A.A.; Formal analysis, A.A.; Investigation, AA., C.B. and P.M.-V.; Methodology, A.A.; Project administration, A.A., C.B. and P.M.-V.; Supervision, A.A., C.B. and P.M.-V.; Validation, A.A.; Visualization, A.A., C.B. and P.M.-V.; Writing—original draft, A.A.; Writing—review and editing, A.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

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

Data Availability Statement: This study was conducted using data sets and analyses that are reasonably accessible to the corresponding author.

Acknowledgments: The first author acknowledges with thanks the support of his research activity at the University of Birmingham by the Imam Abdulrahman Bin Faisal University. All authors consented to this acknowledgement.

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

References

1. World Economic Forum. Engineering and Construction. Available online: https://www.weforum.org/communities/engineering-and-construction (accessed on 8 May 2024).
2. Global Alliance for Buildings and Construction (GlobalABC). *2018 Global Status Report: Towards a Zero-Emission, Efficient and Resilient Buildings and Construction Sector*; International Energy Agency and United Nations Environment Programme: Nairobi, Kenya, 2018.
3. Sariatli, F. Linear Economy Versus Circular Economy: A Comparative and Analyzer Study for Optimization of Economy for Sustainability. *Visegr. J. Bioecon. Sustain. Dev.* **2017**, *6*, 31–34. [CrossRef]
4. Andrews, D. The Circular Economy, Design Thinking and Education for Sustainability. *Local Econ.* **2015**, *30*, 305–315. [CrossRef]
5. Ruiz, L.A.L.; Ramón, X.R.; Domingo, S.G. The Circular Economy in the Construction and Demolition Waste Sector–A Review and an Integrative Model Approach. *J. Clean. Prod.* **2020**, *248*, 119238. [CrossRef]

6. Ellen MacArthur Foundation. Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition. Available online: https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an (accessed on 1 March 2023).
7. Ellen MacArthur Foundation. Towards the Circular Economy: Opportunities for the Consumer Goods Sector. Available online: https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-2-opportunities-for-the-consumer-goods (accessed on 7 December 2022).
8. Potting, J.; Hekkert, M.; Worrell, E.; Hanemaaijer, A. *Circular Economy: Measuring Innovation in the Product Chain*; PBL Netherlands Environmental Assessment Agency: The Hague, The Netherlands, 2017; pp. 14–19.
9. Hysa, E.; Kruja, A.; Rehman, N.U.; Laurenti, R. Circular Economy Innovation and Environmental Sustainability Impact on Economic Growth: An Integrated Model for Sustainable Development. *Sustainability* **2020**, *12*, 4831. [CrossRef]
10. Stahel, W.R. The Circular Economy. *Nature* **2016**, *531*, 435–438. [CrossRef] [PubMed]
11. Ghisellini, P.; Ripa, M.; Ulgiati, S. Exploring Environmental and Economic Costs and Benefits of a Circular Economy Approach to the Construction and Demolition Sector. A Literature Review. *J. Clean. Prod.* **2018**, *178*, 618–643. [CrossRef]
12. Geissdoerfer, M.; Savaget, P.; Bocken, N.M.P.; Hultink, E.J. The Circular Economy–A New Sustainability Paradigm? *J. Clean. Prod.* **2017**, *143*, 757–768. [CrossRef]
13. Kubbinga, B.; Bamberger, M.; van Noort, E.; Reek, E.; Blok, M.; Roemers, G.; Hoek, J.; Faes, K. *A Framework for Circular Buildings Indicators for Possible Inclusion in BREEAM*; Circle Economy, DGBC, Metabolic and SGS: Amsterdam, The Netherlands, 2018.
14. Pomponi, F.; Moncaster, A. Circular Economy for the Built Environment: A Research Framework. *J. Clean. Prod.* **2017**, *143*, 710–718. [CrossRef]
15. Akhimien, N.G.; Latif, E.; Hou, S.S. Application of Circular Economy Principles in Buildings: A Systematic Review. *J. Build. Eng.* **2021**, *38*, 102041. [CrossRef]
16. Tirado, R.; Aublet, A.; Laurenceau, S.; Habert, G. Challenges and Opportunities for Circular Economy Promotion in the Building Sector. *Sustainability* **2022**, *14*, 1569. [CrossRef]
17. Xue, X.; Zhang, R.; Yang, R.; Dai, J. Innovation in Construction: A Critical Review and Future Research. *Int. J. Innov. Sci.* **2014**, *6*, 111–126. [CrossRef]
18. AlJaber, A.; Martinez-Vazquez, P.; Baniotopoulos, C. Barriers and Enablers to the Adoption of Circular Economy Concept in the Building Sector: A Systematic Literature Review. *Buildings* **2023**, *13*, 2778. [CrossRef]
19. Adams, K.T.; Osmani, M.; Thorpe, T.; Thornback, J. Circular Economy in Construction: Current Awareness, Challenges and Enablers. *Proc. Inst. Civ. Eng. Waste Resour. Manag.* **2017**, *170*, 15–24. [CrossRef]
20. Al-Otaibi, A.; Bowan, P.A.; Daiem, M.M.A.; Said, N.; Ebohon, J.O.; Alabdullatief, A.; Al-Enazi, E.; Watts, G. Identifying the Barriers to Sustainable Management of Construction and Demolition Waste in Developed and Developing Countries. *Sustainability* **2022**, *14*, 7532. [CrossRef]
21. Bilal, M.; Khan, K.I.A.; Thaheem, M.J.; Nasir, A.R. Current State and Barriers to the Circular Economy in the Building Sector: Towards a Mitigation Framework. *J. Clean. Prod.* **2020**, *276*, 123250. [CrossRef]
22. Kanters, J. Circular Building Design: An Analysis of Barriers and Drivers for a Circular Building Sector. *Buildings* **2020**, *10*, 77. [CrossRef]
23. AlJaber, A.; Martinez-Vazquez, P.; Baniotopoulos, C. Circular Economy in the Building Sector: Investigating Awareness, Attitudes, Barriers, and Enablers through a Case Study in Saudi Arabia. *Sustainability* **2024**, *16*, 1296. [CrossRef]
24. Al-Otaibi, A. Barriers and Enablers for Green Concrete Adoption: A Scientometric Aided Literature Review Approach. *Sustainability* **2024**, *16*, 5093. [CrossRef]
25. Rios, F.C.; Grau, D.; Bilec, M. Barriers and Enablers to Circular Building Design in the US: An Empirical Study. *J. Constr. Eng. M.* **2021**, *147*, 04021117. [CrossRef]
26. Benites, H.S.; Osmond, P.; Prasad, D. Inquiry on Perceptions and Practices of Built Environment Professionals Regarding Regenerative and Circular Approaches. *Buildings* **2023**, *13*, 63. [CrossRef]
27. Mahpour, A. Prioritizing Barriers to Adopt Circular Economy in Construction and Demolition Waste Management. *Resour. Conserv. Recycl.* **2018**, *134*, 216–227. [CrossRef]
28. Rockart, J.F. The Changing Role of the Information Systems Executive: A Critical Success Factors Perspective. *Sloan Manag. Rev.* **1982**, *24*, 3–13.
29. Hwang, B.-G.; Lim, E.-S.J. Critical Success Factors for Key Project Players and Objectives: Case Study of Singapore. *J. Constr. Eng. Manag.* **2012**, *139*, 204–215. [CrossRef]
30. Gan, X.; Zuo, J.; Ye, K.; Skitmore, M.; Xiong, B. Why Sustainable Construction? Why Not? An Owner's Perspective. *Habitat Int.* **2015**, *47*, 61–68. [CrossRef]
31. Boynton, A.C.; Zmud, R.W. An Assessment of Critical Success Factors. *Sloan Manag. Rev.* **1984**, *25*, 17.
32. Koc, K.; Durdyev, S.; Tleuken, A.; Ekmekcioglu, O.; Mbachu, J.; Karaca, F. Critical Success Factors for Construction Industry Transition to Circular Economy: Developing Countries Perspectives. *Eng. Constr. Arch. Manag.* **2023**. *ahead-of-print*. [CrossRef]
33. Wuni, I.Y.; Shen, G.Q. Critical Success Factors for Modular Integrated Construction Projects: A Review. *Build. Res. Inf.* **2020**, *48*, 763–784. [CrossRef]
34. Aloini, D.; Dulmin, R.; Mininno, V.; Stefanini, A.; Zerbino, P. Driving the Transition to a Circular Economic Model: A Systematic Review on Drivers and Critical Success Factors in Circular Economy. *Sustainability* **2020**, *12*, 10672. [CrossRef]

35. Wuni, I.Y.; Shen, G.Q. Developing Critical Success Factors for Integrating Circular Economy into Modular Construction Projects in Hong Kong. *Sustain. Prod. Consum.* **2022**, *29*, 574–587. [CrossRef]
36. Akinade, O.O.; Oyedele, L.O.; Ajayi, S.O.; Bilal, M.; Alaka, H.A.; Owolabi, H.A.; Bello, S.A.; Jaiyeoba, B.E.; Kadiri, K.O. Design for Deconstruction (DfD): Critical Success Factors for Diverting End-of-Life Waste from Landfills. *Waste Manag.* **2017**, *60*, 3–13. [CrossRef] [PubMed]
37. Ma, W.; Liu, T.; Hao, J.L.; Wu, W.; Gu, X. Towards a Circular Economy for Construction and Demolition Waste Management in China: Critical Success Factors. *Sustain. Chem. Pharm.* **2023**, *35*, 101226. [CrossRef]
38. Clark, V.P.; Creswell, J. *The Mixed Methods Reader*; Sage: Thousand Oaks, CA, USA, 2008.
39. Almeida, F. Strategies to Perform a Mixed Methods Study. *Eur. J. Educ. Stud.* **2018**, *5*. [CrossRef]
40. DeCuir-Gunby, J.T.; Schutz, P.A. *Developing a Mixed Methods Proposal: A Practical Guide for Beginning Researchers*; Sage: Thousand Oaks, CA, USA, 2016; Volume 5.
41. Denzin, N.K. *The Research Act: A Theoretical Introduction to Sociological Methods*; Transaction Publishers: New York, NY, USA, 1978.
42. Freitas, H.; Oliveira, M.; Jenkins, M.; Popjoy, O. The Focus Group, a Qualitative Research Method. *J. Educ.* **1998**, *1*, 1–22.
43. Morgan, D.L. Focus Groups. *Annu. Rev. Sociol.* **1996**, *22*, 129–152. [CrossRef]
44. Guest, G.; Namey, E.; Taylor, J.; Eley, N.; McKenna, K. Comparing Focus Groups and Individual Interviews: Findings from a Randomized Study. *Int. J. Soc. Res. Methodol.* **2017**, *20*, 693–708. [CrossRef]
45. Krueger, R.A. *Focus Groups: A Practical Guide for Applied Research*; Sage: Thousand Oaks, CA, USA, 1994.
46. Morgan, D.L. *Focus Groups as Qualitative Research*; Sage: Thousand Oaks, CA, USA, 1997.
47. Kaplowitz, M.D.; Hoehn, J.P. Do Focus Groups and Individual Interviews Reveal the Same Information for Natural Resource Valuation? *Ecol. Econ.* **2001**, *36*, 237–247. [CrossRef]
48. Creswell, J.W. *Research Design: Qualitative & Quantitative Approaches*; Sage: Thousand Oaks, CA, USA, 1994.
49. Goertzen, M.J. Introduction to Quantitative Research and Data. *Libr. Technol. Rep.* **2017**, *53*, 12–18.
50. Roopa, S.; Rani, M.S. Questionnaire Designing for a Survey. *J. Indian Orthod. Soc.* **2012**, *46*, 273–277. [CrossRef]
51. Yamane, T. *Statistics, An Introductory Analysis*; Harper and Row: New York, NY, USA, 1967.
52. Israel, G.D. *Sampling the Evidence of Extension Program Impact*; University of Florida: Gainesville, FL, USA, 1992.
53. Fincham, J.E. Response Rates and Responsiveness for Surveys, Standards, and the Journal. *Am. J. Pharm. Educ.* **2008**, *72*, 43. [CrossRef] [PubMed]
54. Nulty, D.D. The Adequacy of Response Rates to Online and Paper Surveys: What Can Be Done? *Assess. Eval. High. Educ.* **2008**, *33*, 301–314. [CrossRef]
55. Braun, V.; Clarke, V. Using Thematic Analysis in Psychology. *Qual. Res. Psychol.* **2006**, *3*, 77–101. [CrossRef]
56. Clarke, V.; Braun, V. Thematic Analysis. *J. Posit. Psychol.* **2017**, *12*, 297–298. [CrossRef]
57. Kiger, M.E.; Varpio, L. Thematic Analysis of Qualitative Data: AMEE Guide No. 131. *Med. Teach.* **2020**, *42*, 846–854. [CrossRef] [PubMed]
58. Litwin, M.S. *How to Measure Survey Reliability and Validity*; Sage: Thousand Oaks, CA, USA, 1995.
59. Heale, R.; Twycross, A. Validity and Reliability in Quantitative Studies. *Evid. Based Nurs.* **2015**, *18*, 66. [CrossRef] [PubMed]
60. Taherdoost, H. Validity and Reliability of the Research Instrument; How to Test the Validation of a Questionnaire/Survey in a Research. *Int. J. Acad. Res. Manag.* **2016**, *5*, 28–36. [CrossRef]
61. Cronbach, L.J. Coefficient Alpha and the Internal Structure of Tests. *Psychometrika* **1951**, *16*, 297–334. [CrossRef]
62. Tavakol, M.; Dennick, R. Making Sense of Cronbach's Alpha. *Int. J. Med. Educ.* **2011**, *2*, 53–55. [CrossRef] [PubMed]
63. Davcik, N.S. The Use and Misuse of Structural Equation Modeling in Management Research. *J. Adv. Manag. Res.* **2014**, *11*, 47–81. [CrossRef]
64. Wuni, I.Y. A Systematic Review of the Critical Success Factors for Implementing Circular Economy in Construction Projects. *Sustain. Dev.* **2023**, *31*, 1195–1213. [CrossRef]
65. Bragança, L.; Mateus, R. *Life-Cycle Analysis of Buildings; Environmental Impact of Building Elements*; iiSBE Portugal: Guimarães, Portugal, 2012.
66. Ramesh, T.; Prakash, R.; Shukla, K.K. Life Cycle Energy Analysis of Buildings: An Overview. *Energy Build.* **2010**, *42*, 1592–1600. [CrossRef]
67. Lei, H.; Li, L.; Yang, W.; Bian, Y.; Li, C.-Q. An Analytical Review on Application of Life Cycle Assessment in Circular Economy for Built Environment. *J. Build. Eng.* **2021**, *44*, 103374. [CrossRef]
68. Bertino, G.; Kisser, J.; Zeilinger, J.; Langergraber, G.; Fischer, T.; Österreicher, D. Fundamentals of Building Deconstruction as a Circular Economy Strategy for the Reuse of Construction Materials. *Appl. Sci.* **2021**, *11*, 939. [CrossRef]
69. Akadiri, P.O.; Olomolaiye, P.O.; Chinyio, E.A. Multi-Criteria Evaluation Model for the Selection of Sustainable Materials for Building Projects. *Autom. Constr.* **2013**, *30*, 113–125. [CrossRef]