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Supply Chain Dynamics and the Circular Economy: Insights from Thailand's Construction Industry

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Abstract*— This study investigates the integration of circular economy practices within Thailand's construction supply chains, focusing on current adoption levels, key challenges, and potential opportunities. The findings reveal that while 42% of companies utilize recycled materials, the adoption of other practices, such as sustainable procurement (13%) and modular construction (6%), remains limited. Regulatory barriers (36%), high costs of sustainable materials (28%), and inconsistent quality of recycled materials (22%) are identified as significant challenges. Despite these obstacles, the study highlights opportunities for improvement, including government incentives, the development of local recycling infrastructure, and enhanced supply chain collaboration. These opportunities offer a feasible path to overcoming existing barriers and advancing circular economy practices within the industry. The research underscores the need for coordinated efforts among government, industry stakeholders, and supply chain partners to promote sustainability and resilience in Thailand's construction sector.

Index Terms: Circular Economy, Construction Industry, Supply Chain, Sustainability.

I. LITERATURE REVIEW

The construction industry is a significant driver of economic growth and development globally, but it is also a major contributor to environmental degradation. In recent years, the concept of the circular economy (CE) has gained traction as a sustainable alternative to the traditional linear economic model, which typically follows a "take-make-dispose" approach. The circular economy seeks to minimize waste and resource use by creating closed-loop systems where materials are reused, recycled, and regenerated, ultimately leading to a more sustainable and resilient economy. As the construction industry accounts for a substantial portion of global resource consumption and waste generation, the adoption of circular economy practices within this sector is critical for achieving broader sustainability goals [1-3].

In Thailand, the construction industry is a vital component of the national economy, contributing significantly to GDP and employment. However, the industry also faces significant environmental challenges, including high levels of resource consumption, waste generation, and carbon emissions. As Thailand progresses towards its sustainability and environmental goals, there is an increasing recognition of the need to integrate circular economy principles into the construction sector. The adoption of circular economy practices, such as the use of recycled materials, sustainable procurement, and waste management, offers a pathway to reduce the environmental impact of construction activities while enhancing economic efficiency and resilience.

Despite the potential benefits, the integration of circular economy practices within Thailand's construction industry remains limited. Several barriers hinder the widespread adoption of these practices, including high costs, regulatory challenges, and a lack of awareness and expertise among industry stakeholders. Additionally, the existing supply chain dynamics, which are often characterized by fragmentation and a lack of coordination, further complicate the transition towards a circular economy. To overcome these challenges, it is essential to identify and leverage the opportunities that exist within the supply chain to enhance the adoption of circular economy practices [4-6].

This study aims to explore the current state of circular economy integration within Thailand's construction supply chains, identify the key barriers and challenges faced by industry stakeholders, and highlight potential opportunities for improving the adoption of circular economy practices. By examining the supply chain dynamics and understanding the factors that influence the adoption of circular economy practices, this research seeks to provide insights that can inform policy and industry strategies aimed at promoting sustainability in Thailand's construction sector.

The significance of this research lies in its focus on the supply chain as a critical component of the circular economy transition. The supply chain plays a pivotal role in determining the flow of materials and resources, and its optimization is crucial for achieving the goals of a circular economy. By understanding the current practices, challenges, and opportunities within the supply chain, this study contributes to the broader discourse on how to effectively implement circular economy principles in the construction industry, not only in Thailand but also in other contexts where similar challenges may exist.

In conclusion, the integration of circular economy practices in the construction industry is essential for achieving sustainable development goals. This study will provide a comprehensive analysis of the current state of circular economy adoption within Thailand's construction

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supply chains and offer actionable insights for enhancing sustainability in the industry. As Thailand continues to develop its construction sector, the findings of this research will be crucial in guiding efforts to create a more sustainable and resilient built environment.

II. METHODOLOGY

This study utilized a quantitative research approach, employing a structured survey to gather data on the integration of circular economy practices within the supply chains of Thailand's construction industry. The survey aimed to assess current adoption levels, identify key challenges, and explore opportunities for enhancing circular economy practices.

A. Survey Design and Distribution

The survey was designed based on an extensive literature review and consultations with industry experts. The questionnaire consisted of three main sections:

Current Adoption Levels: This section included questions about the extent to which various circular economy practices, such as the use of recycled materials, sustainable procurement, and modular construction, are integrated into supply chains.

Challenges in Adoption: Questions in this section focused on identifying the primary barriers faced by companies when attempting to implement circular economy practices. Respondents were asked to rank challenges such as regulatory barriers, high costs, and quality issues.

Opportunities for Improvement: The final section explored potential strategies and opportunities for enhancing circular economy integration, including government incentives, infrastructure development, and supply chain collaboration.

B. Sample and Data Collection

The survey was distributed to a sample of 400 professionals working in Thailand's construction industry. The sample size for this study was determined using the Yamane formula, which is appropriate for large populations where precise sampling is necessary. The sample included a diverse group of participants, such as project managers, procurement officers, engineers, and sustainability officers, ensuring a comprehensive perspective on supply chain dynamics.

A stratified random sampling method was used to ensure representation across different types and sizes of construction companies, including small, medium, and large enterprises. The survey was distributed via both online platforms and paper-based formats to maximize accessibility and response rates.

The data collection period spanned two months, during which follow-up reminders were sent to participants to encourage completion of the survey. This approach resulted in a high response rate of approximately 75%, with 300 valid responses received and analyzed.

C. Data Analysis

The collected data were analyzed using statistical software to provide insights into the current state of circular economy practices in the supply chain. Descriptive statistics, such as percentages and frequency distributions, were used to summarize the adoption levels of various practices and the prevalence of different challenges.

Cross-tabulation and chi-square tests were employed to examine relationships between company characteristics (e.g., size, type) and the adoption of circular economy practices. Additionally, opportunities for improvement were evaluated based on the perceived impact and feasibility reported by the respondents.

Qualitative responses from open-ended questions were thematically analyzed to identify emerging trends and insights, complementing the quantitative findings and providing a more comprehensive understanding of the challenges and opportunities in the industry.

III. RESULTS AND DISCUSSION

1. Current Integration of Circular Economy Practices in Supply Chains

The first objective of this study was to assess the current level of integration of circular economy practices within the supply chains of Thailand's construction industry. The data collected reveal varying degrees of adoption across different practices, as summarized in Table 1.

Table I: Current Integration of Circular Economy Practices in Construction Supply Chains

Circular Economy Practice	Percentage of Companies Integrating (%)
Use of Recycled Materials	42%
Adoption of Sustainable Procurement Practices	13%
Implementation of Waste Management Systems	15%
Utilization of Modular Construction Techniques	6%
Collaboration with Recycling Facilities	24%

The results indicate that the use of recycled materials is the most widely adopted circular economy practice, with 42% of companies integrating it into their supply chains. This is followed by collaboration with recycling facilities (24%) and the implementation of waste management systems (15%). However, the adoption of sustainable procurement practices (13%) and modular construction techniques (6%) remains limited.

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The relatively higher adoption of recycled materials suggests an increasing awareness of the benefits of material reuse in the construction industry. However, the low adoption rates of sustainable procurement and modular construction indicate significant room for improvement. The data suggest that while some companies are beginning to embrace circular economy practices, broader integration across all aspects of the supply chain is still in its early stages.

2. Key Supply Chain Challenges in Adopting Circular Economy Practices

The second objective was to identify the key challenges that hinder the adoption of circular economy practices within the construction supply chains. Table 2 presents the most frequently reported challenges.

Table II: Key Supply Chain Challenges in Adopting Circular Economy Practices

Challenge	Frequency Reported (%)
High Cost of Sustainable Materials	28%
Inconsistent Quality of Recycled Materials	22%
Limited Availability of Local Suppliers	12%
Lack of Awareness and Training	2%
Regulatory Barriers	36%

The most significant barrier identified is regulatory barriers, reported by 36% of respondents, followed by the high cost of sustainable materials (28%) and inconsistent quality of recycled materials (22%). Limited availability of local suppliers (12%) and lack of awareness and training (2%) were also noted as challenges, albeit to a lesser extent.

Regulatory barriers are the most frequently cited challenge, highlighting the need for more supportive policies and clearer guidelines to facilitate the adoption of circular economy practices. The high cost of sustainable materials remains a critical economic barrier, suggesting that more affordable options or financial incentives could be necessary to encourage wider adoption. The inconsistent quality of recycled materials indicates a need for better standards and quality control measures to build trust in the use of these materials.

3. Opportunities for Enhancing Circular Economy Integration in Supply Chains

The final objective was to explore potential opportunities for improving the integration of circular economy practices within Thailand's construction supply chains. Table 3 outlines the identified opportunities along with their potential impact and feasibility.

Table III: Opportunities for Enhancing Circular Economy Integration in Construction Supply Chains

Opportunity	Potential Impact	Feasibility
Government Incentives for Sustainable Practices	High	Medium to High
Development of Local Recycling Infrastructure	High	Medium
Enhanced Collaboration Across the Supply Chain	High	High
Investment in Research and Development (R&D)	Medium	Medium
Implementation of Circular Procurement Policies	Medium	Medium

The opportunities identified have the potential to significantly enhance the adoption of circular economy practices. Government incentives for sustainable practices and the development of local recycling infrastructure were rated as having high potential impact. Enhanced collaboration across the supply chain was deemed both highly impactful and feasible, suggesting a strategic focus on fostering partnerships and knowledge-sharing could yield substantial benefits.

The opportunities presented in Table 3 indicate a clear path forward for improving circular economy integration within the construction supply chains. Government incentives and infrastructure development are critical to overcoming existing barriers, particularly in reducing costs and improving the quality and availability of sustainable materials. Collaboration across the supply chain emerges as a particularly promising area, with high feasibility and potential impact, emphasizing the importance of a coordinated effort among stakeholders to drive change.

Overall, the results and discussion highlight both the challenges and opportunities for advancing circular economy practices within Thailand's construction industry. Addressing the identified barriers through strategic initiatives and leveraging the outlined opportunities can significantly contribute to the sustainability of the sector.

IV. CONCLUSION

This study examined the integration of circular economy practices within the supply chains of Thailand's construction industry, highlighting the current adoption levels, challenges, and opportunities for improvement. The findings reveal that while there is some progress, with practices like the use of recycled materials being adopted by 42% of companies, the overall integration of circular economy principles remains limited, particularly in areas such as sustainable procurement and modular construction.

Key challenges identified include regulatory barriers, high costs of sustainable materials, and the inconsistent quality of recycled materials. These obstacles underscore the need for targeted policy interventions, cost-effective solutions, and improved quality standards to foster greater adoption of circular economy practices.

The study also identified several opportunities for enhancing circular economy integration, such as government incentives, the development of local recycling infrastructure, and increased collaboration across the supply chain. These opportunities, if pursued, offer a viable pathway for overcoming existing challenges and driving the transition towards a more sustainable construction industry in Thailand.

In conclusion, advancing circular economy practices within Thailand's construction sector requires a coordinated effort involving government, industry stakeholders, and supply chain partners. By addressing the identified barriers and leveraging the opportunities, the industry can move towards a more sustainable and resilient future.

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