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STAKEHOLDER INFLUENCE AND ROLES ON CIRCULAR ECONOMY ADOPTION IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

The construction industry is a major consumer of resources and contributor to waste, requiring the implementation of sustainable approaches like the Circular Economy (CE). Effective CE implementation needs the collaborative involvement of multiple stakeholders throughout the project lifecycle. This study aims to identify key stakeholder groups in the Sri Lankan construction industry, assess their influence and explore their roles in CE implementation. The study used a mixed-methods approach. The questionnaire survey identified the most influential stakeholder groups, and semi-structured interviews were conducted with two representatives from each of the six key stakeholder groups. The results identified six key stakeholders, namely architects/designers, suppliers/manufacturers, public/statutory authorities, clients/developers, contractors, and cost consultants, as significantly influential (Relative Importance Index > 0.70). Architects/designers exert a strong influence on early-stage CE integration, while contractors and suppliers play a major role in the execution of R principles such as reuse, recycling, and recovery. Further, the study revealed that CE implementation is a shared responsibility across all project stages, identifying the roles of key stakeholders. This study contributes by providing a systematic assessment of stakeholder influence and role-mapping for CE implementation in a developing-country context. The findings also highlight emerging stakeholder responsibilities supporting effective CE adoption.

Keywords: *10R Principles; Circular Economy; Sri Lankan Construction Industry; Stakeholder Influence; Stakeholder Roles.*

1. INTRODUCTION

The construction industry is a significant contributor to the resource crisis, accounting for 40–60% of the depletion of natural materials (Eberhardt et al., 2022). It creates a large amount of construction and demolition (C&D) waste, accounting for 30–35% of total waste globally (Xia et al., 2020). The construction sector is associated with the linear economic model, implying a "take-make-dispose" approach (Saroosh & Khan, 2024). Disposing of construction waste has adverse environmental effects, including soil and

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water pollution, increased deforestation, and loss of wildlife habitats (Noor et al., 2020). Thus, the potential environmental impacts of C&D waste cannot be adequately addressed by current waste management techniques, such as incineration and landfill disposal (Ram et al., 2020). Therefore, it is time for the construction industry to implement concepts like the Circular Economy, which focuses on zero waste (Wanaguru et al., 2022).

The Circular Economy (CE) transforms end-of-life products into resources, promoting closed-loop systems and zero-waste practices (Giorgi et al., 2022). The use of recycled materials and closed-loop supply chains can reduce environmental impacts in construction (Gopal et al., 2023). Integrating CE principles can also improve project time, cost, and quality performance (Victar & Waidyasekara, 2024), making CE essential for achieving sustainable development in the resource-intensive construction sector (Knable et al., 2022).

The Sri Lankan construction industry faces challenges, including ineffective waste management and environmental degradation stemming from excessive resource use and waste generation (Victar & Waidyasekara, 2024). CE implementation in the sector is still at an early stage and faces several barriers, including unclear guidelines, limited stakeholder awareness, weak policy support, and insufficient stakeholder engagement (De Silva et al., 2023; Senaratne et al., 2023; Weerakoon & Thayaparan, 2023; Wanaguru et al., 2022; Wijewansha et al., 2021). These factors and industry conditions may lead to differences in key stakeholders and their roles in Sri Lankan CE implementation compared with those identified in other countries, requiring specific identification of stakeholders in the Sri Lankan construction industry context.

The construction industry is highly fragmented, involving multiple stakeholders across project phases, which also makes CE implementation difficult (De Silva et al., 2023). This challenge is often linked to limited stakeholder engagement and poor communication (Victar & Waidyasekara, 2024). Effective stakeholder engagement is therefore essential for collaboration, knowledge sharing, and material flow in CE adoption (Hossain et al., 2020; Senaratne et al., 2023). While global studies have examined stakeholder engagement strategies and collaborative models for CE implementation (Hossain et al., 2020; Senaratne et al., 2021; Volk et al., 2019), research studies in Sri Lanka mainly focus on CE challenges and drivers (Gamage et al., 2024; Weerakoon & Thayaparan, 2023). However, limited research has examined the specific roles of industry stakeholders in facilitating stakeholder engagement for CE adoption. Despite increasing requirements to address waste and sustainability issues as a geographically small nation, Sri Lanka is at an early stage of CE implementation without a structured approach. Therefore, prioritising the most influential stakeholders is necessary for a more focused and effective initiation of CE practices.

Accordingly, this study aims to identify key stakeholder groups involved in CE implementation in the Sri Lankan construction industry, assess their influence on the R principles, and explore their roles in supporting effective CE practices.

2. LITERATURE REVIEW

2.1 THE CONCEPT OF CIRCULAR ECONOMY

Many scholars have proposed various definitions of CE over the past period. For instance, CE is “one that is restorative and regenerative by design” (Ellen MacArthur Foundation, 2015). Several definitions emphasise CE's role in transitioning from the traditional linear economic model of "take, make, dispose" to a closed-loop system (Saroosh & Khan, 2024). Scholars such as Wanaguru et al. (2022) also highlight its potential to reduce waste, particularly in the construction industry. Key stakeholders in the flow, identified by the Ellen MacArthur Foundation's Butterfly Diagram, include farmers, manufacturers, service providers, consumers, recyclers, and regulators (Riesener et al., 2023). Each stakeholder plays a role in maintaining circularity from sourcing renewable inputs to extending product life and managing end-of-life recovery, ensuring minimal waste and maximising economic and environmental value across the supply chain (Owojori & Okoro, 2022).

2.2 KEY PRINCIPLES OF CE

CE principles guide the practical application of the circular economy model (Velenturf & Purnell, 2021). The concept originates from several theories, including the R-framework, blue economy, biomimicry, and cradle-to-grave, all of which promote closed-loop systems (Lieder & Rashid, 2016). Literature presents different versions of R-principles, widely used as CE principles, evolving from the basic 3Rs to the more comprehensive 10Rs, while recent studies identify over 100 "R" concepts (Zorpas, 2024). The 3R principles (Reduce, Reuse, and Recycle) form the foundation of CE and are widely applied in the construction industry (Liyanage et al., 2022). These were later expanded into the 10R framework, which addresses all stages of the material life cycle (Rahla et al., 2021). The 10R principles include Reduce, Reuse, Recycle, Refuse, Recover, Rethink, Remanufacture, Repurpose, Repair, and Refurbish (Morseletto, 2019). The 10R principles are widely recognised in academic literature as a framework for CE practices. Each principle is linked to functions across different life-cycle stages of a circular building (Çetin et al., 2021; De Wolf et al., 2020; Rahla et al., 2021). Effective material flow in circular supply chains requires stakeholder collaboration and engagement throughout all lifecycle stages (Hossain et al., 2020). Therefore, this study applies the 10R principles to develop a stakeholder engagement framework for CE implementation in the Sri Lankan construction industry.

2.3 CE IN THE CONSTRUCTION INDUSTRY

The construction sector has major environmental impacts due to high resource and energy use and the generation of large volumes of C&D waste, much of which is landfilled (Norouzi et al., 2021). CE principles, such as reuse, recycling, and efficient resource use, can reduce these impacts (Norouzi et al., 2021). However, CE adoption remains limited due to economic, technological, and stakeholder-related barriers, including a lack of guidelines, uncertainty in material reuse, and weak supply chain collaboration (Adams et al., 2017; Moreau et al., 2017). In Sri Lanka, rapid urbanisation, high material costs, and weak waste management further challenge CE implementation (De Silva et al., 2023; Victar & Waidyasekara, 2023).

2.4 STAKEHOLDERS FOR CE IMPLEMENTATION IN CONSTRUCTION

Effective CE implementation in construction requires identifying stakeholders across the project lifecycle, from design and procurement to demolition and recycling (Senaratne et al., 2023). Stakeholder theory highlights the need to consider diverse interests and influence in decision-making (McGrath & Whitty, 2017). Recognising and engaging stakeholders is essential to align interests, promote sustainability, and ensure commitment to circular practices (Senaratne et al., 2021; Oberholzer & Sachs, 2023). Successful CE implementation in construction requires active involvement from diverse stakeholders, each with specific roles and responsibilities (Fobbe & Hilletofth, 2022). The roles of stakeholders towards CE implementation can be summarised in Table 1 in the global context.

Table 1: Stakeholders for CE implementation in construction

Stakeholders	Roles in CE practice (Identified from literature)	Sources
Government and statutory authorities	Developing CE policies and regulations and encouraging public-private collaboration.	[2], [4], [6], [7], [8]
Public authorities	Facilitating partnerships, providing technical and financial incentives, and promoting sustainable practices	[2], [4], [8]
Construction clients and developers	Setting project goals aligned with CE principles, promoting the use of sustainable materials, and ensuring compliance with CE standards	[1], [6], [9]
Contractors and Subcontractors	Implementing on-site CE practices such as waste reduction, recycling, and reuse, coordinating with clients, suppliers, and designers	[2], [9]
Suppliers and Manufacturers	Producing sustainable materials, ensuring their recyclability or reusability, and providing transparent information on material properties and lifecycle performance	[2], [3], [9], [11]
Architects, Designers, and Engineers	Incorporating recycled materials in designs, developing guidance manuals, and promoting design for disassembly to facilitate material recovery at the end of a building's lifecycle	[2], [9], [10]
Demolition contractors	Recovering materials from deconstruction, ensuring proper recycling, and collaborating with the suppliers and contractors to reintegrate materials into new construction	[2], [9], [11]
Investors and Financiers	Providing funding and incentives for CE projects while supporting innovation in sustainable construction	[5], [6]
Researchers	Identifying challenges and opportunities, developing CE assessment methods, and proposing innovative solutions for CE-enabled products and materials	[8]
Community	Promoting demand for sustainable materials, recyclable materials, and remanufactured products	[2], [6]

[1] Acharya et al., 2018; [2] Almeida, 2024; [3] Chen et al., 2022; [4] Christensen, 2021; [5] Ebekozien et al., 2024; [6] Govindan & Hasanagic, 2018; [7] Hartley et al., 2020; [8] Kocaturk & Hosseini, 2023; [9] Senaratne et al., 2023; [10] Tleuken et al., 2022; [11] Volk et al., 2019.

3. RESEARCH METHODOLOGY

The research design for this study is structured into two phases to ensure a comprehensive approach to achieving the research objectives. This study adopted a sequential explanatory mixed-methods approach to obtain a comprehensive understanding of stakeholder engagement in CE implementation. In Phase 1, a quantitative survey was conducted to rank and prioritise stakeholder groups by their influence on CE implementation in the Sri Lankan construction industry, providing a broader, statistically reliable understanding of stakeholder dynamics. Phase 1 is necessary to identify the most influential and context-relevant stakeholders, due to the impracticality of studying all groups within a wide range of stakeholders in a limited time. Phase 1 contributed context-specific prioritisation rather than redefining the stakeholder groups identified in the literature for the Sri Lankan context to address varying influence. In Phase 2, qualitative semi-structured interviews were used to explore stakeholder roles and collaboration with the highest-ranked stakeholder groups in greater depth, offering contextual insights grounded in quantitative stakeholder prioritisation that quantitative data alone cannot capture. Therefore, starting with qualitative would not provide a structured way to prioritise stakeholders across a wide range. A case study strategy was not adopted because CE implementation in the Sri Lankan construction industry is still in its early stages.

Both primary and secondary data collection methods were used, including a literature review, questionnaire survey, and semi-structured interviews. A total of 50 questionnaires were distributed to professionals using purposive and snowball sampling, based on their familiarity with sustainability or circular economy concepts, experience in the construction industry for more than 5 years, and current work in the Sri Lankan construction industry. The respondents included sustainability consultants, project managers, quantity surveyors, engineers, and corporate environmental officers with at least three years of professional experience. Out of the distributed questionnaires, 37 valid responses were received, resulting in a response rate of 74%. The study focuses on stakeholder prioritisation rather than statistical generalisation, and the achieved sample was information-rich CE experts suitable for ranking CE influential stakeholders. Therefore, the responses are considered adequate for this analysis, which is close to the statistically required sample size of approximately 44 respondents calculated through the Yamane (1967) sample size formula.

In Phase 2, semi-structured interviews were conducted to obtain in-depth insights into stakeholder perspectives on CE implementation. Six stakeholder groups were identified based on Phase 1 results, focusing on those with significant influence on CE adoption. Two participants from each stakeholder group were selected using convenience sampling, based on accessibility and availability, to ensure they had adequate knowledge of CE principles and involvement in construction activities as per Table 2.

Table 2: Details of interviewees

Code	Stakeholder group	Designation	Industry Experience	Experience in Stakeholder group
A01	Architects/Designers	Chief Executive Officer (CEO)	> 30 years	5 years
A02		Chartered Architect	> 20 years	> 20 years
SM01	Suppliers/ Manufacturers	Quality Assurance/ Quality Checking (QA/QC) Engineer	> 16 years	8 years
SM02		Technical Manager	> 15 years	5 years
C01	Contractors	Project Manager	> 15 years	> 15 years
C02		Project Manager	15 years	15 years
CL01	Construction clients	Director	11 years	6 years
CL02		Director	> 16 years	12 years
SR01	Statutory & regulatory authorities	Deputy Director General	> 20 years	10 years
SR02		Acting Director	> 25 years	12 years
QS01	Cost consultant	Quantity surveyor	10 years	10 years
QS02		Quantity surveyor	15 years	15 years

The sample size is guided by information richness, relevance, accessibility, and balanced representation across the six key stakeholder groups, rather than by numerical sample size considerations.

Quantitative data were analysed using descriptive statistical methods. The Relative Importance Index (RII) was used to evaluate stakeholders' perceived importance in implementing CE principles, with a threshold value of 0.70 considered significant, following Shanmuganathan et al. (2014) and Manoharan et al. (2020). Qualitative data obtained from interviews were analysed using manual content analysis.

4. RESEARCH FINDINGS, ANALYSIS, AND DISCUSSION

4.1 ANALYSIS OF QUESTIONNAIRE SURVEY FINDINGS

The questionnaire survey assessed stakeholders' awareness, perceptions, and influence on CE implementation in the Sri Lankan construction industry. The questionnaire targeted professionals with experience in the construction industry. 32.4% of respondents had 6–10 years of experience, 27% had 2–5 years, 21.6% had over 10 years, and 18.9% had less than 2 years. Respondents represented diverse construction professions, including engineers (32.4%), quantity surveyors (18.9%), project managers (10.8%), lecturers (10.8%), architects (5.4%), professors (5.4%), sector estimators (3.6%), researchers (3.6%), and freelancers in environmental policy and management.

Respondents were asked to rate each stakeholder group by its influence on implementing the CE concept in the Sri Lankan construction industry using a five-point Likert scale. Table 3 presents the potential influence of each stakeholder on overall CE implementation, based on their RII values. Using the RII threshold of 0.70 (Shanmuganathan et al., 2014; Manoharan et al., 2020), six stakeholders, namely Architects/Designers, Suppliers/Manufacturers, Public and Statutory Authorities, Construction Clients, Contractors, and Cost Consultants, were identified as highly influential in CE implementation as shown in Table 3.

Table 3: Overall stakeholder influence on CE implementation

Stakeholder group	RII value	Rank
Public and statutory Authorities	**0.816**	**3**
Construction Clients	**0.784**	**4**
Contractors	**0.757**	**5**
Subcontractors	0.681	7
Suppliers/ Manufacturers	**0.832**	**2**
Architects/Designers	**0.843**	**1**
Cost consultant	**0.735**	**6**
Financial institutes	0.649	8
Consumers	0.624	9

As per Table 3, Finance Institutes and Consumers showed comparatively lower influence for CE implementation in the Sri Lankan Construction industry, with RII values below 0.70. This indicates that CE practices in Sri Lanka are largely driven by project-level actors such as architects, contractors and clients, rather than end-users or financial intermediaries. However, public and statutory authorities ranked 3, emphasising the necessity of their regulatory and policy-making role. The next section further recognises the influence of CE implementation through the 10R principles.

4.1.1 Stakeholder Influence on Implementing the 10R Principles of Circular Economy in the Sri Lankan Construction Industry

Respondents were asked to rate the influence of each stakeholder group for the 10R principles in 10 sections (Rethink–Recover) using a five-point Likert scale. Table 4 reflects the stakeholders' perceived influence on the implementation of each CE principle in the Sri Lankan construction industry.

As per Table 4, Architects/Designers rank first in most R principles, highlighting their strong influence in integrating CE strategies at the design stage. This emphasises their key role in embedding circular practices through sustainable design, modular construction, and efficient material selection. Almeida (2024), Senaratne et al. (2023), and Tleuken et al. (2022) also confirm that architects and designers recognise the need to incorporate R principles into designs at early stages.

As shown in Table 4, Suppliers/Manufacturers (RII = 0.832, Rank 2) show a strong influence in Repurpose, Reuse, and Recycle, reflecting their role in material sourcing and recycling. Construction Clients (RII = 0.784, Rank 4 overall) score highest in Refuse (0.822) and Reuse (0.827), reflecting a strong influence on procurement decisions. Contractors show a strong influence in Reuse (0.816) and Repair (0.827), due to their site-level responsibilities and ability to manage construction waste and material reuse.

Public and Statutory Authorities mainly influence regulatory areas such as Recycle and Remanufacture, rather than operational CE practices. Although Cost Consultants do not appear among the top five stakeholders for most principles, they still demonstrate significant influence (RII > 0.70) in nearly all principles, except for Repurpose and Remanufacture. Victar and Waidyasekara (2024) identified that integrating CE principles into construction leads to improvements in cost management, ensuring the influential role of Cost consultants. Subcontractors show relatively lower influence, while Finance Institutes and Consumers have limited but still notable influence (RII > 0.60).

Overall, Architects/Designers dominate early-stage and strategic planning CE principles, while Contractors and Manufacturers lead execution-based practices. In summary, Table 5 presents the five top-ranked most influential stakeholders in implementing each R principle in the Sri Lankan construction industry.

4.2 ANALYSIS OF INTERVIEW FINDINGS

Twelve professionals (Table 3) representing six key stakeholder categories, Architects/Designers, Suppliers/Manufacturers, Public and Statutory Authorities, Construction Clients, Contractors, and Cost Consultants, were interviewed.

4.2.1 Potential Roles of Stakeholders in Implementing The 10 R Principles in the Construction Industry

Figure 1 summarises the perspectives of the four highest-ranked stakeholder groups on their roles in CE implementation, based on insights from two interviewees from each group. The roles of Cost Consultants and Public & Statutory Authorities are broadly applicable across most R-principles and are therefore discussed separately.

A01 confirmed the feasibility of applying all CE principles and emphasised design flexibility, material minimisation, and reuse potential, highlighting *"integrating flexible design elements for future reuse and designing for material separation and energy* *recovery at end-of-life reflects a design approach considering whole building life"*. Similarly, A02 mentioned some practical design strategies and gave examples: *"open-plan flexibility and designing movable furniture or wall partitions enable layout adaptability"*. Their views on Rethink, Reuse, and Refuse highlight the critical role of designers in early decision-making towards long-term circular outcomes. They emphasised that effective CE implementation should begin at the design stage, with the support of clients and regulatory frameworks. Senaratne et al. (2023) and Tleuken et al. (2022) also recommended early design-phase integration of CE through design for disassembly (DfD) and modularity, contributing to Rethink, Reuse, and Refuse, while the Sri Lankan construction industry shows a more practical approach for architects and designers, emphasising material selection, cost considerations, and the gradual integration of CE into existing design practices (Figure 1).

SM01 and SM02 highlighted suppliers' and manufacturers' roles in CE by promoting several strategies (Figure 1). *"Use of fewer virgin materials and producing secondary products like pile covers, interlock tiles, and blocks are some methods we can adopt" [SM01]*. SM02 added, *"avoiding non-recyclable materials and reusing packaging like pallets is also possible"*. Almeida (2024) and Chen et al. (2022) also recognised the manufacturers and suppliers' roles in providing recyclable and low-carbon materials and in remanufacture, while this study identifies ways of utilising waste through manufacturers and suppliers and their involvement in Reduce. Literature (e.g., Almeida, 2024; Senaratne et al., 2023) has identified that Contractors play a key role in on-site CE by managing materials, waste, and labour, consistent with the study findings. Additionally, the study proposed strategies such as the use of ready-mix concrete, the reuse of crushed concrete, and take-back programs (Figure 1).

CL01 and CL02 highlighted clients' roles in CE (Figure 1), showing strategic oversight and influence. Importantly, CL01 focused on Rethink, saying, "*If we can encourage value engineering with CE in mind, it will be very effective",* while CL02 highlighted, "*We can review and reject designs that do not meet environmental expectations*." Further, they proposed setting KPIs for contractors to limit material use and mandating the reuse of waste materials such as asphalt millings and crushed concrete. These examples show the client's role as enablers of CE through the client's briefs and tender requirements. The broader strategic focus on the client role is identified in the literature (e.g., Acharya et al., 2018; Govindan & Hasanagic, 2018; Senaratne et al., 2023), while the study provides more practical, context-specific actions relevant to Sri Lanka.

The findings align with the literature on the role of statutory and regulatory frameworks (e.g., Almeida, 2024; Christensen, 2021; Govindan & Hasanagic, 2018). Interviewees from Statutory & Regulatory authorities (SR01, SR02) highlighted their role in CE by formulating regulations on waste minimisation and modular systems, banning unsustainable materials, regulating demolitions and facilitating market coordination via stakeholder registration. In addition, the findings provide more practical regulatory actions relevant to the Sri Lankan construction context. Further, Quantity Surveyors identified their role as a financial enabler of CE through value engineering, early cost planning, and life-cycle cost advice, helping to balance sustainability and financial feasibility. This influential CE role is not explicitly highlighted in the existing literature.

Table 4: Potential of stakeholder influence in implementing the 10R principles of the CE in the construction industry

R principle	**Rethink**		**Repurpose**		**Refuse**		**Reduce**		**Reuse**		**Repair**		**Refurbish**		**Re-manufacture**		**Recycle**		**Recover**	
Stakeholder group	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
Public & statutory Authorities	0.725	5	0.665	6	0.730	4	0.746	4	0.659	8	0.654	8	0.710	6	0.697	3	0.768	2	0.714	6
Construction Clients	0.838	2	0.719	3	0.822	1	0.778	2	0.827	1	0.757	4	0.773	2	0.714	2	0.768	2	0.735	3
Contractors	0.757	3	0.703	4	0.697	6	0.773	3	0.816	2	0.827	1	0.762	3	0.692	4	0.735	5	0.762	2
Subcontractors	0.730	6	0.670	5	0.654	9	0.719	7	0.762	5	0.768	2	0.676	8	0.681	6	0.735	5	0.703	7
Suppliers/ Manufacturers	0.735	4	0.746	2	0.757	3	0.708	5	0.816	2	0.762	3	0.757	4	0.692	4	0.822	1	0.719	4
Architects Designers	0.854	1	0.805	1	0.816	2	0.800	1	0.789	4	0.730	5	0.838	1	0.751	1	0.762	4	0.811	1
Cost consultant	0.703	7	0.665	6	0.703	5	0.730	6	0.719	7	0.719	6	0.719	5	0.665	7	0.708	7	0.719	4
Finance institutes	0.665	9	0.622	9	0.605	8	0.643	9	0.638	9	0.632	9	0.638	9	0.622	9	0.686	9	0.686	9
Consumers	0.670	8	0.659	8	0.654	7	0.746	8	0.741	6	0.708	7	0.708	7	0.654	8	0.697	8	0.697	8

Table 5: Five most influential stakeholders in implementing the 10R principles in the Sri Lankan construction industry

	Rethink	**Repurpose**	**Refuse**	**Reduce**	**Reuse**	**Repair**	**Refurbish**	**Re - manufacture**	**Recycle**	**Recover**
1	Architects Designers	Architects Designers	Construction Clients	Architects Designers	Construction Clients	Contractors	Architects Designers	Architects Designers	Suppliers/ Manufacturers	Architects Designers
2	Construction Clients	Suppliers/ Manufacturers	Architects Designers	Construction Clients	Contractors/ Suppliers/ Manufacturers	Subcontractors	Construction Clients	Construction Clients	Construction Clients/ Public & statutory Authorities	Contractors
3	Contractors	Construction Clients	Suppliers/ Manufacturers	Contractors		Suppliers/ Manufacturers	Contractors	Public & statutory Authorities		Construction Clients
4	Suppliers/ Manufacturers	Contractors	Public & statutory Authorities	Public & statutory Authorities	Architects Designers	Construction Clients	Suppliers/ Manufacturers	Contractors/ Suppliers/ Manufacturers	Architects Designers	Suppliers/ Manufacturers/ Cost consultant
5	Public & statutory Authorities	Subcontractors	Cost consultant	Suppliers/ Manufacturers	Subcontractors	Architects Designers	Cost consultant		Contractors/ Subcontractors	

Rethink		Repurpose		Refuse		Reduce		Reuse	
Repair		Refurbish		Remanufacture		Recycle		Recover	

Architects/Designers' Role	Suppliers/Manufacturers' Role	Contractors' Role	Construction Clients' Role
Integrate flexible & adaptable design layouts for future reuse. Apply passive design to reduce energy demand. Plan durable elements with retrofit potential.	Produce low-carbon concrete using fly ash, slag, and recycled aggregates. Optimise delivery logistics to reduce transport emissions.	Select multi-use materials. Plan logistics to reduce overuse & transport emissions.	Promote value engineering to optimise material use.
Enable reuse of leftover/surplus site materials.	Utilise waste concrete for products (curbs, tiles, pile covers).	Use packaging/off-cuts for temporary works or protection. Use crushed concrete for road base or temporary paths.	Accept the use of offcuts and demolition waste for other purposes
Avoid composite materials difficult to separate.	Avoid river sand and high-embodied-carbon materials like aluminium. Avoid supplying non-recyclable materials.	Avoid single-use, low-durability materials. Have supplier agreements to reduce non-recyclable items & overpackaging.	Reject high-waste or poor environmental designs/materials.
Minimise material use through efficient design.	Minimise the use of natural materials. Apply just-in-time delivery to reduce waste.	Use ready-mix concrete to minimise waste. Apply ERP systems, BIM, and lean practices to minimise over-ordering and reduce off-cuts.	Establish KPIs for contractors to minimise material use and emissions. Select efficient designs that avoid material duplication.
Include reusable components	Implement return schemes for excess materials. Encourage on-site reuse of pallets and packaging.	Participate in take-back schemes (scaffolding, timber, formwork). Salvage and reuse precast elements where possible.	Mandate the reuse of building components, where safe and possible.
Not mentioned a specific role	Promote maintenance practices	Repair tools & equipment instead of replacing. Establish in-house maintenance workshops.	Promote repair of machinery/ infrastructure over replacement.
Design building elements for refurbishment and reuse, and collaborate with suppliers to enable remanufacturing of building parts	Manufacture components for refurbishment and reuse across multiple projects.	Retrofit and reuse existing elements where feasible.	Prioritise refurbishment or widening instead of demolition.
Redesign elements for alternative uses after demolition.	Convert returned/rejected concrete into other possible products.	Send offcuts &excess for reprocessing	Accept the adoption of remanufactured steel and concrete components in new developments.
Specify recycled materials in design specs.	Recycle demolition into usable material for new production.	Segregate waste on-site. Send waste to registered recyclers.	Not mentioned a specific role
Design for material separation, energy recovery	Waste minimisation and material separation at source.	Direct non-reusable materials to energy recovery.	Encourage bio-waste energy recovery from site clearing.

Figure 1: Key roles of Most influential Stakeholders in CE implementation in the Sri Lankan Construction Industry

5. CONCLUSIONS

This study demonstrates that effective CE implementation in the Sri Lankan construction industry relies on the influence of multiple stakeholders. Six key stakeholder groups, namely architects/designers, suppliers/manufacturers, public/statutory authorities, clients/developers, contractors, and cost consultants, were found to be significantly influential, with RII values exceeding 0.7. Their influence on the 10R principles also demonstrates that Architects/Designers play a strong influential role in integrating CE strategies at the design stage. The key roles of the most influential stakeholders in implementing CE through the 10R principles were identified, emphasising that CE adoption is a shared responsibility across these stakeholders. This research contributes to the literature by providing a systematic assessment of stakeholder influence on the 10R principles in a developing country context and by offering a role-mapping for CE implementation in construction. The novelty lies in identifying emerging responsibilities towards CE implementation in practice.

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