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PRIVATE SECTOR ROLE AS A KEY STAKEHOLDER TOWARDS THE CIRCULAR ECONOMY IN THE CONSTRUCTION INDUSTRY IN SRI LANKA

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ABSTRACT

The construction industry has become a major cause of environmental pollution as it consumes large number of natural resources and energy. Additionally, large amount of waste is added to the environment due to construction activities. Accordingly, protecting the environment from harmful construction activities is a major responsibility of the construction industry. Therefore, the concept of circular economy (CE) has gained worldwide attention as a solution to material waste in the construction industry, as it aims on more sustainable economy by designing products and processes where resources are efficiently and continuously cycled. However, the implementation of CE in the Sri Lankan construction industry is still at an immature stage. Therefore, this study aims to explore the role of the private sector and its potential contribution to the implementation of the CE in the built environment of Sri Lanka. This study has adopted the mixed method and findings emphasize even though that there are many benefits of implementing CE principles in the construction industry, CE principles are still not implemented satisfactorily in the built environment in the Sri Lankan construction industry, at least in the private sector. Also, the findings of the research emphasize that there are barriers under different types such as, technological, social and political for the private sector to implement CE in Sri Lanka's built environment.

Keywords: *Circular Economy; Construction Industry; Private Sector; Sri Lanka.*

1. INTRODUCTION

The construction industry plays a very important role in the development of a country. It contributes significantly to the Gross Domestic Product (GDP) as well as the Gross National Product (GNP). However, various issues have arisen due to activities related to the construction sector and construction waste has become a major issue. It has become a serious environmental problem (T. G. Weerakoon et al., 2023). As currently practicing linear economic model in the construction sector mostly affects this. Due to that the construction industry produces about 25% of solid waste and extracts more than 30% of natural resources (Owojori & Okoro, 2022).

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As a result, circular economy (CE) is getting the global attention as a major support in order to address the construction waste management. The CE model, as proposed by the Ellen MacArthur Foundation, is an environmentally friendly industrial system that aims to minimize waste and maximize resource use (Geissdoerfer et al., 2017). CE is a multi-level resource use system that requires the complete closure of all resource loops, with recycling and other practices contributing to its success. The private sector, which contributes to 90% of employment and contributes to the supply of goods and services, plays a crucial role in implementing CE (Heshmati, 2017).

However, the private sector's contribution to sustainability in the built environment is essential, as the government cannot manage the built environment alone. In the construction industry, public-private partnerships (PPPs) account for significant emissions and impacts on economic sustainability and the environment. In the European Union, PPP projects account for 50% of raw material use, 40% of energy consumption, 36% of greenhouse gas emissions, and 33% of water consumption (Owojori & Okoro, 2022).

The private sector's role in the CE in the built environment in Sri Lanka is under-researched, and this research aims to study the role of the private sector as a key stakeholder for the CE in the built environment. By focusing on the private sector's role in implementing CE, Sri Lanka can contribute to a more sustainable economy and reduce environmental challenges such as resource depletion, urbanization, and climate change (T. G. Weerakoon et al., 2023).

Construction-related activities pose a significant challenge to the global construction industry, leading to the need for CE solutions (Anastasiades et al., 2023). In Sri Lanka, the construction industry is also grappling with waste generation and environmental pollution. Limited research has been conducted on CE implementation in the construction sector, focusing on monitoring measures, barriers, and drivers. However, the focus on stakeholders in the built environment is limited, with the private sector contributing significantly to adverse environmental effects. This research aims to investigate how the private sector can contribute to CE in Sri Lanka's construction industry (Illankoon & Vithanage, 2023).

Accordingly, the aim of the study; which is to explore the role of the private sector and its potential contribution to the implement of the CE in the Construction industry of Sri Lanka is achieved through four major objectives: (1) To identify circular economy principles currently being implemented by the private sector in the built environment in the global and local context, (2) To explore the benefits to the private sector from using the circular economy principles in the built environment in the global and local context, (3) To identify the challenges faced by the private sector in using the circular economy principles in the global and local context and (4) To suggest recommendations to increase the private sector's contribution to the circular economy in the built environment in Sri Lanka (Adams et al., 2017).

2. LITERATURE REVIEW

2.1 CIRCULAR ECONOMY DEFINITION

The Ellen MacArthur Foundation defines the CE as an industrial system that is restorative or regenerative by design, replacing the end-of-life concept with restoration, shifting

towards renewable energy, eliminating toxic chemicals, and aiming for waste elimination through superior design of materials, products, systems, and business models (Guerra & Leite, 2021). CE promotes reuse/recycling of materials, goods, and components to reduce waste generation, minimize resource input and waste, emission, and energy leakage, and optimize resource flow through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. CE is a multi-level resource use system that ensures the complete closure of all resource loops, aiming to eliminate waste and pollution (Ishan et al., 2023).

2.2 IMPORTANCE OF CIRCULAR ECONOMY

The construction industry is a significant contributor to environmental pollution, generating significant waste and material losses (Pan et al., 2015). The linear economic model of "take-make-use-dispose" has failed to address sustainability challenges, particularly in renovation and maintenance. The linear economy produces 25% of solid waste in the construction industry and extracts over 30% of natural resources. In Sri Lanka, construction activities generate 14% of cement, 14% of brick, 10% of ceramic tile, and 10% of wood waste. To address these issues, a sustainable solution is to adopt the CE principles (Kulatunga et al., 2006). CE principles can help achieve resource efficiency in the construction industry, and as the use of CE in Sri Lanka is low, it is crucial to embrace it for the ever-expanding construction industry. By adopting CE principles, the construction industry can reduce waste generation, improve resource efficiency, and contribute to a more sustainable future (P. Weerakoon & Thayaparan, 2023).

2.3 AWARENESS ON CE IN THE CONSTRUCTION INDUSTRY

2.3.1 Global Awareness

As mentioned previously, CE is a major sensation globally. Accordingly, to get a proper understanding regarding the CE awareness, implementation and practices along with the current CE principles in the global context, past studies were reviewed. As per the research studies carried out in the building industry, the European Union (EU) has taken the lead in promoting CE principles (Mahpour, 2018). Policies like the Waste Framework Directive and the EU Circular Economy Action Plan promote the use of sustainable materials and set greater recycling goals. By 2050, nations like the Netherlands and Denmark hope to create a circular construction industry with a focus on closed-loop technology and resource efficiency. The usage of circular buildings with modular designs that facilitate simple disassembly and material reuse, for instance, has been pioneered by the Netherlands. In a similar vein, Denmark has enforced strict recycling laws for construction debris, guaranteeing that materials like wood and concrete are used again rather than being thrown away.

Moreover, while advancing more slowly than in Europe, North America is becoming more conscious of the circular economy's concepts in the building industry (Cruz Rios et al., 2021). Waste reduction and material recycling are two examples of sustainable construction practices that are promoted by the U.S. Green construction Council (USGBC) and its LEED (Leadership in Energy and Environmental Design) certification. However, rather than being required by law, the adoption of CE ideas is mostly driven by the market. Through programs like The National Zero Waste Council, which encourages the reuse of building materials, Canada has made progress in incorporating circular

construction (Guerra & Leite, 2021). In order to integrate circular ideas into urban development, cities such as Toronto and Vancouver have also set high sustainability targets.

Construction industry's understanding of CE is still in its infancy in Latin America and Africa. Financial limitations, a lack of policy enforcement, and inadequate waste management infrastructure are the main obstacles. Nonetheless, certain projects are gaining momentum, such as sustainable home developments that use locally produced and repurposed materials. To encourage sustainable building, Latin American nations like Brazil and Mexico are looking at LEED-style green building certifications. Earth-based building methods, such as compressed earth blocks, are being promoted by organizations in Africa as a sustainable substitute for resource-intensive materials like concrete (Hart et al., 2019).

2.3.2 Local Awareness

As the CE is playing a new role in the Sri Lankan construction industry, it has not been properly implemented locally, while there is also a lack of awareness. Therefore, the study focused on the research carried out in the area of CE in the construction industry. Table 1 provides a summary of the identified research (P. Weerakoon & Thayaparan, 2023).

Table 1: CE awareness in Sri Lanka

Year	Title	Studied Area	Reference
2021	A case study on the application of circular economy principles in the pre-construction phase in the Sri Lankan construction industry	Investigating the use of circular economy in the pre-construction phase of construction projects	Wijewansha et al., (2021)
2023	Evaluation of the adoption of circular economy framework in the construction industry of Sri Lanka	Determine the potential and barriers for circular economy implementation in the construction sector in Sri Lanka	T. G. Weerakoon et al., (2023)
2023	Examining barriers to the adoption of circular economy practices in the built environment of Sri Lanka	Identify barriers to circular economy implementation	P. Weerakoon & Thayaparan, (2023)
2023	Circular economy approaches for waste management in Sri Lanka, emphasizing demolition, repurposing, material recovery, and production phases	Analyse the implementation of circular economy strategies in the construction sector	Victar & Waidyasekara, (2023)
2023	Highly efficient circular economy practices across the life cycle of construction projects	Investigating the most effective circular ecoomy practices at each stage of a construction project's life cycle	Ishan et al., (2023)

Year	Title	Studied Area	Reference
2023	Incorporating circular economy principles into modular construction for enhanced sustainability	Integrating circular economy principles into Modular Construction (MC) processes	Garusinghe et al., (2023)
2023	The contribution of quantity surveyors to circular economy principles in the pre-contract phase of construction projects in Sri Lanka	The role of quantity surveyors about circular economy principles at the pre-contract stage	Jayawardhana & Withanage, (2023)

2.4 PRINCIPLES OF CIRCULAR ECONOMY IN THE CONSTRUCTION INDUSTRY

Although CE systems are currently being implemented, implementing process of CE concept need to be address systematically. Accordingly, CE goals and principles need to be better considered and translated into actions, and more coordinated actions among different levels of implementation are necessary (Suárez-Eiroa et al., 2019). Initially, the CE concept was based on the 3R principle, i.e., reduce, reuse, recycle. The principle of reduce improves the efficiency of production and consumption and reduces the input of primary energy, raw materials and waste.

For the past decade, CE has been discussed in-lining with different principles and frameworks (Amudjie et al., 2023). Recently conducted study by Amudjie, et al. (2023), summarize the currently existing and practicing CE principles briefly. Accordingly, R models were identified. Among these R models the most common and the convenient one is the 3R principle, which refers to the Reduce-Reuse-Recycle model (Munaro & Tavares, 2023).

According to the study done by Amudijie, et al. (2023), principles of CE can be summarized as presented in Table 2.

Table 2: Summary of CE principles

CE Principle	Concept of the Principle	Source of reference
3R Model	Reduce- Recycle- Reuse model	Patwa et al., (2021)
6R Model	Reuse- Recycle- Redesign- Remanufacture- Reduce- Recover model	Geissdoerfer et al., (2017)
9R Model	Refuse- Reduce- Reuse- Repair- Refurbish- Remanufacture- Repurpose- Recycle and Recover	van Buren et al., (2016)
5R Model	Rethink- Reduce- Reuse- Repair- Recycle	Ping Tserng et al., (2021)
10R Model	Recover- Recycle- Repurpose-Remanufacture- Refurbish- Repair- Reuse- Reduce- Rethink and Refuse	Potting et al., (2016)
11R Model	Recover- Recycle- Repurpose- Remanufacture- Refurbish- Repair- Reuse- Reduce- Rethink- Refuse and Replace	Çimen, (2021)

However, according to Acevedo-García et al., (2020), the most common and applicable method of CE principles has identified as the 6R principle. Over and above that Kosanović et al., (2021) have identified a slightly different set of CE principles which also can be applicable in the construction industry and summarized in Table 3.

Table 3: Principles of circularity

	Circularity Principle (CP)
CP1	Circular Supply
CP2	Decreased Material Use
CP3	(De)construction Waste Reduction
CP4	Long-lasting Use
CP5	Easy Repair and Maintenance
CP6	Upgrade Sharing Product as a Service
CP7	Reselling
CP8	Reuse
CP9	Recycling
CP10	Recovery

It can be commonly understood that most common CE principles are mainly dealing with the different 'R' models, and these different concepts are practiced in different perspectives in the construction industry.

3. METHODOLOGY

This study used a mixed method approach by gathering data in both quantitative and qualitative base. Accordingly, both expert interviews and questionnaire surveys were carried out. The questionnaire survey was distributed among professionals in various disciplines, with an 84% response rate. Consequently, the survey collected quantitative data from 42 construction industry professionals, including project managers, engineers, quantity surveyors, and architects. Moreover, the literature review covered CE definitions, the importance of CE in global and local contexts, and CE research conducted globally and locally in the construction sector. Six expert interviews were conducted with construction industry professionals, selected based on purposive sampling techniques. Through expert interviews, the benefits of CE principles in the local context were identified, along with the challenges faced by the private sector in applying CE principles. Specifically, both primary data and secondary data were collected. Objective one was achieved through a literature review and collected data was verified using expert interviews. Data for objectives two, three and four were collected through questionnaire surveys and validated through expert interviews. The data collected was analysed using manual analysis with the support of Microsoft Excel tools.

4. DATA ANALYSIS AND DISCUSSION

4.1 EXPERT INTERVIEWS

Six expert interviews were carried out and participants represent various areas in the industry; Accordingly, the team was compiled with three project managers, two charted civil engineers and a Charted Quantity Surveyor who have industry experience for more than 15 years. Interview guideline was classified under three main themes, where majorly focus on research objectives. Following presented is the summary on the experts' point of view on the particular themes.

4.1.1 Theme 1- Implementation of Circular Economy (CE) Principles in the Sri Lankan Construction Industry

According to the experts, foreign countries have paid special attention to implementing CE principles to the construction practices massively and two experts out of six emphasized that USA and European countries have paid special attention to these principles. Interviewees emphasized that some projects in private sector have implemented CE principles up to a certain extent in the Sri Lankan context, but it is very low when compared with foreign countries. Additionally, interviewees, mentioned that the 3R principle; Reduce, Reuse and Recycle which were also identified as the basic CE principles, are currently being practiced, but the implementation and the practice of the rest of the principles such as repair, renewability, repurpose etc. is in a poor level.

Additionally, in the perspective of reduction, reducing the construction waste, reducing the energy and water consumption has been addressed. And also, the experts stated that, alterations have been introduced for some of the existing construction materials as a result of CE practices.

Interviewees highlighted the principle of recycling in construction is practiced during the reuse of materials like valves and aluminium. They highlighted the use of system formwork for large-scale projects and the recycling of old iron and aluminium, as well as paint and bathroom fittings. Furthermore, interviewees stated that CE principles such as repurpose, refurbishment, renewable, and reconsideration in the construction industry is a key focus of the Green Building Council of Sri Lanka (GBCSL). Examples for implementing such CE principles in the construction industry include landfills, recycling, and reusing waste. The use of alternative fuels like waste clothing, oil, and wood dust can reduce coal usage by 50%. Moreover, building design incorporates large openings for natural airflow and proper sunlight orientation. INSEE Cement and INSEE Eco cycle Lanka are examples of projects implementing CE principles in the private sector.

4.1.2 Theme 2- Benefits of Implementing CE for the Private Sector in Sri Lankan Construction Industry

Majority of the interviewees emphasized that CE implementations in the private sector in Sri Lankan's construction sector can significantly reduce material wastage and resource wastage, which can be identified as a massive benefit in the first place. Accordingly, experts stated that technological monitoring of material wastage allows for control and decision-making, while computerized systems can monitor energy consumption and water usage which make a positive impact on the industry. Moreover, precast concrete and sustainable building components can reduce cement requirements and heat inside buildings. Therefore, as per the experts, CE principles are profitable in the long run, even

with higher initial costs for special technical equipment and materials. They can reduce raw material, plant, and labour costs, and contribute to environmental protection. Despite the increase in implementation of CE principles in the Sri Lankan construction industry, environmental pollution remains unsatisfactory. Most large-scale industrial companies focus on short-term profits rather than preserving the environment. Despite this, CE principles are being implemented in the private sector, contributing positively to the preservation of resources and the environment for future generations.

4.1.3 Theme 3- Suggestions to Improve the Circular Economy Practices in the Sri Lankan Built Environment

Even though the implementation of the CE principles in the Sri Lankan construction industry has increased, environmental pollution remains a significant issue. Large-scale industrial companies have primarily focused on CE principles, while small and medium-sized companies have not. Accordingly, to address this, several suggestions have been presented by the experts, including educating society, establishing rules and regulations, conducting training programs, setting up incentive schemes, limiting energy supply, and not approving designs incompatible with CE principles. Moreover, experts stated that, Government support is crucial for implementing CE principles in the construction industry, as it is difficult for the private sector to carry out alone. Government funds and incentives should be provided to promote CE principles within the local built environment. The initial cost of implementing CE is high, so investors should be sought. In addition to that, using high-quality materials for construction can support implementing CE. Further, commencing construction after all designs are completed can minimize defects and re-construction. Promoting green practices and renewable energy also can enhance the concept of CE. Moreover, following suggestions were raised; companies can motivate their employees to implement CE by offering awards and competition, concepts like Zero Energy Building (ZEB) and Net Zero Energy (NZE) can also help reduce electricity consumption and save the environment.

4.2 QUESTIONNAIRE SURVEYS

4.2.1 Demographical Data

The questionnaire survey was carried out with the professionals who are with construction industry experience. The questionnaire was distributed among 50 professionals, and the response rate was recorded as 84%, which consists of 33.33% each of civil engineers and quantity surveyors and 14.29%, 11.9%, 4.76% and 2.38% respectively from the backgrounds of electrical and mechanical engineering, architecture and project management. Meanwhile there are 14 employees in each group, with the majority of responders having 0–5 and 5–10 years of work experience. Eleven employees, representing a moderate proportion, fall into the 10- to 15-year experience category. There are only three employees in the 15–20-year experienced category, which has the lowest representation.

4.2.2 Contextual Data

Contextual data was considered under couple of areas, which has been summarized in the Table 4.

Table 4: Summary of collected data

Questioned Area	Summary of the Data
Awareness on CE principles	The survey shows that 76.2% of industry professionals are aware of the benefits of circular economy principles, while 14.3% are not, and only 9.5% have a comprehensive understanding.
Benefits of implementing CE to the private sector	The survey revealed that 34.1% of respondents believe that implementing CE principles to minimize waste generation and reduce costs as the main benefit followed by 26.8% who believe it is long-term cost reduction. 19.5% believe resource efficiency and long-term profit are the main benefits. Implementing these principles has enabled efficient use of materials and resources, reduced project costs, and reduced energy consumption. A small percentage of respondents believe it contributes to increased company profits. Overall, 81% of respondents believe the circular economy concept will benefit their organization in the long run while the rest 19% do not have a clear picture about the benefits.
Barriers of implementing CE	The majority of respondents, 42.9% identified limited access to resources, such as trained workforce and modernized equipment, as a barrier. Additionally, 28.6% identified lack of financial resources, 19% mentioned low demand for circular economy implementation, and 9.5% stated lack of public sector support as the additional barriers.

Furthermore, with a broad focus on the barriers to implementing CE principles in Sri Lanka's construction sector, political and regulatory barriers, social barriers, and technological barriers were identified. The following figures show the barriers identified according to the respondents.

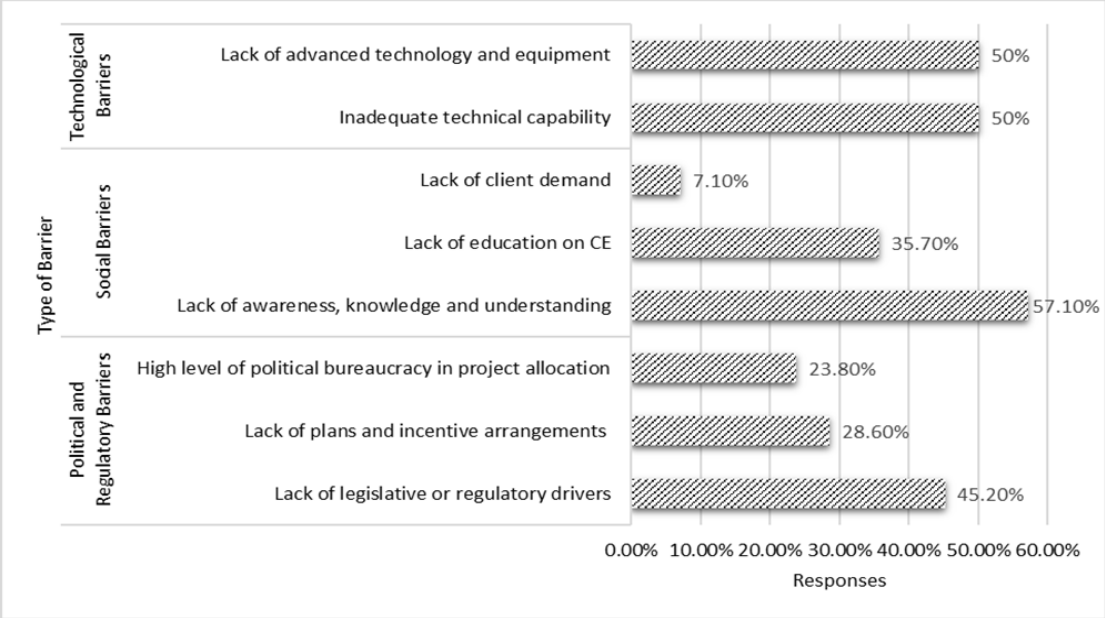

Figure 1: Barriers for implementing CE principles

According to the collected data, considering the political and regulatory barriers of implementing CE in private sector, majority highlighted lack of legislative or regulatory

drivers and it was 45.2%, meanwhile the rest stated lack of plans and incentives as well as high level of political bureaucracy in project allocation also has a certain impact on implementing CE principles in the construction industry. In account of social barriers, majority of respondents; 57.1% identified lack of awareness, knowledge, and understanding on the CE concept as the main barrier, also, 35.7% have identified lack of education on CE strategies among stakeholders while, 7.1% of the respondents identified lack of client demand as a barrier to implement CE principles in construction industry. Finally on the aspect of technological barriers, 50% of the respondents identified inadequate technical capability and expertise in CE as a barrier, while the other 50% of the respondents identified lack of advanced technology and equipment to implement CE as the main technological barrier.

As the latter part of the questionnaire, participants were questioned regarding the recommendations to increase the contribution of the private sector to the circular economy in the construction sector in Sri Lanka. Accordingly, 45.2% of respondents emphasized that it is important to introduce special benefit schemes for the private sector stakeholders in the construction industry. Meanwhile 28.4% of respondents recommend training sessions for private sector parties in the construction industry and 14.3% of respondents recommended introducing technology facilities for CE practices in the Construction industry. Finally, 11.9% of respondents recommended developing regulations to adopt the CE concept in the construction industry.

The implementation of CE principles in the construction industry in Sri Lanka is relatively low, compared to countries like the USA and Europe. However, the private sector is increasingly adopting CE principles, such as reducing waste generation, reducing energy consumption, and using building demolition waste for landfills. The 3R principles of reduce, reuse, recycle, repurpose, rethink, renewability, refurbish, and recover are being implemented, but small and medium-scale construction companies are not paying attention to these principles.

The research confirms that adopting CE principles can bring long-term benefits to the private sector, including financial savings, environmental sustainability, and increased profitability. However, the private sector faces challenges such as limited access to resources, financial constraints, low client demand, and lack of public sector support.

To increase the private sector's contribution to the circular economy, the research recommends introducing special benefit schemes, conducting training sessions, and establishing necessary laws and regulations. Additionally, awarding certificates and recognition to companies that excel in CE implementation can encourage others to adopt the concept. Government support is also essential for the successful implementation of CE principles in the construction industry.

5. CONCLUSIONS

Initially the study focused on the CE principles currently being implemented by the private sector in the built environment in the global and local context and the as per the collected data primarily and secondarily, emphasized that although there are several CE principles currently operating in the Sri Lankan construction industry, compared to the global context, the implementation of CE principles in the Sri Lankan construction industry is in a low level. Secondly the attention was caught on the point, how the CE implementation could positively be impacted on private sector in Sri Lanka. Accordingly,

the findings showed that the private sector can achieve many benefits by using CE principles, such as minimization of waste generation, long-term cost reduction and resource efficiency, long-term profitability etc.

Thirdly, consideration was paid on the challenges faced by the private sector in using the CE principles. Accordingly, the results showed that various barriers arise for the private sector in implementing CE principles. Limited access to adequate resources such as a trained workforce and modernized equipment, lack of financial resources, low client demand for CE and lack of adequate support and incentives from the public sector were identified as the barriers to implementing CE in private sector. Final objective was to propose suggestions to increase the private sector's contribution to the circular economy in the built environment in Sri Lanka. Several proposals were put forward to as suggestions. In summary, Introduction of special benefit schemes for private sector stakeholders in the construction industry by government authorities involved in the construction industry, conducting training sessions for private sector stakeholders, introducing technologies facilitating circular economy practices and developing regulations to adopt the circular economy concept in the construction industry were suggested by the participants.

5.1 RECOMMENDATIONS AND LIMITATIONS

In conclusion the proposed recommendations can be summarized as, introduction of special benefit schemes by the government such as, tax subsidies and incentives for companies that follow CE principles, and awards etc. Moreover, conduction training sessions, use of advanced technical facilities and development of regulatory frameworks were recommended. The research study is mainly focused on the potential contribution of implementing CE principles in the private sector construction industry in Sri Lanka.

5.2 WAY FORWARD

As a suggestion to future studies, examining the readiness of other construction professionals (government agencies, academics, and civil society) to embrace this concept, and analyse the cost-effectiveness of adopting CE principles in the construction sector compared to the linear economy concept, can be considered.

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