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RESEARCH ARTICLE

Capacity Building for Sustainability and Circular Economy: Identifying Educational Barriers and Opportunities in Asia

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Abstract: The transition from a linear to a circular economy (CE) is a pressing imperative for Southeast Asia, a region facing rapid industrialization and environmental risks. This study, part of the CEBCAT project, examines the current state of higher education in Indonesia, Laos, and Vietnam with respect to CE and sustainability. The purpose was to identify existing knowledge and ability gaps and instructional problems, thereby informing the development of a master's curriculum in CE and sustainability. Using a mixed-methods approach across six partner universities in Asia, data were collected from 103 individuals, including students, academic staff, and industry professionals. The findings reveal that, although there is a foundational awareness of sustainability, a deep conceptual understanding of the circular economy is limited. Critical skill gaps were identified in practical application, environmental impact assessment, and digital literacy, and a strong preference for experiential learning over purely theoretical or online instruction. However, the study highlights significant institutional barriers, including limited funding, outdated resources, and heavy faculty workloads. Effective CE capacity building requires a shift toward interdisciplinary, practice-based curricula supported by robust industry partnerships and institutional investment.

Keywords: circular economy, higher education, Southeast Asia, capacity building, curriculum development, online instruction

1 Introduction

The continuous development of education has become a central pillar of the global political agenda (Rachmad, 2025). Over the last two decades, higher education systems have faced significant pressure to become more dynamic, transforming not only their delivery methods, such as the shift toward part-time, work-based, and distance learning (Bridges, 2000), but also their content. As societal needs evolve, education systems must incorporate new subjects to ensure

that graduates possess the skills and competencies required by a dynamic society (Buyukyazici et al., 2025; Rae, 2010).

One of the most pressing societal imperatives today is the transition from a traditional linear economy to a circular economy (CE). In a market-based society, economic growth has historically resulted from the efficiency of production systems, which consume natural resources until they reach a critical limit (Huo & Peng, 2023). The CE concept introduces new paths to disengage resource consumption from economic development, breaking the bottleneck of resources and the environment (Voulvoulis, 2022).

While there is a growing interest in the circular economy across the public and private sectors, its integration into higher education curricula, especially in Southeast Asia, remains in its early stages. This is evident in the fact that, although many Asian economies are growing rapidly, this development often relies heavily on fossil fuels and uncontrolled resource use. Developing Asia accounts for approximately half of global emissions. As more people move to cities, the region faces rigid linear economic models that harm the environment and human health (Giardino et al., 2024). As a result, there is an urgent need for educational programs that teach not only the basic concepts of circularity but also how to apply them in practice, how to think across disciplines, and how to address the social, economic, and environmental issues in a given area.

The CEBCAT project was initiated to address these problems. It is based on the principles of the European Green Deal and aims to close the gap between European sustainability requirements and the current conditions in Asian partner countries. The project consortium is comprised of universities and organizations from four European countries, namely Spain, Romania, Greece, and Luxembourg, collaborating with six universities from Southeast Asia, i.e., Vietnam, Indonesia, and Laos, with two institutions from each nation. The program aims to disseminate information, enhance skills, and equip practitioners and academic institutions in Indonesia, Laos, and Vietnam to apply circular concepts by fostering cooperation between European and Asian institutions (Amara & Qiao, 2023). This approach aligns with recent findings suggesting that educational strategies focusing on international mobility and intercultural competencies are essential for building self-confidence and communication skills in global environments (Patelarou et al., 2022). To accomplish this, the initiative seeks to develop master's degree programs that integrate circular economy principles in significant, locally tailored ways. Consequently, a study was conducted across six Southeast Asian institutions to identify existing knowledge gaps, requisite skills, and challenges in teaching and learning, particularly regarding sustainability and the circular economy, within the context of the Asian partner countries.

2 Literature Review

2.1 The Shift from Linear to Circular Economy: A Pedagogical Perspective

The traditional "take-make-dispose" model is increasingly viewed as environmentally unsustainable (Richardson et al., 2023). This linear system treats the environment as a waste reservoir and lacks a built-in tendency to recycle (Pieroni et al., 2019). In contrast, the circular economy is defined as an industrial system that is restorative or regenerative by intention and design (Kirchherr et al., 2023). The core objective of CE is to curtail material flows and to use energy efficiently through the "3R" principles: reduce, reuse, and recycle (Zeng et al., 2017; Tura et al., 2019).

From an educational standpoint, the circular economy draws on a rich theoretical foundation in science education (Nguyen, 2023). It is directly related to fundamental concepts such as the conservation of matter and energy, sustainability, and the environment. Teachers can help students understand how natural resources can be renewed rather than depleted by incorporating CE into the curriculum (Nguyen, 2023). Additionally, connecting CE with the natural sciences improves critical thinking and raises environmental awareness, thereby encouraging the use of scientific knowledge for sustainable development (Kirchherr & Piscicelli, 2019; Nguyen, 2023).

2.2 Environmental Problems and Policy Drivers in the ASEAN Region

The European Union's Green Deal has helped disseminate sustainable practices worldwide by emphasising the need to combat climate change while also benefiting the economy (Amara & Qiao, 2024). However, transitioning to sustainability in Asia, and especially in Southeast Asia, is challenging due to differences in infrastructure and understanding. To be more specific, in

Vietnam, rapid industrialisation has produced highly resource-intensive consumption patterns in which construction materials constitute the majority of material use, and extraction activities have triggered severe ecological issues (Miatto et al., 2021; Wang et al., 2024).

Additionally, substantial differences exist between emissions from production and consumption, necessitating policy measures that target production patterns specifically (Campos-Romero & Rodil-Marzábal, 2024). Nevertheless, Vietnam has begun to slowly prioritise integrating CE principles into economic sectors (Tran et al., 2024). On the other hand, in Laos, extraction, including mining and hydropower, remains a primary component of the economy (Hien et al., 2020), and waste management is poorly developed. This demonstrates the need to move from a "collect and dispose" to a "recover and reuse" approach (Soudachanh & Salhofer, 2024). Indonesia also recognises the significance of these problems and is working to make circularity a priority across its industries (Dutt et al., 2025). Despite these efforts across the region, challenges such as a strong reliance on fossil fuels, outdated waste management systems, and limited public awareness persist (Javed et al., 2024).

2.3 Capacity Building and Curriculum Development Methodology

Implementing CE principles in developing nations faces distinct challenges, including a lack of standardised curricula, insufficient funding for technology, and a disconnect between industry and academia (Switch Asia, 2022). Capacity building in higher education is a critical aspect that, unfortunately, is undervalued and insufficiently prioritised (Serrano-Bedia & Perez-Perez, 2022).

Following Saunders & Machell's (2000) neo-correspondence theory, which identifies the need for students to rehearse the employment practices they are likely to encounter, and seeking to address the aforementioned issues, the CEBCAT project employed a two-round methodology to identify students' needs and challenges and to design a meaningful postgraduate program. The first round established a baseline understanding of educational needs by collecting data on existing knowledge levels and perceived gaps, supplemented by focus group discussions. The second phase confirmed the suggested curriculum structure based on these results. It added specialized modules on digital skills, interdisciplinary integration, and business skills to make sure the program matches the needs of the local job market. This initiative aims to empower Asian academic institutions to become drivers of sustainable development by providing instructional resources aligned with European standards and by encouraging international collaboration.

3 Methodology

3.1 Research Design and Procedure

The methodology comprised two key phases to identify existing knowledge gaps, required skills, and challenges in teaching and learning within the context of Asian partner countries (Figure 1). The first phase involved individual data collection using structured questionnaires to obtain baseline information on training needs, preferences, and challenges related to sustainability and circular-economy education. The second step comprised Focus Group Discussions (FGDs) with students and academic staff to examine in-depth viewpoints on the themes identified in the survey.

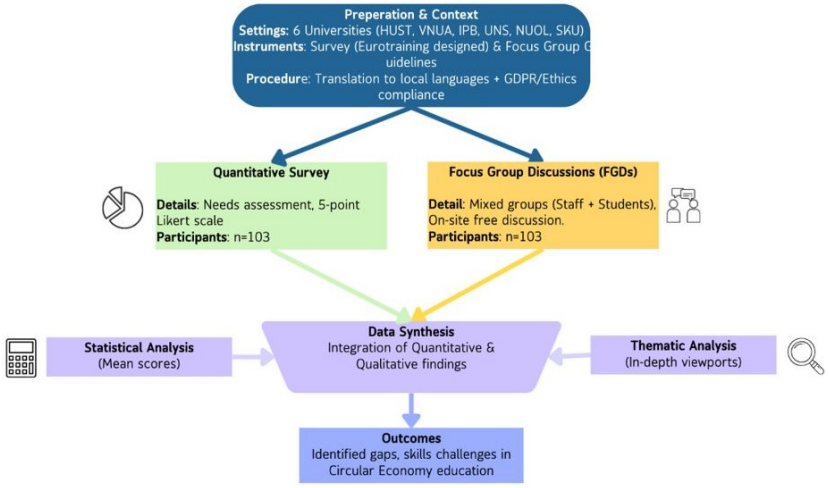

Figure 1 Methodological Framework

To maintain clarity and cultural relevance, all study materials – including the questionnaire, consent form, and participation list – were translated into the local languages of each institution while preserving the core meaning of the original English versions. Due to logistical and contextual limitations, all interviews were conducted on-site. In the second phase, the groups were frequently mixed, including both staff and students in each session. This was done to facilitate open discussion and diverse perspectives.

The analysis employed a systematic approach, examining both the quantitative survey responses and the qualitative insights from the talks to ensure a comprehensive set of results. The results were then combined to provide a comprehensive overview.

3.2 Data Collection

This analysis is based on data collected from six partner universities in Southeast Asia: Hanoi University of Science and Technology (Vietnam), Vietnam National University of Agriculture (Vietnam), IPB University (Indonesia), National University of Laos (Lao PDR), Savannakhet University (Lao PDR), and Universitas Sebelas Maret (Indonesia). The data collection process primarily employed convenience sampling to recruit participants, ensuring accessibility and feasibility across diverse academic environments.

The first round of the survey included 103 participants: 47 men, 56 women, 60 students, 40 academic personnel, and 3 field professionals. Similarly, the focus group talks included 103 participants: 60 students, 40 academic staff, and 3 field professionals, with 47 men and 56 women. The demographics differed somewhat by university. For instance, at HUST, participation comprised students, academic staff, and field professionals. In contrast, other universities, such as UNS and SKU, included administrative staff or focused primarily on students and academic staff.

3.3 Instruments and Data Analysis

To evaluate the educational state of sustainability and circular economy, two primary instruments were utilized. The first instrument was the Round 1 questionnaire, developed by Eurotraining in collaboration with all partners, including experts from each university. This instrument utilized both 5-point Likert scale questions and open-ended questions to acquire baseline data on training needs and preferences. The second instrument consisted of structured focus group discussions. Additionally, strict ethical guidelines were adhered to, and the study complied with the General Data Protection Regulation (GDPR) in all activities involving the collection and processing of personal data (Petousi & Sifaki, 2020). All participants were informed about how their data would be used, stored, and protected. Explicit consent was obtained for participation in the questionnaires and focus groups, including permission for any video or audio recording. To maintain clarity and cultural relevance, all study materials were translated into the local languages of each institution. The data analysis followed a rigorous synthesis process.

The quantitative data from the questionnaires were analyzed to determine mean scores regarding the relevance of topics and to identify specific skill gaps. Simultaneously, thematic analysis was utilized in the qualitative data from the focus groups to provide context to these statistics. Finally, the findings from both the quantitative and qualitative phases were synthesized to identify the specific skills, knowledge areas, and institutional barriers present in the current education or professional training regarding the circular economy.

4 Results

4.1 Knowledge and Skills Gaps

The most crucial aspect of sustainability was pollution management and environmental impact assessment (Table 1). In particular, respondents gave an average score of 3.86, with values ranging from 3.67 to 4.00 across all schools. This indicates that participants are well aware of the importance of addressing pollution in efforts to achieve greater sustainability. The fundamentals of sustainability and the circular economy received mixed evaluations, with an average score of 3.57 (range = 3.00–4.00). Participants recognized the significance of basic knowledge but did not regard it as the paramount subject. On the other hand, circular processes in some fields, such as agricultural and automotive, were less critical, with an average of 3.44 (range = 3.00–3.80). This means that their importance varies across fields. These quantitative findings are contextualized by the focus group insights. There was considerable agreement on the meaning of sustainability, but the circular economy remains a relatively new concept that many don't fully understand, particularly in Vietnam and Laos. Students, in particular, had difficulty distinguishing between

circular and linear economies and were unfamiliar with the concept.

Moreover, the results reveal that when looking for significant skill gaps, there is always an emphasis on how to utilize sustainability ideas and practical applications in real life. This skill got the highest relevance rating across all datasets (M = 4.01, Range = 3.43–4.31), which shows that individuals want to acquire knowledge about how to do things rather than merely knowing about them (Table 1). The analysis of data for environmental impact assessments was also rated as highly important (M = 3.99, Range = 3.71–4.20), indicating a need for quantitative skills to monitor environmental performance. In contrast, advanced digital technologies like AI and Big Data were linked to innovation in circular business models (M = 3.96, Range = 3.60–4.16). Participants noted that these cutting-edge tools are missing from current curricula but are essential for business design and market development. Finally, respondents identified broader skill gaps in business management and the alignment of skills with the United Nations Sustainable Development Goals (SDGs).

Table 1 Knowledge and Skills gaps results

Category	Specific Indicator	Mean Score	Range	Qualitative Key Finding & Insights
Knowledge	• Pollution Management & Env. Impact	3.86	3.67–4.00	• Concept Confusion: Students (especially in Vietnam & Laos) struggle to differentiate between circular and linear economies • Application *vs*. Theory: Strong preference for learning *how* to do things rather than just knowing *about* them
	• Fundamentals of Sustainability & Circular Economy (CE)	3.57	3.00–4.00	
	• Circular Processes in Specific Fields	3.44	3.00–3.80	
Skill gaps	• Applying Sustainability in Real Life	4.01	3.43–4.31	• Need for digital proficiency in modern sustainability contexts. • Need for skills in AI, Big Data. • Alignment with SDGs: The ability to ensure skills and projects align with the United Nations Sustainable Development Goals.
	• Data Analysis for Env. Impact Assessment	3.99	3.71–4.20	
	• Circular Business Model Innovation	3.96	3.60–4.16	

4.2 Challenges in Learning and Teaching

When attempting to combine sustainability with CE ideals, several issues arise (Table 2). The most frequently cited complaint was the lack of opportunities for hands-on instruction, with an average score of 3.85 (range = 3.51–4.00). Respondents believed that the lack of hands-on learning made it harder to apply what they had learned in the real world, which they considered essential. It was challenging to identify appropriate research and tools (M = 3.82, Range = 3.41–4.07). Additionally, the lack of institutional support and resources was a significant problem (M = 3.75, Range = 3.34–4.09), indicating that instructors lacked sufficient structural support. The problems were even more evident during the focus group talks. Participants reported they didn't engage with industry as much as they would have liked because they had concerns about funding or because businesses wouldn't work with them. Additionally, academic staff indicated that heavy workloads and outdated syllabi were key challenges that hindered their ability to modify the curriculum or adopt more interactive teaching methods.

Table 2 Challenges in Learning and Teaching results

Category	Specific Indicator	Mean Score	Range	Qualitative Key Finding & Insights
Challenges	• Lack of hands-on instruction	3.85	3.51–4.00	• Industry Disconnect: Faculty cite difficulty engaging with industries due to funding concerns or lack of business cooperation. • Structural Issues: Heavy workloads and outdated syllabi prevent curriculum updates.
	• Finding research/tools	3.82	3.41–4.07	
	• Institutional Support	3.75	3.34–4.09	

4.3 Teaching and Learning Preferences

The analysis of the most effective learning methods reveals a clear trend toward practical, experience-based approaches (Table 3). Real-world examples and case studies were the most effective among the strategies, with an average of 4.21 (range = 3.86–5.00). In addition, hands-on workshops or projects were strongly preferred, with an average of 4.00 (range = 3.70–4.14). These findings indicate that interactive, applied learning significantly enhances the comprehension of circular economy principles.

On the other hand, online interactive modules were rated the least preferred method, with a mean of 3.29 (SD = 0.98), ranging from 2.00 to 3.98. Although some still regard it as applicable, the wide range of responses indicates controversy among respondents, with many indicating that digital learning lacks the engagement and depth of collaborative approaches. Focus group participants specifically noted that experiential methods are essential for bridging the gap between

theory and application, while project-based learning enhances cross-disciplinary problem-solving. Regarding the format, the majority favoured a blended learning approach. However, direct face-to-face learning remained a vital method.

Table 3 Teaching and Learning Preferences

Category	Specific Indicator	Mean Score	Range	Qualitative Key Finding & Insights
Preferences	• Real-world examples/cases	4.21	3.67–4.00	• Experiential Methods: Essential for bridging the gap between theory and application.
	• Hands-on workshops	4.00	3.70–4.14	• Project-Based Learning: Enhances cross-disciplinary problem-solving skills.
	• Online interactive modules	3.29	2.00–3.98	• Blended Learning: Favored by the majority of participants as the preferred approach.

4.4 Resources and Recommendations

Regarding the resources required for effective teaching (Table 4), opportunities for internships were regarded as critical, with an average of 4.32 (range = 3.90–5.00). This is supported by the high value placed on laboratory and fieldwork opportunities (M = 4.29, Range = 3.93–5.00), underlining the necessity of tangible, investigative learning experiences. Additionally, practical tools and software were deemed highly important (M = 4.12, Range = 3.98–5.00), suggesting that digital and technical resources are essential. Case studies and real-world examples were also rated as a top resource (M = 4.13, Range = 3.84–5.00), bridging the gap between theory and practice. Nevertheless, difficulties in obtaining these resources were acknowledged, with participants citing financial limitations, time constraints, and limited internet access as significant barriers.

Regarding the postgraduate program features and how to strengthen them (Table 4), the most essential idea was to work with businesses to give students real-world experience (M = 4.21, Range = 3.77–5.00), whereas the second in line was the collaboration with international institutions (M = 4.02, Range = 3.84–4.13). The inclusion of digital tools and technologies (M = 3.89, Range = 3.64-4.09) and industry-relevant skills (M = 3.88, Range = 3.73-4.11) was also highly regarded, reflecting the need for digital proficiency in modern sustainability contexts. Focus group participants concluded that programs must balance domestic and global relevance, suggesting that cross-disciplinary collaboration is essential to holistically address sustainability challenges.

Table 4 Resources and Recommendations results

Category	Specific Indicator	Mean Score	Range	Qualitative Key Finding & Insights
Resources	• Internships	4.32	3.90–5.00	• Resource Constraints: Financial limitations, time constraints, and limited internet access.
	• Laboratory and fieldwork opportunities	4.29	3.93–5.00	
	• Practical tools and software	4.13	3.98–5.00	
	• Case studies and real-world examples	4.12	3.84–5.00	
Recommendations	• Practical Application/ Case Studies	4.21	3.77–5.00	• Balance domestic and global relevance • Cross-disciplinary collaboration is essential to respond holistically to sustainability challenges
	• International Collaboration	4.02	3.71–4.20	
	• Digital Tools	3.89	3.64–4.09	
	• Industry-relevant skills	3.88	3.73-4.11	

5 Discussion

This study aimed to investigate the current educational landscape regarding sustainability and CE in Indonesia, Vietnam, and Laos, using data from six universities, two in each country. More specifically, the main goal was to identify knowledge gaps, training needs, and the necessary features to develop a postgraduate curriculum in sustainability and CE. Based on the combined analysis of the questionnaire and focus group discussions, it is evident that, although there is foundational awareness of sustainability, significant gaps remain in the conceptual and practical application of the circular economy (Herrador & Van, 2024; Switch Asia, 2022).

Regarding understanding of key concepts, strong familiarity with general sustainability principles was observed among academic staff and students. Nonetheless, understanding of the Circular Economy (CE) remains limited and is often framed in linear terms, particularly among students. This underscores that the shift towards circularity in developing Asia remains in its nascent phase and is hindered by entrenched linear economic frameworks (Indiran et al., 2025; Wardani et al., 2025). The findings also indicated that, despite the prioritisation of pollution management and environmental impact assessments, there is a disconnect in understanding the application of

Circular Economy (CE) principles across several sectors, including agriculture and engineering. This supports the notion that without a clear definition and unified framework, the shift from a "take-make-dispose" model to a regenerative one remains conceptually abstract for learners (Kirchherr, 2023).

Regarding knowledge and skill gaps, the results highlight a critical need for structured learning materials that cover macroeconomic and institutional topics, including governance, taxation, and community engagement. Consequently, effective CE implementation requires not just technical solutions but also new policy frameworks and reporting requirements (Zawawi et al., 2025). Furthermore, a deficiency in technological and analytical competencies, particularly in quantitative methods for environmental impact assessments to monitor performance and use of advanced technologies, such as AI and Big Data, with the development of circular business models was identified. This deficiency is particularly concerning given the established link between innovation and sustainability, especially regarding energy efficiency and technological innovation (Campos-Romero & Rodil-Marzábal, 2025).

Consequently, the integration of digitalisation and innovative infrastructure is increasingly recognised as a catalyst for sustainable industrial development and a key enabler of the circular economy's transformation (Lacy & Rutqvist, 2015; Liu et al., 2022). Furthermore, the implementation of specific digital interventions, such as e-toolkits during international teaching weeks, has been shown to significantly improve digital content creation and problem-solving skills in hybrid work environments (Kalogiannakis et al., 2023).

Mobile technologies offer a critical pedagogical bridge to address the disparity between students' desire for hands-on learning and the identified gaps in digital literacy and in access to digital devices and equipment (Kormos & Wisdom, 2022; Poultsakis et al., 2021). While participants rated the online interactive modules poorly, potentially due to their static nature, blended learning was highly favoured. This distinction suggests that participants may not simply discard digital tools; rather, they reject the isolation of static distance learning and prefer technologies that augment physical practice, such as mobile devices, to support fieldwork and enable active data collection and analysis (Tavani et al., 2022). This approach can bypass barriers of limited funding and outdated resources by utilizing mobile technologies, for instance, in order to run simulations and digital learning objects that would otherwise require unavailable computer labs (Poultsakis et al., 2021). The evolution of coding platforms into HTML5-based mobile apps can further enable students to engage in computational thinking directly on tablets or phones, making digital literacy accessible even in remote settings (Papadakis & Kalogiannakis, 2019; Chatzopoulos et al., 2023). Additionally, integrating AI-supported tools on mobile devices can increase access to expert guidance, serve as personalised mentors during independent fieldwork, and directly support the United Nations Sustainable Development Goals for quality education (Uğraş et al., 2024).

From a research perspective, these results also reinforce the importance of situated, context-aware learning designs, suggesting that mobile learning is most effective when integrated directly into physical environments such as workshops and internships (Ng, 2021). In the context of sustainability and CE education, mobile devices can act as mediating tools that bridge digital and physical spaces, facilitating real-time monitoring of environmental impacts, waste streams, and resource efficiency (Maketo et al., 2023). Consequently, these mobile-supported practices aim to enable learners to connect theoretical knowledge with practical decision-making, reinforcing essential skills in environmental assessment (Layyinah, et al., 2024) and circular business innovation (Lindgren, 2024).

Regarding teaching and learning preferences, participants strongly favoured experiential and applied learning methods, such as case studies, internships, and project-based learning. Connecting academia and industry, theory and practice, hands-on training, and industry exposure has always been a vital issue in higher education (Machell & Saunders, 2000; Nunes et al., 2018; Switch Asia, 2022). Moreover, the preference for blended learning models reflects the broader trend in higher education towards more dynamic delivery methods (Ortiz-de-Montellano, et al., 2023). However, the study also highlighted significant institutional barriers. The lack of funding, outdated laboratories, and heavy administrative workloads for faculty restrict the adoption of these innovative teaching methods in circular practices (Serrano-Bedia & Perez-Perez, 2022).

6 Limitations

Firstly, the use of convenience sampling to recruit participants from the six partner universities may limit the ability to generalize these results to the broader higher education sector in Southeast

Asia. Moreover, although the total sample size of 103 participants across both questionnaires and focus groups yielded substantial data, a larger sample size might have yielded more statistically significant quantitative outcomes. Additionally, the study relies on self-reported data on abilities and preferences, which may be subject to bias. Additionally, some participants who responded to the poll noted that specific terms, such as "opportunities for interns," were somewhat vague, which may have influenced their responses. This study aimed to provide a foundational understanding of educational requirements to inform the development of a specific master's program. On the other hand, involving a wide range of participants, such as students, academic staff, and professionals in the field, gave a multi-perspective view that is important for developing a curriculum.

7 Conclusions

The present study offers vital insights and showcases that establishing a postgraduate program in sustainability and Circular Economy (CE) in Southeast Asian universities requires a fundamental shift from theoretical instruction to practical, interdisciplinary application. The analysis indicates that a standardised curriculum integrating economic, environmental, and technological dimensions can significantly enhance students' labour-market readiness, provided it is supported by experiential learning opportunities such as internships and fieldwork (Plakitsi et al., 2014).

The successful integration of blended learning emerged as a valuable pedagogical strategy. This approach balances the need for flexibility with the crucial requirement for hands-on engagement in laboratories and industry settings. Furthermore, viewing CE skills not merely as technical knowledge but as a holistic competency encompassing social awareness, digital literacy, and regulatory understanding is essential. Educators and curriculum designers should be encouraged to link CE learning with real-world industry challenges and align curricula with the Sustainable Development Goals (SDGs) to ensure global and local relevance.

However, the role of institutional support is critical in realizing these benefits. The successful implementation of the proposed master's program depends heavily on strengthening partnerships with industry and government to secure necessary resources and practical exposure (Nunes et al., 2018). Moreover, universities need to invest in faculty training and reduce administrative burdens to enable curriculum innovation. Consequently, supporting educators and fostering international collaboration will be essential to empowering Asian academic institutions to drive the transition to the circular economy.

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Disclaimer

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Conflicts of interest

The authors declare that they have no conflict of interest.

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