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Analyzing the Contribution of Green Buildings Towards Circular Economy in Sri Lanka

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Abstract

The circular economy concept is crucial in moving forward with sustainable development in any country. It has been identified that implementing CE (Circular Economy) in the built environment has various benefits towards the environment, society as well as the economy. Although this approach has various benefits, its implementation in Sri Lanka is still at a premature stage. Green rating systems are used to qualitatively assess the building's performance regarding sustainability aspects of the built environment. It remains unclear whether green rating systems in Sri Lanka provide an appropriate guide towards implementing the CE concept. Hence, this paper aims to analyze the contribution provided by green ratings in Sri Lanka towards the implementation of CE. Two pilot case studies and semi-structured interviews were carried out among industry experts who have hands-on experience in green rating systems and work experience in green building projects. Findings indicate that Green building projects have implemented various kinds of sustainable features to obtain a rating. Nevertheless, the practice of these features are not adequately reflecting the implementation CE concept due to numerous barriers to implement CE in Sri Lankan context. The study concludes that in Sri Lanka, the green rating system does not adequately contribute towards the implementation of CE.

Keywords
Circular Economy, Green Ratings, GREEN^{SL}, Sri Lanka, Construction Industry

1 Introduction

Sustainable construction (SC) practices have been rapidly increasing worldwide in recent years due to the unsustainable activities of humankind (Lima et al. 2021). As a model to move more toward a sustainable construction industry, Circular Economy (CE) concept has been promoted, which is defined as "a regenerative system that aims to keep materials in a closed loop at their highest value" (EMF 2015). Anastasiades et al. (2020) have also identified CE as a bridge toward a sustainable construction industry. The sustainability assessment tools were introduced to evaluate buildings' performance and to take into account sustainability aspects, reduce damage to the environment and encourage investors and facilities managers to improve buildings' performance by observing environmentally friendly procedures (Waer & Sibley 2005). In Sri Lanka, the construction industry is regarded as an essential indicator of economic growth (Rathnasinghe et al. 2020); on the other hand, it generates a considerable amount of waste due to the excess use of materials in various means (Osmani 2011; Rameezdeen et al. 2004; Zhao et al. 2020). Developing countries have a huge demand for sustainable construction practices (Alsanad 2015).

The demand towards Sri Lanka's SC is high, but Sri Lanka needs to adequately incorporate SC practices (Jayalath & Gunawardhana 2017). In the context of SC practice, even in Sri Lanka, various researchers have dealt with the application of CE concepts (Atapattu et al. 2022; Wanaguru et al. 2022); although it is still a new concept, the industry's adaptability is poor (Liyanage et al. 2019). Consequently, the need to adopt the CE concept in Sri Lanka's construction

industry still exists. Green Building Council Sri Lanka has introduced the GREEN^{SL} rating system to encourage green building practices (Weerasinghe & Ramachandra 2018).

This paper presents a brief literature review on Circular Economy in Built Environment and sustainable development. The methodology adopted is then presented, followed by the findings of case studies and semi-structured interviews, which had been analyzed in depth in terms of the adoption of CE practices within green rating systems in Sri Lanka.

Literature Review

Construction Industry

The construction industry can be considered as one of the significant contributors to uplifting the three-dimensional aspects, which are; the environment, economic and social of a developed or developing country (Rajabi et al. 2022). On the other hand, this industry is one of the largest natural resource utilisers due to its liner economic-based model, "take, make, dispose," which has been practiced for decades (Zu Castell-Rüdenhausen et al. 2021). Due to the linear approach, resources used for construction become obsolete once the life cycle is over (Benachio et al. 2020), leading to environmental degradation (Nakic 2018). Further, the construction sector accounts for 30% of global CO2 emissions and between 45 – 65% of the waste deposited in landfills (Nakic 2018). The sustainable construction industry plays an essential role in balancing human needs by providing a safe, healthy, and physiologically comfortable building environment, ultimately improving human satisfaction and productivity (Sev 2009). Novel concepts are being used in the industry to move towards sustainable construction practices, such as Lean, Nature-Based Solutions and Circular Economy (Soharu et al. 2021).

Circular Economy

The model of a circular economy grew out of concepts from the 1970s, including the Rome Club's "growth limits" theory (1972), the concepts of Braungart and McDonough's "cradle to cradle", the performance economy of Stahel, and the regenerative design model of Lyle(ARUP 2016). There is no unique definition for CE (Del Baldo & D'Anghela, 2020). Different researchers have defined the CE concept in various ways, as shown in Table 1.

Table 1. CE Definitions

Definition	References
"The efficiency of resource cycling in the natural environment"	Frankel, (1996)
"Closed resource loop"	Stahel., Reday-Mulvey, & Reday-Mulvey, (1981)
"reducing, reusing and recycling activities conducted in the process of production, circulation and consumption."	The Republic of China, (2008), Akanbi et al., (2018)
"an industrial system that restorative, regenerative and seeks to keep products, components, and materials at their highest level of utility and value."	EMF (2015, p. 9), Yuan et al. (2008, p. 4), Geissdoerfer et al. (2017, p. 759), Ellen MacArthur Foundation (2013)
"It entails activities that both support economic growth and facilitate the closing of material loops and the overall promotion of resource efficiency."	Fernández (2007)
"It is a new model of economic development that promotes the maximum reuse/ recycling of materials, goods and components in order to decrease waste."	Ghisellini et al., (2018)
"CE is a road map to a more sustainable economy."	Anastasiades et al., (2020)
"An alternative approach to the traditional linear model"	Lieder & Rashid, (2016, p. 36)
"Optimisation at the end-of-life of buildings, such as by maintaining and reusing durable components"	Addis, W., & Schouten, (2004)

Among the several definitions listed in Table 1, this paper considers Circular Economy as "an industrial economy that is restorative or regenerative by intention and design" as it has been framed by (EMF, 2015, p. 9) as the most renowned definition. CE core principles are mainly based on different R frameworks ranging from 3R to 10R (Kirchherr et al., 2017). Among these frameworks, 3R (Reduce-Reuse-Recycle) is the most fundamental in the CE principle (Brennan et al., 2015). Besides the above definitions, CE can be defined as a broad concept not only based on resource and waste management(Stewart & Niero 2018) but also as a wider economic through material recycling (Purchase et al. 2021) .The CE model ensures a different view of the interaction between the economy, the environment and society, and when implemented, it will help create a more unified system (Rizos et al. 2015). According to Stoyanova (2019), the circular economy provides the potential to rethink the current economy and enhance its sustainability and competitiveness. This enhancement would benefit both the public and industrial sectors.

Implementation of CE in the built environment

Circular Economy Framework

In the direction of the implementation of CE, many frameworks have been introduced by different researchers (Kristoffersen et al. 2020; Lewandowski 2016), in particular, the framework introduced by the EMF, shown in Figure 1, has been discussed by many researchers (Lüdeke-Freund et al. 2019)

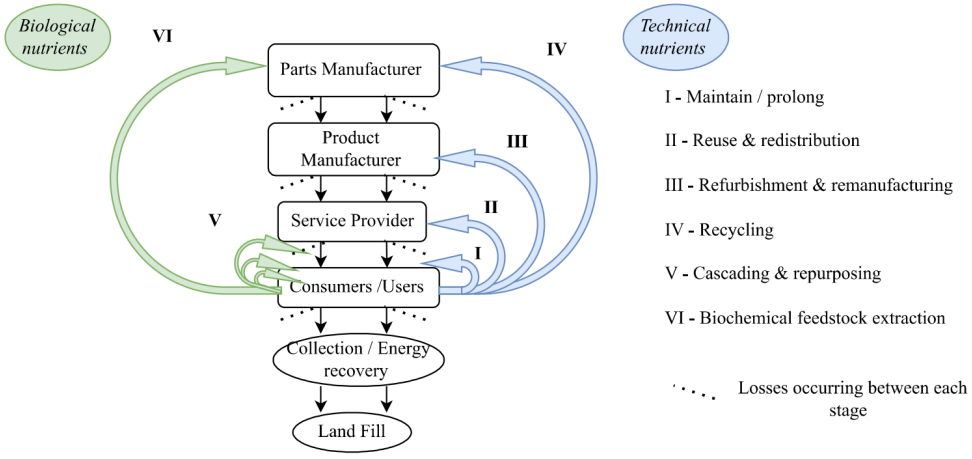

Figure 1. CE Framework

Adopted from (EMF, 2015)

Despite numerous variations, the CE framework focuses on better resource management through rejection, reconsideration and reduction of unnecessary consumption behavior (Potting et al. 2017). Moreover, the framework's ultimate objective is to keep materials and resources circulating at the highest value within. This confines the globe to prevent the need for more natural resources to make commodities and ensures that disposed of materials are not considered waste (Cheshire 2019; Potting et al. 2017). Simultaneously, Guerra et al. (2021) highlight that CE is a better economic model for any industry which extracts natural resources since the cost of natural resources is high due to their scarcity. Despite several models of implementing CE in the general business background, only a few frameworks are available for implementing CE in Built Environment (Hossain et al. 2020).

Barriers to implement CE in the built environment

CE concept has been discussed widely in academia; nevertheless, the implementation of CE remains limited (Masi et al. 2017). Numerous issues plague the construction industry (CI), including its nonlinear economy and lack of financial support (Yu et al. 2021, Tokazhanov, Galiyev, Lukyanenko, Nauyryzbay, Binder et al. 2022, Hossain et al. 2020, Adams et al. 2017), inadequate technology & unhelpful infrastructure for application (Benachio et al. 2020, Tokazhanov et al. 2022, Adams et al. 2017) and lack of governmental commitment to sustainable development (Guerra & Leite 2021), lack of policy and regulations (Tokazhanov, Galiyev, Lukyanenko, Nauyryzbay, Binder et al. 2022, Adams et al. 2017) and lack of understanding and awareness on CE information (Meath et al. 2022, Superti et al. 2021, Adams et al. 2017, Purchase et al. 2021). The complexity of CI is due to uncertainties, fluctuations in raw material prices, material shortages, demand growth, urbanisation, climate change, lack of waste management infrastructure and inappropriate recycling methods(Joensuu et al. 2020).

Implementing CE principles in CI reduces industry costs and adverse environmental effects, makes urban areas more livable, productive and convenient, and helps deal with these processes' complexity (Ghisellini et al. 2016). There needs to be more agreement on the concept of CE due to the absence of knowledge on implementing CE in the construction sector (Eberhardt et al. 2019). Further, the main challenges of implementing CE in the construction sector are the high complexity of the supply chain and the focus on short-term goals, which create competition between stakeholders instead of the collaboration needed for the CE concept (Eberhardt et al. 2019). However, the absence of adequate methods for assessing the sustainability of the economy provided by the circular economy principles is evident worldwide.

Achieving sustainability in the Built Environment

In 1997 (Elkingto 1998), Elkington invented the phrase "Triple Bottom Line" (TBL), which stands for "People, Planet, and Profit," and it has since gained popularity throughout the world. Based on three crucial aspects of sustainable development—environmental quality, social equality, and economic benefits—the Triple Bottom Line model has established the fundamental elements of long-term strategies for businesses switching to sustainability. Figure 2 illustrates the two variations of the Triple Bottom Line model.

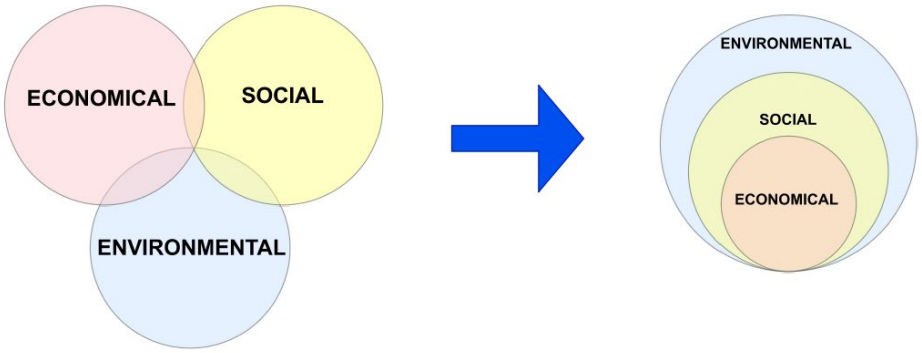

Figure 2. Triple Bottom Line (Ring Model Vs Nested Model)

According to Bazan (1997) and Rees (1995), the nested model in the triple bottom line had introduced as a corrective model for the "3 ring model" with prioritising the environmental factor. Further, Ndah (2014) confirms this argument asserting that in any area, economic and social development endeavors must be nested within the limits of the environmental carrying capacity because human life itself depends on the environment. Green rating tools are introduced to measure and maintain the sustainability aspects of the built environment. In the global text, several tools such as Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), Comprehensive Assessment System for Built Environment Efficiency (CASBEE), and Green Star New Zealand (Green Star NZ) (Doan et al. 2017). GREEN^{SL} rating system is one of the rating systems practised in Sri Lanka (Denagama 2019).

Several building evaluation tools focus on diverse areas of sustainable development Fowler & Rauch (2006). Life cycle assessment, life cycle costing, energy systems design, performance evaluation, productivity analysis, indoor environmental quality assessments, operations and maintenance optimisation, whole building design, and operations tools are some of these tools (Waidyasekara & Silva 2013). In addition, Ali & Al Nsairat (2009) has divided these assessment tools into criteria-based systems and the life cycle assessment (LCA) method, where green rating systems come under criteria-based systems. To address the environmental, social and economic challenges facing the country and the construction industry, Sustainable Construction Practices (SCP) have been identified and practiced in the industry (Villoria Saez et al. 2013). Green rating tools are being used to evaluate the SCP throughout a building project's life cycle, enabling it to transmit towards sustainable development in terms of social, economic and environmental perspectives (Braulio-Gonzalo et al. 2022). Wijewansha et al. (2021) asserted that the acknowledgement of circularity principles in the Sri Lankan construction industry is currently at a primitive phase. The Green Building concept is also an upcoming trend in the Sri Lankan construction industry.

Research Methodology

This research adopts a qualitative approach. Initially, a comprehensive literature review was conducted to gather knowledge on the concepts related to the sustainable construction industry, CE principles and green rating systems.

A pilot study was conducted to analyze the extent to which the CE concepts are incorporated within the green rating system in Sri Lanka. Two case studies were conducted for the pilot study, followed by expert interviews. Desk study and semi-structured interviews formed the main data collection techniques. Pilot case studies were conducted to identify the strategies implemented to obtain a green rating. Two projects were selected from Sri Lanka and the UK, which have gained platinum ratings using GREEN^{SL} rating system for built environment GREEN^{SL} and LEED, respectively. The two rating systems GREEN^{SL} and LEED have more similarities than differences, hence comparable to each other (Denagama 2019). Two projects from different countries were selected to facilitate a comparative study

of the sustainability features used in the selected projects. The features identified were further analysed to map with the CE principles.

Additionally, seven pilot interviews were carried out with experts to discuss the industry's perception of the CE concept within green practices and rating systems. Industry experts who have either worked or have sufficient knowledge of GREEN rating systems have been selected. The purposes of conducting the pilot interviews were to identify the extent to which green practices are followed and to know the level of awareness of the CE principles within the Sri Lankan construction industry. The number of interviews was limited to seven due to data saturation, according to the "saturation" concept; In qualitative research, the point at which incoming data does not provide any new facts - is accepted as a benchmark for defining sample size (Guest et al. 2006; Guest & MacQueen 2008). Comparative analysis and content analysis were carried out to analyze the primary data collected through case studies and expert interviews, respectively.

1 Analysis, Findings and Discussion

1.1 Comparative Analysis of Case Studies

Case study 01 is a completed Apartment Building in Sri Lanka located in Galle and has received Platinum status from the GREEN^{SL} rating system. The major sustainable features of this case study are water efficiency and waste management. Concerning the water efficiency feature, approved plumbing accessories with low flow and natural water (spring water) for construction have been considered. These aspects are relevant to the CE principle 'Reduce'. Re-selling waste materials and using them for landfilling as a material for new products (e.g., durra panels, fly ash in cement, and lightweight blocks) were carried out to implement the waste management feature in this case study.

Case study 02 is a completed Exhibition Centre located in the UK and obtained the Platinum category in the LEED rating system. The major sustainable features used in this project were; a) building intelligence - which controls all the Mechanical & Electrical (M&E) systems of the building using 3,500 data points, b) heating and cooling - with the use of 100% natural heat sources; around 60% of outgoing heat or cooling energy is recovered, c) light and ventilation - using self-shading with high-performance solar glass, d) water – with the concept rainwater harvesting and black water treatments and used for flushing systems and irrigation, and e) energy – with the use of solar photovoltaic roof panels. Also, this project is known as the most sustainable building in the world (Siemens 2015).

Table 2. Comparative Analysis of case studies

CE Model	Case study 01	Case study 02
Reduce	• Use of approved plumbing accessories with low flow. • Use of natural water (spring water) for construction	• Building Energy Management System (BEMS), which controls all the M &E systems of the building using 3,500 data points • Self-shading glass
Reuse	• 100% concrete waste used for land fillings • Another demolition waste is used for new products such as durra panels, fly ash in cement, and lightweight blocks.	• Use of high-performance solar glass • Rainwater harvesting and black water treatments and used for flushing systems and irrigation
Recycle	• During the operational stage, biodegradable waste will be composted soil using a compost machine.	• Use 100% natural heat sources; around 60% of outgoing heat or cooling energy is recovered. • Use of solar photovoltaic roof panels

Table 2 presents the sustainable features used within the selected case studies and maps such features with the three key CE principles such as Reduce, Reuse and Recycle. When comparing Case study 01 with Case study 02, there are some significant differences between the policies used and priorities given for sustainable aspects, where the latter gives comparatively higher considerations for sustainable aspects than the former. These are briefly discussed below.

Case study 01, which is one of the latest projects to obtain the Platinum category in the GREEN^{SL} rating system, has used landfilling as a policy for waste management. In Sri Lanka, landfilling has been used to effectively manage Municipal Solid Waste (MSW) for over 30 years. On the contrary Vaverková (2019) claimed that even though landfill, has been used for years as a method for MSW Management, it has become a significant threat to the environment due to various effects which have happened over the years. In agreement, Marasinghe et al. (2019) have highlighted that in Sri Lanka currently, landfilling has caused significant environmental pollution factors. These facts confirm that

using landfilling as a waste management policy cannot be sustainable anymore. According to the observations and discussions during the case study, the respondents of this project highlighted that the main reason for following these unsustainable policies are due to financial limitations. Additionally, a waste collection point at the operational stage of this project was established, and a compost-generating machine that can be used for bio-degradable materials was installed in the project.

As a country advantageously located near the equator, Sri Lanka is rich with sunlight throughout the year, specifically in coastal areas, creating a great potential for solar energy as a key energy source. Even though Case study 01 project is located near a coastal area, the **use of Renewable Energy has not been considered.** The officers confirmed that, due to profit factors, the proposals for solar panels were rejected, despite the high potential from solar panels to produce renewable energy in this project. Just like sunlight, Sri Lanka is also rich with rainwater. However, in the Case study 01 project, there were neither rainwater collection points established nor **water treatment** plant designed. The prominent reason given by the case study respondents for eliminating the water treatment plant was low *return on the investment*. However, as a control point, all the bath accessories used in this project have a built-in water pressure controlling system, which will prevent wasting water from high pressure.

Even though the reduce, reuse and recycle concepts have been used within Case study 01, the question still remains whether the CE principles are fully implemented. As shown in Figure 1, all the resources should be in a closed loop and to get the maximum economic benefit it is essential to go with minimum environmental pollution. Further, concerning the nested diagram in the triple bottom line elaborated under section 2.4, the current sustainability practices should priorities the environmental factors. However, based on several observations and discussions withing the case study, it was clarified that though we adopt 'reduce', 'reuse' and 'recycle' principles to a certain extent, the "circular economy" as concept is not fully realised by those who practice sustainable construction in Sri Lanka. Thus, core practice of effective resource utilisation under circular economy concept, is still lacking in Sri Lankan built environment. In summary, merely satisfying the requirements to obtain a green rating is not adequate to fully realise and implement the concept of circular economy in achieving sustainability in the built environment.

Analysis of Expert Interviews

Profile of the respondents

The respondents' profile of the expert interviews are provided in Table 3

Table 3. Profile of the respondents of expert interviews

Respondent	Designation	Worked on GREEN rated project	Years of Experience with GREEN^{SL} (year/ years)	Years of Experience in Built Environment (year/years)
R - 01	Deputy General Manager	Yes	5	28
R - 02	Quantity Surveyor	Yes	13	15
R – 03	MEP Engineer	Yes	3	12
R - 04	Academia	Yes	3	20
R - 05	Facilities Manager	Yes	1	3
R -06	Senior Lecturer & GREEN AP	Yes	3	8
R - 07	Architect & GREEN AP	Yes	5	15

Barriers to implement CE in the construction industry in Sri Lanka

Respondents stressed that CE concepts are widely used in academia but there is ***lack of awareness about the Circular Economy concept in the industry***. It was mentioned that the reduce, reuse and recycle principles are practised mainly by large-scale construction companies as the majority of the small and medium-scale contractors (SMC) are not aware of this concept at all. Nevertheless, ***R01*** highlighted that there needs to be more awareness about this concept, even among major construction companies. A common fact mentioned by all the respondents was that sustainable practices within SMC are very limited due to lack of financial capacity to install and implement such practices. Connecting this

fact with academia, researchers such as Setiawan et al. (2017), Rizos et al. (2016), Stekelorum (2020) have highlighted this fact.

The purpose of obtaining a green rating system was uncertain to most of the respondents. ***R01,*** with 28 years of experience in a different range of projects and countries, highlighted that in Sri Lanka, *"the reason for obtaining green rating system seems more for marketing purpose than achieving true sustainability". Also,* he emphasized that *"only a few construction companies in Sri Lanka are in a position to focus on sustainable aspects due to financing limitations"*. ***R05*** also stated that obtaining a green rating system for a project, specifically for an apartment building like in Case study 01, can be a marketing strategy mainly for tourist attractions. ***R06 & R07*** mentioned that even though the green rating system included some points adhering to the CE concept when it comes to the industry practice in Sri Lanka, the primary considerations are more towards profitability than sustainability. Further, the respondents highlighted that even in a green-rated building, implementation of CE concept was not fully realized.

Prioritising economic factors over environmental factors was one of the significant issues highlighted by all the respondents. During their experience of working with rating systems, in most cases, the top management would make decisions based on economic factors. As mentioned previously, the primary consideration is towards profitability which can be obtained within relatively short period. ***R06 & R07*** mentioned that the decision makers of many companies in Sri Lanka need to be aware of the long-term economic benefits that can be gained through implementing CE. ***R01*** emphasised that *"even though much research is available in academia concerning the scarcity of natural resources, construction companies do not consider this as a matter of fact when making decisions".*

Most of all, the respondents highlighted that there is no ***second-hand market for reusable products including secondary raw materials*** in Sri Lanka. Without such markets, the implementation of CE in the Sri Lankan construction industry by promoting reuse as a central principle will not be successful. Therefore, lack of proper market for reused items should be considered as the most profound concern. There is a general consensus among the users that the second-hand materials are not up to the expected quality and there was no way for ***quality validation of such materials available for reuse.*** The respondents insisted that the quality of the materials available for reuse should be assured before selling, due to the unavailability of a validation procedure for the quality of second-hand products in Sri Lanka. Besides, some materials which are not so valuable, are costly in the market due to their mere antique appearance and unnecessary marketing strategies of the sellers. When people do not receive a financial benefit for selecting a second-hand product over a new product, they are naturally inclined to go for new product, which in turn will reduce the demand for second-hand markets.

Another striking element expressed by R01, R02, and R07, was the **reluctance of general public to change from long-term use of conventional methods** as they are afraid to come out of their comfort zone to try new and non-traditional materials and methods.
One concern expressed by the respondents regarding implementing the 'Reuse' principle of CE was **the cultural and religious beliefs of the people.** People are unwilling to buy second-hand materials/products due to various beliefs. ***R01*** stated that many people in Sri Lanka believe myths in 'Wasthu Vidyava' (Spatial Sciences in Built Environment), which are not technically or scientifically proven. Due to the negative points mentioned in these myths, some people are reluctant to purchase a house that has been used before.

All the barriers that are discussed above are evident for the lack of implementation of CE in the construction industry. The majority of respondents felt that there are ***no proper guidance or government regulations toward the implementation of CE in Sri Lanka.*** In this regard the following strategies are proposed by the experts to address the barriers discussed above and to promote the CE implementation in the construction industry of Sri Lanka.

Proposed strategies to promote the implementation of CE
Policy-level change towards CE implementation: R06 & R07 highlighted the necessity for policy-level changes from the government towards implementing CE in Sri Lanka. According to them, since Sri Lanka is a developing country, various economic benefits can be gained by implementing CE which will also help uplifting the nation's economy since construction industry in Sri Lanka significantly impacts the economic performance of the country such as GDP (Gross Domestic Product).

Educate the industry about the CE concept:
All respondents highlighted, "Implementing a new concept cannot be done at once or forcefully." Therefore, it should be done methodically. R04, R06 and R07 highlighted that there is a considerable level of lack of understanding of the

basic concepts of CE in Sri Lanka and worldwide. Therefore, they suggested improving the knowledge and awareness of the CE concepts in the industry by eliminating the misunderstanding of the concept is vital. For that, educating investors on the long-term economic benefits of implementing CE is essential too.

Provide guidelines to promote CE concepts within the green rating system:
The unavailability of proper guidelines was highlighted as a significant barrier, hence introducing guidelines within green rating systems will help promoting the CE concepts within the green construction. The experts suggested to establish mandatory checkpoints to implement the CE concepts within the currently practiced green rating system in Sri Lanka and to devise a monitoring mechanism to ensure this is achieved. Provide guidelines and standard procedures to follow for CE implementation should also be extended to contractors, investors, industry practitioners and relevant professional bodies. As such, the implementation of CE concepts within the construction industry of Sri Lanka can be made possible when there is increased awareness of the concept, actual realization of benefits, and introduction of policy-level changes and necessary guidelines.

Conclusions and Recommendation

The Circular Economy concept has been introduced to the construction industry worldwide as an approach towards a sustainable construction industry. Based on the pilot case studies and pilot interviews, it was evident that in Sri Lanka, even in green-rated buildings, CE concept has not been appropriately implemented, which on the other hand, implies that the green rating system itself has room for improvement for the implementation of CE. Further, based on the expert interviews, several barriers towards implementing the CE economy in Sri Lanka have been identified. These findings suggest that the government and decision makers in the industry should take necessary actions towards implementing CE and incorporate it within the existing green rating system. Policy level changes to support and coordinate the transition of the Green Rating System and CE, as along with mandatory checks and monitoring mechanisms within the Green Rating System are essential to achieve economic, environmental and social benefits. As such prioritisation of environmental factors over the economic factors is significant in implementing the circular economy concept and to attain sustainability in the Sri Lankan construction industry. Identifying the necessary actions to be taken by the industry practitioners, decision markers, professional bodies and the government to improve CE implementation within the sustainable practices in the built environment in Sri Lanka is the way forward of this research.

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