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ADOPTING CIRCULAR ECONOMY PRACTICES IN MAJOR BUILDING MATERIALS AND ELEMENTS TO MINIMISE WASTE IN SRI LANKA

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ABSTRACT

Construction waste causes soil and water pollution, resulting in severe social and environmental concerns. Construction waste management systems in Sri Lanka are reactive and felt only when waste is generated. Hence, a proactive approach such as Circular Economy (CE) to minimising waste generation is required. The individual disposal of construction materials and elements contributes highly to construction waste in Sri Lanka, e.g., timber, bricks, doors, and windows. Therefore, applying CE practices concerning major building materials and elements is essential to minimise waste proactively. Thus, this study aims to guide the adoption of CE practices in major building materials and elements to minimise waste in the Sri Lankan context. A comprehensive literature review was conducted on the CE concept and its application to main building materials and elements. Using snowball sampling, ten experts fulfilling predefined criteria were selected and interviewed to collect qualitative data. The collected data were analysed using content analysis. Results show that current, material selection in Sri Lankan construction projects does not consider CE aspects. Current disposal practices include demolition and combusting while reusing and recycling are rarely used. The study recommended recycling, downcycling, cradle-to-cradle approach, material banks, and reduction to dispose of building materials and elements towards adopting the CE concept. CE can be implemented from the design stage to the whole life cycle, preferably initial stages, as an applicable practice to the Sri Lankan construction industry leading to minimising building materials and elements.

Keywords: *Building Elements; Circular Economy; Construction Materials; End of Life; Waste Management.*

1. INTRODUCTION

Construction and Demolition (C&D) waste consists of numerous materials including metals, plastic, timber, concrete, insulation materials, gypsum-based materials (Ghosh et al., 2016), PVC, and rubble (Elgizawy et al., 2016). Construction waste disposal causes

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soil and water pollution (Patil et al., 2021) and negatively affects a country's environment, costs, productivity, and society (Nagapan et al., 2011). Concerning the high amount of waste, an approach to re-use, remanufacture, and regenerate materials can be a prominent solution, which is why circularity concepts must be implemented (Liu et al., 2017).

CE concept reverses "make, use, dispose of," which generates a massive pile of waste in the current linear economy by creating a loop/circle as in nature (Ellen MacArthur Foundation [EMF], 2015). Hence, a Circular Economy (CE) model would be an excellent solution to maintain the generation of construction waste (Mangialardo & Micelli, 2018), which is to be implemented at the earlier stages of construction projects (Benachio et al., 2020). CE concept could be used in the planning and design stages for decision-making (Sanchez & Haas, 2018), which determines the requirement of re-using materials in higher percentages when the building is demolished at the end of its lifetime (Benachio et al., 2020).

The selection of building materials must be in line with the CE concept. Therefore, the designers must select the most appropriate materials (Antonini et al., 2020; Campbell, 2019). Those decisions are to be made at the planning stage, supporting the implementation of CE in the construction industry.

In the Sri Lankan context, construction material wastage is high during construction and demolition (Liyanage et al., 2019). As per the survey by Arsath et al. (2023), construction waste is generated due to activities such as discarded building materials, debris from renovations, and demolitions. Furthermore, Arsath et al. (2023) suggest incorporating the principles of Reduce, Reuse, and Recycle (3R) and innovative methods to mitigate this Construction and Demolition (C&D) waste. Although many research studies have been conducted worldwide to investigate how to adopt CE principles in building materials and elements (e.g. Mohammadiziazi & Bilec, 2023; Bertino et al., 2021), there is a dearth of studies in the Sri Lankan context. Accordingly, this research is mounting the research problem: "How CE practices can be adopted in building materials and elements to minimise C&D waste in the Sri Lankan Construction industry?" Thus, this study aims to guide the adoption of CE practices in major building materials and elements to minimise C&D waste in Sri Lanka.

2. LITERATURE REVIEW

2.1 MATERIAL WASTE IN THE CONSTRUCTION INDUSTRY

The construction sector generates almost one-third of all waste in developing countries (Eckelman et al., 2018). C&D waste varies depending on the type of construction activity (Gulghane & Khandve, 2015). It includes materials such as concrete, wood, bricks, tiles, glass, steel, metal, and roofing (Arsath et al., 2023). Berge (2007) stated that the contribution of construction materials to waste generation starts at primary levels, from raw material extraction to transformation, construction, and demolition. Building materials are disposed of in landfills after construction projects and the end of service life (Nasi et al., 2017).

Therefore, minimising material waste is the most appropriate way to reduce C&D waste generation. Arsath et al. (2023) suggest that selecting sustainable materials at the design and planning stage can significantly reduce waste. According to Eberhardt et al. (2022), such material selection is a prevalent method for implementing CE in buildings.

The Sri Lankan construction industry must focus on enhancing the transition towards a more resource-efficient and sustainable future with CE implementation (Weerakoon et al., 2023). However, the current waste management practices in Sri Lanka are primarily linear (Victar & Waidyasekara, 2023) due to construction professionals' lack of awareness of CE (Weerakoon et al., 2023). Therefore, Wijewansha et al. (2021) emphasised the requirement for more studies on CE implementation strategies in the Sri Lankan construction industry.

2.2 APPLYING CIRCULAR ECONOMY PRACTICES TO BUILDING MATERIALS AND ELEMENTS

"A CE is an economic system designed with the intention that maximum use is extracted from resources and minimum waste is generated for disposal" (Deutz, 2020. p.193). The CE concept is focused on changing the traditional pattern of "take-make-dispose" by keeping resources in use for more extended periods where waste is considered valuable input (EMF, 2015). Thus, the CE concept is focused on the circularity of resources while reducing waste (Stahel, 2019), minimising the extraction, and reducing the need for inefficient material extraction (Benachio et al., 2020). Schroeder et al. (2018) manifested that applying CE practices can accomplish many Sustainable Development Goals (SDGs). Hence, applying CE to the construction industry helps achieve sustainable construction and enhance performance (Núñez-Cacho et al., 2018).

The construction industry is the major buyer of resources (Stahel, 2019) and uses significant resources for which the CE concept can be adopted (Adams et al., 2017). However, construction materials end up as waste at the end of building life cycles (Adams et al., 2017). Therefore, CE implementation in the construction sector is necessary to reduce waste generation and disposal (Hossain & Ng, 2018). It focuses on the material supply chain and recovery of materials for direct reuse (Akinade & Oyedele, 2019). Hence, adopting CE can reduce the amount of extraction from resources, promoting reuse, reduction, recycling, upcycling, remanufacturing, and repair (Stahel, 2016), material banks (Manelius et al., 2019) and material passports (Copeland & Bilec, 2020). EMF (n.d) provided three major principles of CE i.e. (i) eliminate, (ii) circulate, and (iii) regenerate, where circulate refers to circulating the products and materials at their highest value.

Among many CE practices, reuse, reduce, repair, recycle, and recover have an immense potential to minimise material waste in the construction industry (Mancini et al., 2021). Table 1 gives the CE practices and their brief explanations per the literature.

Table 1: Circular economy practices

CE Practice	Explanation	Sources
Reuse	Using materials without any transformation	Vefago and Avellaneda (2013); EMF (2015).
Reduce	Minimise waste of product within its production and use phases	Kirchherr et al. (2017); Akenji et al. (2016).
Recycle	The process of reusing waste to create new products with equal qualities to their previous stage and fit for the same purpose again	Gao et al. (2001); Chini (2007)
Repair	Fixing or restructuring a product to its previous state	Kirchherr et al. (2017);
Recover	Recover material from waste	Akanbi et al. (2019)

C&D waste of building materials and components largely contributes to waste generation in the Sri Lankan context (Liyanage et al., 2019). However, effective C&D waste management, including construction materials and elements, is still lacking in developing countries including Sri Lanka (Arsath et al., 2023). CE principles allow more building products, elements, and materials to re-enter the supply chain by recovering them from waste (Bertino et al., 2021). Therefore, adopting CE principles in building materials and elements requires research study in the Sri Lankan construction industry.

3. RESEARCH METHODOLOGY

A literature review was conducted to identify the CE concept, CE principles, and its applicability to C&D waste management. The Sri Lankan construction industry is in the initial stages of implementing the CE concept (Weerakoon et al., 2023). Therefore, a quantitative approach cannot be used to collect the data due to many construction industry practitioners' lack of awareness of the concept, where selecting a reliable large sample was difficult. The primary goal of qualitative research is to investigate and understand the circumstances and experiences of individuals (Kumar & Shukla, 2022) while allowing researchers to participate actively in data collection (Creswell & Creswell, 2017). Therefore, a qualitative research approach was chosen for this study to collect qualitative data using semi-structured interviews with experts having both CE and C&D waste management knowledge and experience. This allowed the researcher to obtain precise data on CE principles and C&D waste management, focusing on building materials and elements while acquiring any additional data that emerged during interviews. Accordingly, 15 experts with CE and waste management experience were selected for the interviews. Due to the saturation of data, only Ten expert interviews were conducted to collect data. Finding professionals who are aware of CE was challenging; therefore, the snowball sampling technique was used to select building construction experts for interviews, fulfilling the criteria shown in Table 2.

Table 2: Selection criteria of interviewed experts

Code	R1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R10
Designation	**Project Manager**	**Quantity Surveyor**	**Quantity Surveyor**	**Architect**	**Quantity Surveyor**	**Civil Engineer**	**Architect**	**Quantity Surveyor**	**Quantity Surveyor**	**Project manager**
Having more than 5 years of experience	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Construction-related reputed professionals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Graduated in a construction-related degree	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Working at reputed organisations	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Verbal interview data were audio-recorded with the interviewees' consent and transcribed to textual data. The qualitative data gathered in this study were analysed using the 'Content Analysis' method, which makes systematic, credible, valid, and replicable inferences from text (Drisko & Maschi, 2016).

4. RESEARCH FINDINGS AND DISCUSSION

Due to time constraints, this study was limited to a few building materials, elements, and CE principles for collecting data. Accordingly, concrete, wood, and steel were identified as three major materials that are commonly used in building structures in the Sri Lankan context. Altogether, four building elements were identified i.e., (i) columns and beams, (ii) roofs, (iii) walls, and (iv) floors, considering them as main elements related to building envelopes. Moreover, six CE practices were selected i.e. (i) recovered, (ii) reused, (iii) designed for disassembly, (iv) recycled, (v) repaired, and (vi) reduced to conduct the interview.

4.1 ASPECTS CONSIDERED IN THE CURRENT CONSTRUCTION MATERIAL SELECTION PROCESS: CONCRETE, STEEL AND WOOD

The current considerations in selecting construction materials, specifically concrete, steel, and wood, for a construction project are demonstrated in Table 3.

Table 3: Current material selection aspects

Material Selection Aspects	Concrete	Steel	Wood
Cost/ Price	R1, R2, R3, R4, R6, R7, R8, R9	R1, R2, R5, R7, R8	R1, R2, R6, R7, R10
Suitability to environment/ Green credentials	RI, R4		R5
Design lifetime	R1, R5	R1	
Strength (Grade)	R2, R3, R4, R5, R7, R8, R10	R2, R3, R4, R5, R6, R7, R9	R3, R4
Workability	R2, R3, R6		
Brand/Quality	R2	R2	R6
Fire resistance	R3		
Approval requirements	R4		
Durability	R8, R9		R2, R10
Familiarity	R8, R10	R3	R9
Exposed conditions		R1	
Flexibility/ Versatility		R3, R10	R3
Availability of workmanship		R4, R5, R6	
Fast construction		R5	
Functionality		R8	
Aesthetical view			R1, R4, R5, R8, R9
Blending to location			R1, R8
Use/Purpose			R6
Natural Experience			R5
Availability			R1, R2, R3, R7, R9

As per Table 3, interviewees mentioned several aspects they currently consider when selecting concrete, steel, and wood for construction. Accordingly, most experts consider cost and strength when selecting concrete and steel since these materials are mostly used for structural purposes. On the other hand, cost, aesthetic view, and availability are the most concerning factors when selecting wood. However, experts rarely consider CE-related aspects, such as reusability and recyclability, in the current material selection process.

4.2 CONSIDERATION OF THE END-OF-LIFE (EOL) OF A BUILDING WHEN SELECTING MATERIALS AT THE DESIGN AND CONSTRUCTION STAGE

As per all the interviewees, in the Sri Lankan context, mild attention is given to the building's EOL at its design and construction stage. The interviewed experts explored the reasons behind this, as shown in Figure 1.

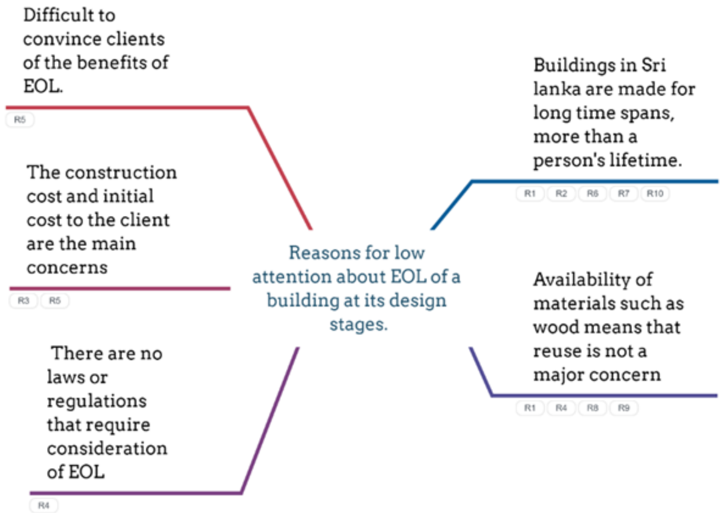

Figure 1: Reasons for low attention on EOL of a building at its design stages

As per findings, although steel and wood are sometimes reused at the EOL of buildings, their reusability is not considered at the design stage. Further, R1 mentioned, "*concrete structures are made for long periods; in Sri Lanka, we cannot have such long-term plans and predictions*". In line with that, R8 stated that due to the long-life span of buildings, EOL is less considered by builders and clients. R5, R6, R7 and R10 supported the argument that the EOL of a building may not come within the Client's lifetime. Thus, it is not considered at the designing stage. R5 explained that even though professionals consider EOL, it is difficult to convince its benefits to clients. On the other hand, R3 said, *"We still give little regard for EOL; we are mainly concerned with the initial cost".* R4 stated that though materials from buildings can be reused and recycled to some extent, it is not a significant concern at the design stage. R8 added, "*Now, builders give a certain consideration to the EOL of a building due to some policies, but still, they are not self-motivated to do so".*

4.3 DISPOSAL OPTIONS OF ELEMENTS IN PRACTICE

According to current practice, the interviewees were asked about the disposal techniques used in the construction industry to dispose of selected building elements made of selected materials.

Table 4 gives experts' responses on the disposal methods of major building elements based on the material used to construct the respective building element.

Table 4: Disposal of major building elements

	Disposal Options in Current Practice

Building Element	Building Material	Demolish	Combustion	Reuse	Recycle	Recover
Columns & Beams	Concrete	All		R3		
	Steel			R3, R5, R7, R8	R3, R5, R10	
	Wood		R4, R5	R5, R9		R5
Roof	Concrete	All				
	Steel			R3	R3	
	Wood		R5, R6	R1, R2, R5		R5
Walls	Concrete	R1, R2, R4, R5, R6				
	Wood		R5, R6	R3, R5, R10	R9	R5
	Brick/Block	R1, R2, R5, R9	R5	R3		
Floors	Concrete	R1, R3, R5, R7, R9				
	Steel			R5	R5	
	Wood		R6, R10	R5, R9		R5

As per Table 4, all the respondents stated that concrete columns and beams are landfilled after demolition because the reusability of concrete is questionable. However, R3 noted, *"Sometimes precast decorated concrete columns are disassembled and fixed in structures only for aesthetical appearance*". Similarly, the reuse of steel columns and beams in Sri Lanka is mostly limited to steel fixtures due to the lack of design for disassembly practices [R8].

All the respondents opined that concrete flat roofs are demolished and landfilled (refer to Table 4). As per R1, most wooden rafters and purlins are reused. R2 and R5 mentioned that roof tiles and asbestos are reused, and gypsum boards are sometimes recycled.

As shown in Table 4, many interviewees stated that concrete-made, cement block-made walls are demolished and landfilled in the current practice. R2 said, *"Practically, reusing cement blocks is very difficult because we do not have the technology to separate them"*. In addition, R3 highlighted, *"Bricks can be reused more than blocks. However, the plaster cannot be reused."* On the other hand, R9 said, *"Sometimes internal walls can be made of timber partitions, which can be reused or recycled"*.

The fourth major building element considered for the study is floors. R6 said, *"After a long use, wooden floor finishes cannot be easily used for any purpose; therefore, combustion is the option"*. However, R9 argued, *"Most of the timber planks used in floors can be reused because usually very quality wood is used for flooring". R4 said, "Wood combustion is a good option if we use the energy it generates"*.

4.4 APPLY CIRCULAR ECONOMY PRACTICES FOR BUILDING MATERIALS AND ELEMENTS

Table 5 illustrates the suggestions given by respondents regarding disposal options of certain materials and elements instead of current practice. In addition, the table consists of the areas to improve, considering CE practice to minimise waste.

Table 5: Disposal options found empirically

Suggested Option related to CE practice	Experts highlighted	Example(s) mentioned
Use of reusable and flexible building elements	R1, R5, R6	Internal walls and partitions
Have short-life span buildings with flexible design	R2, R4, R6, R7	Reuse columns, beams and wall panels
Design buildings based on reused and recycled materials and elements	R1, R3, R8	Reuse columns, beams, roof tiles, wall bricks, doors, and windows. Design buildings to give an antique look
Use building elements or materials to get at least a lower value from them	R2, R4, R7	Use concrete and wood waste for landscaping, roads, walking paths
Demolish with minimum waste and maximise reusability	R3, R6, R8, R9, R10	Demolish brick walls carefully to reuse bricks, roofs to reuse roof tiles and timber members. Steel members.
After-sale service from suppliers/ manufacturers and suppliers. Return to manufacturers after use for recycling or reproduction.	R3	Wall panels, roofing sheets, steel

Interviewees described that Sri Lankans are used to constructing buildings that last longer than they need to; however, their needs change as the generations change. Therefore, R2 stated that buildings with 20-25 years of life span are enough. "*The design should have the flexibility to be easily redesigned. The use of heavy-duty materials is not necessary*". [R2]. Therefore, the waste generated through the lifetime of a building will be less in short-life-span buildings with flexible designs where assembly and disassembly are easy.

R3 suggested obtaining after-sales services from suppliers who provide technical support and awareness on maintaining and recycling, sometimes buying old stock. Moreover, R3 emphasised encouraging builders and clients to finalise their designs using reused/ recycled materials without using virgin materials. This concept can be incorporated among contractors of government projects to use materials recovered from other projects.

R6 stated that current disposal options need less waste generative, *"the most preferred option for concrete is demolishing because it is hard to reuse, but if we can demolish with minimum waste and landfill, it is still a better option*". R4 believes that concrete structures could be crushed and used as the aggregate for road fillings. The remaining crushed concrete particles could be used to fill walking paths. Further, R4 stated*, "If the wood is not treated, then wood can be used as compost, and sometimes wood can be downcycled to particles and used as a landscaping material, for example, in children's parks"*.

R3 accused, *"The problem is that the current buildings are not designed to be deconstructed and are constructed to demolish. If disassembly is available, you can take out the parts to reuse. However, in Sri Lanka, even the rebars are not reused"*. R8 said that in other countries, satisfying with minimum resources is practice. However, we still do not have that ideology in Sri Lanka. R9 stated, *"There are material surveyors in other* *countries to estimate exact material requirements avoiding overconsumption and waste. Therefore, Sri Lanka also needs material surveyors as a profession".*

4.5 IMPLEMENTING CE PRACTICES IN THE SRI LANKAN CONSTRUCTION INDUSTRY

All respondents emphasised the need know the concept for its proper application. As per the findings, the practical use of CE is problematic since the clients and society are unaware of the CE concept. Therefore, the CE concept must be taught at schools, and the syllabuses must be updated to acknowledge society. R3 said, *"Whether we like it or not, we have to do it since the world is moving towards CE"*. Furthermore, to apply this CE concept in Sri Lanka, "*firstly we have to do it by heart and have the mindset to do it, and secondly, government regulations and mandatory curriculum must be implemented, thirdly particular incentives to be given for practising, formal accreditors, certificates like LEEDS certificates must be given and finally tax concession for practising resource-saving concepts*" [R3].

R4. R6 and R7 also responded positively to CE in Sri Lanka. R4 said, "*CE can be applied at any stage of a project lifecycle and get benefits*". R4 further explained that the applicability of CE does not depend on the geographical area, and it considers the availability of certain alternative materials. As per R7, the availability of technology for enhanced recycling is questionable in Sri Lanka. R8 said, "*CE should be implemented in every country; even though there are technology-related limitations, we can start from the material selection process*". On the other hand, R5 said, "*We have not been using many material-saving concepts, which require necessary rules and regulations*". Due to the economic crisis, Sri Lanka has restricted the importation of building materials including steel, cement, and tiles. Therefore, the findings highlighted that the Sri Lankan construction industry could have benefited if CE practices of reusing, reducing, and recycling had been considered for building materials and elements during that period. In conclusion, all the respondents were positive about implementing CE in the Sri Lankan context, especially in selecting building materials and designing building elements.

4.6 INITIATION OF IMPLEMENTING CE PRACTICE FOR BUILDING MATERIALS AND ELEMENTS IN SRI LANKA

Interviewees were further asked their opinion on the initiation steps that should be taken to implement CE practices relating to building materials and elements in the Sri Lankan context. R1, R2 and R5 suggested applying the CE concept to building materials and elements in public sector projects. R1 mentioned, *"Government can commence applying CE concept in public projects, where they can promote using recycled materials and elements"*. R5 added, *"Government projects can be advised to use reusable materials and elements from other demolished buildings, thereby reducing the cost"*. R10 proposed that this can be enhanced by having a policy framework in the government and enforcing regulations. R8 urged, "*government has to enforce strict regulations for demolition of buildings restricting demolishing buildings as a whole"*. R8 added, *"This will allow demolitions to be done carefully, saving materials and elements as much as possible for reuse*". R6 proposed developing a separate specialisation for contractors named 'demolition contractors.

R2, R4, and R7 emphasised the need for public awareness programmes regarding reusable and recycled materials and elements and their use. R7 highlighted, *"We can promote the* *use of reusable and recycled materials and elements among the public by using marketable terms like 'antiques"*. R4 suggested promoting the establishment of material banks in the Sri Lankan construction industry, where regulatory authorities like the Construction Industry Development Authority (CIDA) can be involved.

5. DISCUSSION

The study findings disclosed that the current building material selection process and element design in the Sri Lankan construction industry do not concern CE practices including reducing, reusing, recycling, and designing for disassembly. Experts argued that attention to the EOL of buildings is required at these stages to minimise C&D waste of building materials and elements. However, there is low attention paid to the EOL of buildings in the material selection process due to the long building life span in Sri Lanka, clients' preference for initial cost, and the absence of related laws and regulations. Research studies by Akinade et al. (2019), Hart et al. (2019), Hossain et al. (2020), Kanters (2020), and Rakhshan et al. (2020) identified a lack of consideration of EOL issues in materials selection as a barrier for CE implementation in building materials and elements which is affected by an unwillingness by the client, and lack of regulations.

The study's findings suggest that building design and material selection are required to minimise C&D waste. Considering this, Rahla et al. (2021) identified *"recycled and recovered content from the buildings which reaches the EOL"* as the first significant CE criteria for material selection. Moreover, Zoghi et al. (2022) emphasised the need to choose construction materials that make the reusability and recyclability of building components. Similarly, Schiller et al. (2019) identified design for disassembly as a branch of reuse that can be applied to building elements including walls, columns, and beams. In line with that, Cooper et al. (2021) also identified the design requirement to emphasise reducing waste.

The literature emphasises the importance of reusing building materials and elements and reducing the use of virgin materials in construction to minimise C&D waste and protect the environment (Stahel et al., 2019; Vefago & Avellaneda, 2013). This study suggests designing based on reused materials as much as possible to apply CE principles to building elements and materials.

Findings mentioned the method of downcycling for applying CE to building materials and elements, a concern in literature for decades (e.g., by Gao et al., 2001). The cradle-to-cradle approach and closed-loop supply chain management are introduced in literature (e.g., Braungart & McDonough, 2002), which reclaims products by nature or returns them as another product when they are no longer used. Experts also proposed this approach when disposing of building materials and elements.

Accordingly, the literature review identifies disposal options for building materials and elements related to CE practices, which need to be applied in the Sri Lankan construction industry to reduce C&D waste of building materials and elements.

6. CONCLUSIONS

Circular Economy (CE) is a widely accepted concept focused on circulating materials in loops, maximising their use, and generating minimum waste. The CE practices were identified as reuse, reduce, recycle, repair, recover, design for disassembly, material bank concept and material passports. The study was limited to building materials concrete, steel, wood, and building elements: columns and beams, roofs, walls, and floors to adapt the CE concept. The selection aspects of major building materials identified are unrelated to Sri Lankan CE practices. The disposal practices used in the current practice were identified for the building elements columns and beams, roof, wall, and floor. All the concrete elements are demolished in the current practice, and wood is combusted. Landfills with materials are highly used, while reuse and recycling are rarely used in the Sri Lankan context.

CE is identified as an ideal concept to be implemented for building materials and elements to reduce C&D waste in the Sri Lankan construction industry. The research found that since CE supports the circularity of materials within the country, it reduces the need for imports, which is very beneficial during situations such as economic crises where imports are restricted. It is identified that the main steps should be taken at the material selection and element design stages to enable most of the CE practices including reuse and recycling at the EOL. The study identified reusing, recycling, downcycling, and cradle-to-cradle approaches to be implemented in the Sri Lankan construction industry with building elements and materials to reduce C&D waste. Further, to minimise waste in the Sri Lankan construction industry, flexible design enabling disassembly, a short span of buildings, after-sales services from suppliers, encouragement from contractors and clients, and the use of materials recovered from other projects were proposed.

Accordingly, this study investigated from a qualitative, in-depth perspective how CE practices can be adopted in building materials and elements to minimise C&D waste in the Sri Lankan construction industry.

This study contributes to the body of knowledge by outlining certain CE practices that could be implemented at a building's EOL as disposal options for building materials and elements. Further, the study offers a guide to initiate the implementation of CE for building materials and elements in Sri Lanka. Establishing material banks, enforcing strict regulations for demolition works, raising public awareness, and developing separate specialisations for demolition contractors are strategies to initiate the implementation of the CE concept for building materials and elements in the Sri Lankan construction industry. Further, this study would contribute to developing a sustainable nation in this wide society by proposing ways to minimise the waste generated from construction and demolition.

The study addressed CE practices for specific materials and elements in building construction. It focused on CE implementation in the Sri Lankan construction industry. However, the research findings can also be extended to other contexts matching similar settings.

Further studies can be carried out to investigate the adoption of CE practices for other building materials and elements to make the globe sustainable for future generations.

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