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Promoting village self-sufficiency through edu-tourism: A circular economy approach

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ABSTRACT

This study examines the integration of Circular Economy (CE) principles into edu-tourism (education-based tourism) to promote economic, social, and environmental sustainability. CE based edu-tourism applies sustainable practices such as waste reduction, resource efficiency, and integrated agriculture to create educational and eco-friendly tourism experiences. Using a case study in Pancasan Village, the research demonstrates how this approach enhances community awareness, empowers local residents, and stimulates innovation. These outcomes indicate that adopting CE-oriented strategies in rural tourism can strengthen community-based economic development and serve as a practical model for sustainable village transformation. The Balanced Scorecard (BSC), adapted to CE principles, was employed to design and assess sustainability strategies across four perspectives, financial, customer, internal processes, and learning and growth. The findings underscore that aligning sustainability practices within each BSC perspective supports the achievement of strategic goals, while the digitalization of strategic management enhances implementation effectiveness.

Keywords: balanced scorecard, circular economy, community empowerment, edu-tourism, integrated farming system, strategic management

INTRODUCTION

Tourism is a sector that has a significant contribution to the economy, both at the national and local levels (Aponno, 2020). This contribution is not only seen in increasing regional income and creating jobs, but also in developing infrastructure and improving the quality of life of local communities. Tourism also has an important role in introducing local culture and increasing awareness of the importance of environmental conservation (Sari et al., 2022). In recent decades, the tourism sector has undergone a transformation with the emergence of various alternative forms of tourism that are more sustainable and focus on empowering local communities. One form of alternative tourism that is currently developing is edu-tourism.

Edu-tourism or education-based tourism not only offers recreational tourism experiences, but also provides added value in the form of education and learning for tourists (Prasetyo & Nararais, 2023). Tourists can learn about local culture, history, environment, and sustainable practices implemented in the tourist destinations they visit. Edu-tourism can also be a means of increasing public awareness and understanding of global issues such as climate change, environmental conservation and food security (Magnaye, 2019; Owino et al., 2022). Thus, edu-tourism not only contributes to the economy, but also has a positive impact on education and environmental awareness.

Circular economy education in Indonesia is an initiative that combines educational concepts with circular economy practices to increase awareness about sustainability and the environment (Mulyani et al., 2024). An example of the implementation of this initiative can be seen in Wonosidi Village, Tulakan District, which has developed itself as a tourist village with a focus on circular economy education. This program aims to educate the public about waste management and circular economy practices that can improve the welfare of local communities (Pacitan Regency Government, 2021). In addition, the Indonesian government recognizes the huge potential of the circular economy, which is estimated to reach IDR 500 trillion, and this sector is expected to become one of the main pillars in Indonesia's future economy. Eduwisata plays an important role in introducing this concept to the wider community, especially in priority sectors such as food and beverage, textiles, construction, wholesale and retail (plastic), and electronics (Wisnawa & Putra, 2025). Through these various initiatives, circular economy education in Indonesia has the potential to become an effective tool for increasing public awareness and

understanding of the importance of sustainability and efficient resource management.

Circular economy education is not limited to the evidence in the previous paragraph. In this study, the synergy between circular economy principles and edu-tourism refers specifically to the integration of three key aspects. First, circular production systems that reduce waste and reuse resources. Second, educational activities that build community knowledge and awareness of sustainability, and third, participatory management that empowers local stakeholders to co-create value in tourism development. The circular economy concept is starting to be adopted in the development of edu-tourism destinations, especially those based on integrated agriculture (Hamdir & Nurhasanah, 2021). A circular economy is an approach that focuses on reducing waste and reusing resources in a sustainable production and consumption cycle (Geissdoerfer et al., 2017; Kirchherr et al., 2017). Circular economy principles are in line with integrated agricultural practices, where various agricultural components such as crops, livestock and fisheries are managed holistically to create an efficient and environmentally friendly system. Integrating circular economy concepts in integrated agricultural-based education provides opportunities to create tourist destinations that are not only attractive and educational, but also sustainable.

Edu-tourism based on a circular economy in integrated agriculture has an important role in various aspects, including educational, environmental, economic and social. This program provides an opportunity for tourists to learn first-hand about sustainability principles, such as waste reduction and efficient use of resources, which increases environmental awareness. In addition, this edu-tourism strengthens the local economy by creating additional sources of income and new job opportunities for village communities, as well as preserving traditional agricultural knowledge integrated with modern sustainable practices (Abreu et al., 2024). Edu-tourism also encourages innovation in agriculture through exchanging knowledge with tourists and researchers, as well as empowering local communities to be actively involved in managing their natural resources, increasing their sense of ownership and responsibility for the environment (Tomasi et al., 2020). By offering unique and educational tourism experiences, edu-tourism increases tourist attraction and supports sustainable development, making it a model that not only educates but also drives positive change in the local economy and environmental conservation.

Even though it is important, it turns out that research that focuses on developing integrated agricultural education often faces several limitations, such as limited resources, both in terms of budget, infrastructure and human resources, which can limit the research's ability to carry out projects effectively (Hangara, 2018). In addition, farmers often have limited knowledge and skills in integrated farming, which affects the quality of agricultural products and the entire farming system. Reliance on advanced technology also becomes a challenge if the technology is not available or difficult to access. Development of integrated agricultural education is often not well integrated with local communities, which can affect the long-term success of the project. However, this research also has great potential for developing innovative integrated agricultural models, such as using the *mina mendong* system which combines fish cultivation with food crops in one area, as well as integrating circular economy technology to increase agricultural efficiency and productivity while reducing environmental impacts. By providing comprehensive education and training, this research helps increase farmers' knowledge and skills in the field of integrated agriculture and integrates the development of integrated agricultural education with local communities, increasing community awareness and participation in sustainable agricultural development. Therefore, the research "Development of Integrated Agricultural Circular Economy Edu-tourism" can overcome several existing gaps and provide significant new conclusions in the field of integrated agriculture.

Despite its potential, the development of integrated agricultural edu-tourism still faces several challenges, including limited financial and human resources, insufficient knowledge of integrated farming practices, and weak community involvement. These constraints often hinder the long-term success and scalability of sustainability-oriented projects. Integrating Circular Economy (CE) principles into edu-tourism provides an opportunity to address these issues by promoting resource efficiency, environmental stewardship, and community empowerment through education. Furthermore, the Balanced Scorecard (BSC) offers a structured framework for translating these strategic goals into measurable indicators and ensuring continuous performance monitoring.

Therefore, this study aims to identify strategic objectives for developing an integrated agricultural edu-tourism model based on CE principles that supports economic, social, and environmental sustainability, formulate performance indicators across the four BSC perspectives to monitor the implementation of CE-oriented edu-tourism strategies, and evaluate implementation performance through digital simulation using BSC Designer software to assess strategic alignment, indicator achievement, and areas for improvement.

LITERATURE REVIEW

Circular Economy

A circular economy (CE) is a sustainable approach to resource management that minimizes waste by promoting the continuous use of materials in a closed loop system (Geisendorf & Pietrulla, 2018; Korhonen et al., 2018). This approach reduces the need for new raw materials and environmental impact with principles such as designing for circularity, where products are created to be easily recovered, repaired and recycled. These products are also designed using recyclable and biodegradable materials. Circular economy models encourage sharing and collaboration through rental and product-as-service concepts, which reduce resource consumption and extend the life cycle of materials through recycling (Yadav et al., 2025). CE practices involve assessments using methods such as Life Cycle Assessment (LCA) and other circularity indicators to measure their impact (Rigamonti & Mancini, 2021). However, implementation is often hampered by challenges such as misunderstanding, inadequate policies, resistance to change, high costs, and limited technology.

Enablers include the use of digital tools, stakeholder engagement, and the adoption of a systemic perspective. In certain industries, such as construction, CE strategies focus on efficient resource management, market orientation, knowledge dissemination, and regulatory compliance. However, awareness and implementation of circularity practices is often limited, especially in areas such as repair and reuse.

Educational Tourism

Edu-tourism, or educational tourism, is a tourism concept that combines educational elements with recreational experiences, aiming to provide fun and interactive learning to visitors (Maga & Nicolau, 2018; Tomasi et al., 2020; Widawski et al., 2023). In edu-tourism, participants gain new knowledge and skills through direct experience outside the formal education environment. For example, they can learn about history, culture, nature, or technology through visits to historic sites, museums, science centers, or plantations. Edu-tourism emphasizes interactivity and real context, where learning occurs directly in everyday life settings, such as picking fruit in the garden, making traditional crafts, or participating in environmental conservation activities (Selvakumar et al., 2024). Apart from providing educational benefits, edu-tourism also offers fun and relaxation, making it a meaningful form of recreation. Thus, edu-tourism not only provides valuable and unforgettable experiences, but also increases environmental awareness, culture and practical skills for participants.

Integrated Farming

Integrated agriculture is a system that integrates various types of agricultural activities such as food crops, livestock, fisheries and forestry on one land with the aim of utilizing resources optimally and sustainably (Patra, 2016; Sulaksana et al, 2023). In this system, waste from one agricultural activity is utilized as input for another activity, creating an efficient closed cycle. For example, livestock manure is used as organic fertilizer for plants, and plant waste is used as animal feed or compost. Integrated agriculture is also designed to reduce the use of synthetic chemicals, increase soil fertility, and control pests naturally through crop diversification and rotation (He et al., 2019). In addition, this system allows optimizing land and water use, increasing productivity and farmer income by producing various commodities in one area. Although it offers many benefits, such as increased efficiency and environmental sustainability, integrated agriculture also faces challenges in complex management, large initial capital requirements, and requires the right knowledge and technology to implement effectively.

Balanced Scorecard for Circular Economy

The Balanced Scorecard (BSC) for the Circular Economy (CE) is an adaptation of the traditional BSC framework that aligns strategic management with sustainability principles (Martín-Gómez et al., 2024). The CE emphasizes waste minimization and resource optimization through recycling, reusing, and regenerating materials (Indrayani, 2021). Within this context, the BSC's four perspectives, financial, customer, internal process, and learning and growth, are reoriented to integrate environmental and social objectives (Torgautov et al., 2022). This approach enables organizations to monitor performance beyond economic outcomes by embedding circularity into financial efficiency, customer value, operational processes, and innovation capacity.

Previous studies have applied BSC–CE models across various sectors, yet with differing priorities. In manufacturing, they focus on material efficiency, cost savings, and waste reduction (Torgautov et al., 2022), while in urban waste management, they emphasize operational optimization and stakeholder collaboration (Rigamonti & Mancini, 2021). Similarly, Martín-Gómez et al. (2024) proposed a corporate transformation model aligning CE principles with strategic innovation.

By contrast, this study extends the BSC–CE framework to the rural edu-tourism sector, an area rarely examined in the literature. Unlike industrial or urban contexts, the indicators here integrate resource efficiency with educational, cultural, and empowerment dimensions. This adaptation reflects the unique characteristics of rural villages, where sustainability is closely linked to social learning and community participation. Consequently, the study offers a novel contribution by contextualizing BSC–CE for community-based, non-industrial development.

METHOD

This study adopts a qualitative case study design to explore the integration of Circular Economy (CE) principles within edu-tourism development. The research was conducted in Pancasan Village, Central Java, Indonesia, selected for its ongoing transition toward sustainability-oriented tourism.

Research Respondents

The number of respondents in the research was 41 people, consisting of several groups that were directly related to the development of Pancasan Village edu-tourism. First, village officials such as the Village Head and village officials (4 people) need to be involved because they understand the vision, mission and goals of village development, including the edu-tourism sector. Second, the Pancasan Village edu-tourism managers (12 people) are the parties directly responsible for the management and operationalization of edu-tourism, so they can provide in-depth information regarding internal conditions and management strategies. Third, community leaders and traditional leaders (3 people) need to be included to provide perspectives regarding local values, culture and traditions which are the attraction of edu-tourism. Fourth, tourists or edu-tourism visitors (7 people) can provide relevant input for the customer perspective in the Balanced Scorecard method.

Fifth, local business actors (6 people), such as craftsmen, traders, or supporting service providers, can provide insight regarding the impact of edu-tourism on the local economy and its contribution to the tourism ecosystem. Sixth, educational institutions or educational groups (3 people), such as teachers or trainers, are also important to provide input regarding educational activities that are part of edu-tourism. Seventh, tourism experts or consultants (3 people) can provide strategic analysis and professional input regarding tourism

development based on the Balanced Scorecard method. Finally, representatives from related agencies, such as tourism, agriculture or environmental agencies (3 people), need to be involved to ensure strategic planning is in line with local government policies and programs.

Data Analysis

This research uses a descriptive qualitative approach with a Balanced Scorecard (BSC) analysis framework adapted for the circular economy context. Data was collected through in-depth interviews, focus group discussions (FGD), and participatory observation of 41 respondents consisting of village officials, edu-tourism managers, community leaders, tourists, local business actors, educators, tourism experts, and representatives of related agencies.

The first step in the analysis was to identify the vision, mission and strategic objectives of Pancasan Village edu-tourism, which were confirmed through primary data from interviews with village officials and tourism managers. The second step is to analyze the internal and external environment using the SWOT approach. This analysis allows the identification of strengths, weaknesses, opportunities and threats that directly influence the design of edu-tourism strategies.

Next, field findings are classified based on the four main perspectives of BSC, financial, customer, internal processes, and learning and growth, each of which is associated with economic, social and environmental aspects of sustainability. For example, input from local business actors regarding increasing income is used as a basis for determining Sales Growth indicators from a financial perspective. Meanwhile, insight from tourists regarding the importance of environmental education served as the basis for defining the indicator customer awareness campaign on sustainability under the customer perspective.

To operationalize Circular Economy (CE) principles within the BSC, each perspective was modified to include sustainability-driven objectives and indicators. In the financial perspective, profit-oriented metrics were complemented by indicators capturing cost savings from waste reduction and income from recycled products. The customer perspective emphasized satisfaction with sustainable products and awareness of environmental education. The internal process perspective integrated resource efficiency, renewable energy use, and waste minimization as core performance measures. Meanwhile, the learning and growth perspective focused on human resource capacity-building, staff sustainability training, and community empowerment programs. This adaptation ensured that the BSC not only measured strategic alignment but also captured tangible progress toward CE-oriented transformation.

From the results of this classification, a strategy map is prepared to describe the cause-and-effect relationship between strategic objectives in each perspective. Each goal is then formulated into a performance indicator with two assessment categories, namely result (final result) and inducer (performance booster), as shown in **Table 1**. These indicators are linked to the responsible unit (coordinator), as detailed in **Table 2**, to ensure structured implementation and can be evaluated periodically.

Finally, all data and indicators were entered into the BSC Designer software to visualize and analyze the strategy

Table 1. Objective indicator proposal

Code	Perspective	Objective	Indicator	Type
F	Finance	Increase profits	Sales growth	Result
		Increase productivity through good communication between management and workers	The level of SOP implementation is carried out well	Result
		Enabling long-term sustainability with recycling and waste management	The amount of costs incurred for the recycling process	Result
C	Customer	Increase customer satisfaction levels	Customer satisfaction	Result
		Increasing customer awareness of the need for sustainability and the benefits of implementing	Customer awareness campaign on sustainability	Inducer
		Incorporating recycled materials into the manufacture of products that support educational tourism	Number of recycled products used in educational tourism	Result
I	Internal process	Improving service efficiency, maintenance of facilities and infrastructure	Costs incurred to improve service efficiency, maintenance of facilities and infrastructure	Result
		Reducing the number of work accidents	Number of work accidents during educational tourism	Result
		Consuming renewable energy	The amount of renewable energy used	Result
G	Learning and growth	Establish economic incentives for personnel to increase productivity	Incentives provided	Result
		Increase employee satisfaction levels	Employee satisfaction level	Result
		Raise staff awareness of the need to implement circular and environmentally friendly principles	Staff awareness campaign on sustainability and circular principles	Inducer

Table 2 (Continued). BSC indicators and coordinators

Code	Objective	Coordinator	Indicator
F1	Increase profits	Operational and marketing manager	Sales growth
F2	Increase productivity through good communication between management and workers	Human Resource Management	The level of SOP implementation is carried out well
F3	Enabling long-term sustainability with recycling and waste management	Operational management	The amount of costs incurred for the recycling process

Table 2 (Continued). BSC indicators and coordinators

Code	Objective	Coordinator	Indicator
F1	Increase profits	Operational and marketing manager	Sales growth
F2	Increase productivity through good communication between management and workers	Human Resource Management	The level of SOP implementation is carried out well
F3	Enabling long-term sustainability with recycling and waste management	Operational management	The amount of costs incurred for the recycling process

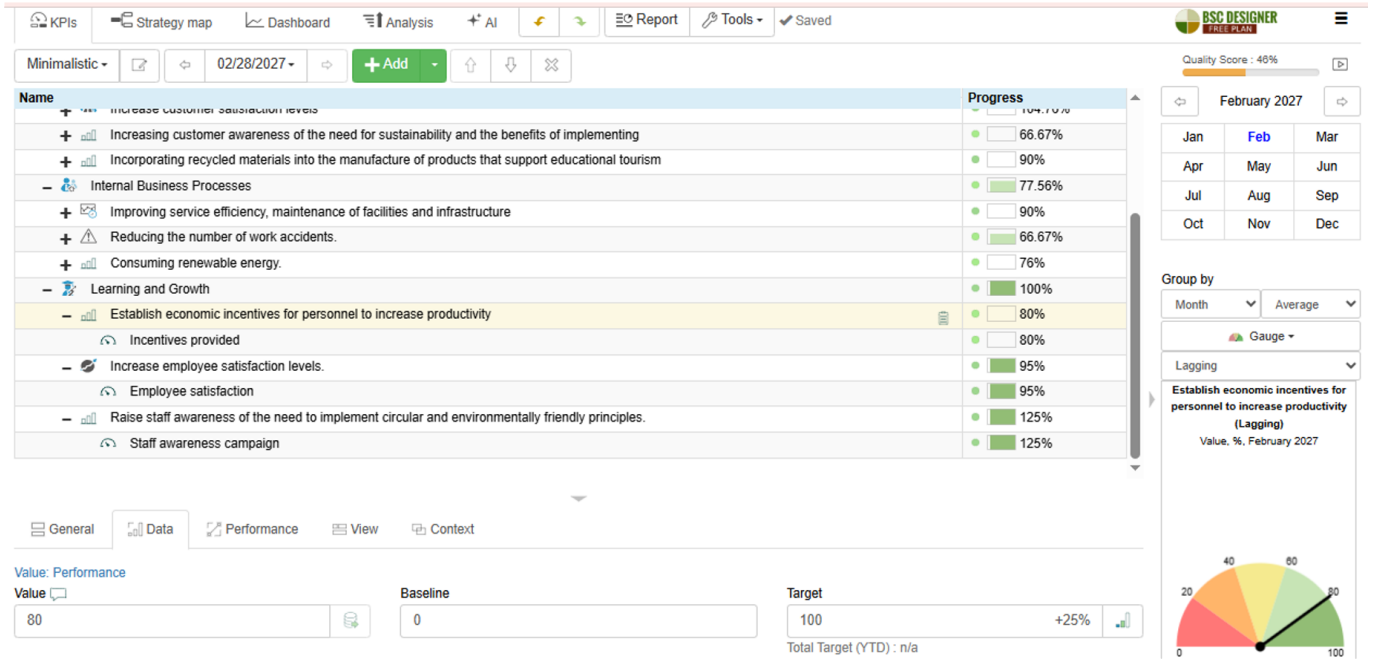

Figure 1. Organization KPI screen in BSC Designer software (Source: Authors' own elaboration)

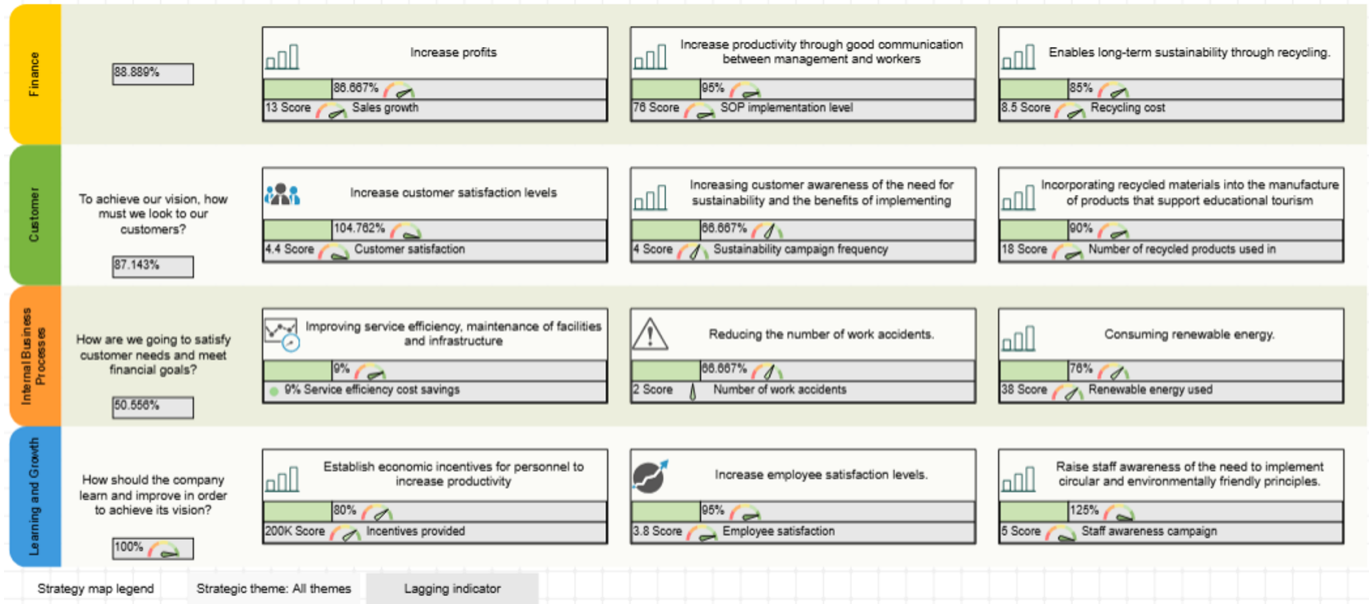

Figure 2. Organizational strategic map using BSC Designer software (Source: Authors' own elaboration)

implementation. Unlike a purely hypothetical simulation, the values displayed in **Figures 1** and **2** represent actual field data collected from respondents and on-site observations, which were then processed and organized within the Balanced Scorecard framework. The software was used to translate these empirical findings into measurable performance indicators and to map their interactions across financial, customer, internal process, and learning and growth perspectives.

RESULT AND DISCUSSION

The results of this research reveal how circular economy principles can be integrated into the Balanced Scorecard framework in the context of edu-tourism development in Pancasan Village. Information obtained from 41 respondents was used to develop evidence-based strategies by considering

Table 3. SWOT analysis

External environment	
Threats	**Opportunities**
Pancasan Village may be vulnerable to floods or landslides.	Potential for integrated agro-tourism development
Fluctuations in commodity prices, such as agricultural and fishery products, in local and national markets.	Pancasan Village has the opportunity to become a model village for effective waste management.
Limited public understanding of edu-tourism and the circular economy.	The village's fisheries unit can serve as an educational fish farming attraction, appealing to families.
Inadequate infrastructure conditions.	Pancasan Village can collaborate with schools, universities, or other educational institutions for edu-tourism programs.
Pancasan Village has to compete with other tourist destinations in Banyumas.	Pancasan Village can adopt environmentally friendly technologies.
Limited access to the internet and technology.	Development of local products and village-specific souvenirs .
Challenges in waste management.	Digital marketing to attract tourists.
Changes in tourist behavior.	Support from the Government and NGOs.
	Development of community-based tourism programs.
	Potential for health and relaxation tourism.
Internal environment	
Weaknesses	**Strengths**
Limited infrastructure	Pristine natural environment
Lack of promotion and branding	Diversity of integrated business units
Insufficient tourism support facilities	Potential for environmental and agricultural education
Limited human resources	Strong and cohesive community
Low public awareness of tourism potential	Availability of extensive agricultural land
Dependence on natural conditions	Local wisdom and culture
Limited access to technology and internet	Presence of water resources
Suboptimal waste management	Support from village government and educational institutions

local realities, community aspirations, and the challenges and opportunities faced.

Strategy Analysis

In line with the first research objective, which seeks to identify strategic objectives for implementing Circular Economy (CE) principles within edu-tourism, a SWOT analysis was conducted to understand the internal and external conditions influencing Pancasan Village's development. The case study used to apply the proposed methodology is based on the edu-tourism potential of a region. Before formulating a strategy and understanding the situation of Pancasan Village's edu-tourism potential, a SWOT analysis was carried out and presented in **Table 3**. This tool helps determine a strategy to ensure the feasibility of the proposed new project.

After making a SWOT analysis, a strategy can be defined to increase strengths, overcome weaknesses, control threats and take advantage of opportunities. To strengthen the analytical traceability, the results of the SWOT analysis were directly linked to the formulation of Balanced Scorecard (BSC) indicators. Each SWOT item was examined in relation to the four BSC perspectives (financial, customer, internal process, learning and growth). For instance, one of the strengths identified was the strong commitment of local leaders and managers in promoting edu-tourism. This strength was translated into the indicator SOP implementation level (F2) under the financial perspective, reflecting the institutionalization of management practices. Meanwhile, a weakness such as limited marketing capacity was addressed through the indicator customer awareness campaign on sustainability (C2) to ensure improved outreach.

Opportunities identified, such as increasing tourist demand for sustainable experiences, were converted into indicators like number of recycled products (C3), demonstrating how market opportunities drive innovative product development. Threats, such as potential environmental degradation due to unmanaged waste, were integrated into indicators like renewable energy consumption (I3) and work accident number (I2), which emphasize preventive measures and sustainable resource use. This systematic translation ensures that SWOT findings are not only descriptive but also operationalized into measurable indicators. The explicit link between SWOT elements and BSC perspectives improves transparency in how strategic issues were prioritized and transformed into performance metrics.

The proposed goal for developing edu-tourism in Pancasan Village is to make its economic, social and environmental activities more sustainable by implementing circular economy (CE) principles. The application of this principle is an implementation of BS 8001:2017. BS 8001:2017 is a standard released by the British Standards Institution (BSI) which focuses on implementing circular economy principles in organizations. This standard aims to help organizations of all sectors and sizes understand and adopt a circular economy approach to reduce waste, increase resource efficiency, and create environmental, social and economic value.

In this case, the proposed CE implementation process starts from the first step, namely determining the framework, scope, and strategic objectives and roles.

The first step, determining the framework includes questions regarding:

1. Does Pancasan Village's edu-tourism vision comply with the definition of a circular economy?
2. Have the benefits and opportunities of implementing CE been understood by Pancasan Village edu-tourism stakeholders?

Table 4. Goal setting and strategic map

	Economic	Social	Environment
Finance	Increase profits	Increase productivity through good communication between management and workers	Enabling long-term sustainability with recycling and waste management
Customer	Increase customer satisfaction levels	Increasing customer awareness of the need for sustainability and the benefits of implementing	Incorporating recycled materials into the manufacture of products that support educational tourism
Internal process	Improving service efficiency, maintenance of facilities and infrastructure	Reducing the number of work accidents	Consuming renewable energy
Learning and growth	Establish economic incentives for personnel to increase productivity	Increase employee satisfaction levels	Raise staff awareness of the need to implement circular and environmentally friendly principles

3. How is CE communicated within the Pancasan Village edu-tourism organization?
4. What systems in Pancasan Village edu-tourism are related to CE's vision and goals?

The second step, scope includes questions regarding:

1. How can CE influence the Pancasan Village education system?
2. What assumptions are used to implement CE in the Pancasan Village education system?
3. What problems might arise, and are there any unintended consequences of the proposed action?

The third step, determining goals and strategic maps. Strategic objectives are created based on elaboration from a balanced scorecard perspective which considers financial, customer, internal process and expenditure aspects as well as growth with a sustainability perspective which considers economic, social and environmental aspects. Determining the objectives and strategic map of Pancasan Village edu-tourism is presented in **Table 4**.

Balanced Scorecard Design

Addressing the second research objective, which focuses on formulating measurable indicators across the four BSC perspectives, the study developed a set of performance indicators grounded in stakeholder perceptions and field findings. The selection of indicators was strongly influenced by community perceptions gathered through interviews, FGDs, and participatory observations. For example, tourists consistently highlighted the importance of gaining educational value and environmental awareness from their visits. This perception guided the inclusion of the indicator customer awareness campaign on sustainability (C2), ensuring that visitor expectations were embedded in the performance framework.

Local business actors, such as handicraft producers and food vendors, emphasized the need for economic empowerment through product innovation and training. Their views were directly reflected in the indicators sales growth (F1) and number of recycled products (C3), which capture both financial benefits and market expansion derived from sustainable practices.

Village leaders and community elders underlined the importance of cultural preservation and collective responsibility, which supported the formulation of SOP implementation level (F2) and staff awareness campaign on sustainability (G3). Meanwhile, feedback from education groups and trainers stressed the necessity of continuous learning opportunities, leading to the adoption of indicators like employee satisfaction (G2) and personnel incentives (G1). By explicitly linking perceptions of diverse stakeholders with the final indicators, the study ensures that the Balanced Scorecard does not merely reflect theoretical constructs but represents a grounded, participatory strategy responsive to local realities.

After defining the indicators that will be used, the next step is to determine the coordinator for each goal. **Table 2** shows selected indicators related to each strategic objective and its respective coordinator.

Each indicator was then characterized in accordance with the recommendations of the UNE 66175:2003 standard. UNE 66175:2003 is a standard that provides guidance for the implementation of indicator systems in quality management. This standard is designed to help organizations design and implement performance indicators that can be used in quality management systems, ensuring that quality management objectives can be monitored and evaluated effectively. There are 12 indicators proposed, but in this paper one indicator template will be presented. The indicator used is consuming renewable energy which will be presented in **Table 5**.

The results of interviews and FGDs show that the majority of respondents from local management groups and business actors highlighted improving the economy through skills training and local products, which was then formulated as a strategic goal. *Increase profits* And *Sales growth* in a financial perspective (F1). Apart from that, village officials and community leaders expressed the importance of building a collaborative work culture, which was translated into indicators *SOP implementation level* (F2).

In the customer perspective, tourists express interest in the educational and sustainable aspects of tourism activities, which form the basis for goal setting *Increase customer satisfaction* (C1) and *Customer awareness campaign on sustainability* (C2). Tourism products that contain recycled materials, such as crafts from organic waste, are also a special attraction, thus an indicator *Number of recycled products* (C3) becomes relevant.

Field findings from the observation process and interviews with managers show that efforts to increase service efficiency and work safety are still the main focus. This underlies the determination of indicators *Service efficiency cost* (I1) and *Work accident number* (I2). Meanwhile, the use of solar panels and

Table 5. Indicator assessment template

Code 13	Indicator consuming renewable energy	Type	Results
		Perspective	Internal process
		Strategic objective	Environment
		Responsible	Operational management
Definition		The amount of renewable energy used	
Frequency		Annual	
Calculation rule		(amount of renewable energy used / total energy used) x 100%	
Target		> 50% 20 – 50% < 20%	
Source of information		Operational data	
Coordination responsible for the information		Operational management	
Necessary actions		Notes on the amount of renewable energy used in the operation of educational tourism activities	

Table 6. Performance indicator

Code	Perspective	Indicator	Target	Actual	Performance	Status
F1	Finance	Sales growth	15%	13%	86.7%	Fair
F2	Finance	SOP implementation level	80	76	95.0%	Fair
F3	Finance	Recycling cost (% from total operations cost)	10%	8.5%	85%	Good
C1	Customer	Customer satisfaction (survey 1–5)	⩾ 4.2	4.4	104.8%	Good
C2	Customer	Sustainability campaign frequency (per year)	6	4	66.7%	Poor
C3	Customer	Number of recycled products used in Edu-tourism	20	18	90.0%	Fair
I1	Internal Process	Service efficiency cost savings (% from baseline)	10%	9%	90.0%	Fair
I2	Internal Process	Number of work accidents	⩽ 3	2	Achieved	Good
I3	Internal Process	Renewable energy used (% of total energy)	>50%	38%	76.0%	Fair
G1	Learning & Growth	Incentives provided (Rp/month/person)	250000	200000	80.0%	Fair
G2	Learning & Growth	Employee satisfaction (survey 1–5)	⩾ 4.0	3.8	95.0%	Fair
G3	Learning & Growth	Staff awareness campaign (events/year)	4	5	125%	Good

other environmentally friendly technologies is starting to be tested, which are categorized as indicators *Renewable energy consumption* (I3).

From a learning and growth perspective, interviews with village officials and trainers stated the importance of appreciation and continuous training. Therefore, strategic objectives such as *Personnel incentives*, *Employee satisfaction*, And *Staff awareness campaign on sustainability* (G1–G3) were formulated as part of a sustainability-oriented HR development strategy. Furthermore, the data is presented in **Table 6**.

All these indicators have been entered and simulated through software *BSC Designer* to ensure the link between objectives, indicators and implementer responsibilities. Visualization of strategy maps and organizational performance makes it easier to monitor achievements and identify aspects that need improvement. With this approach, Pancasan Village edu-tourism has a strategic framework that is measurable, participatory and adaptive to environmental and socio-economic challenges.

BSC Implementation and Simulation

In accordance with the third research objective, which aims to evaluate implementation performance using digital simulation, all strategies and indicators were entered into BSC Designer software for visualization and performance analysis. This application, designed specifically for Balanced Scorecard (BSC) management, enables systematic tracking of each indicator across financial, customer, internal process, and learning and growth perspectives. It greatly facilitates data entry, visualization, and real-time monitoring, allowing managers to assess progress effectively.

Although the software requires initial training, capacity building for local coordinators is a worthwhile investment, as it significantly enhances strategic management efficiency. In this study, data were entered based on selected frequencies for each indicator over one year to simulate medium-term implementation performance. The software automatically sets strategic objectives for each perspective and visualizes their interrelationships through key performance indicators.

This screen provides comprehensive information, enabling users to monitor indicator performance, track progress, review the latest data entered, and verify whether the information has been updated. Users can also easily identify indicator types graphically (green performance indicators and gray result indicators) and assess whether their performance is adequate using the traffic light system.

When compared with prior applications of the BSC–CE framework, the present study highlights a different set of priorities. In manufacturing and urban waste management, for example, indicators tend to emphasize efficiency gains, material recovery, and regulatory compliance (Rigamonti & Mancini, 2021; Torgautov et al., 2022). By contrast, the rural edu-tourism context requires the integration of social learning, cultural preservation, and community empowerment as equally important dimensions alongside financial and environmental indicators. This distinction underscores the adaptability of the BSC–CE framework, while its structure remains consistent, the selection of indicators must be grounded in the socio-economic realities of the sector under

study. Thus, this research demonstrates that rural edu-tourism is not merely an application of an industrial model but a unique context where sustainability metrics must incorporate educational and participatory aspects to remain relevant and effective.

A comparative reflection with prior BSC–CE applications further illustrates the uniqueness of this study. In manufacturing contexts, BSC–CE is typically applied to monitor material flow efficiency, energy consumption, and waste minimization (Torgautov et al., 2022). In urban waste management, the framework is mainly used to evaluate recycling rates, cost reductions, and regulatory compliance (Rigamonti & Mancini, 2021). These applications emphasize process optimization and environmental performance.

By contrast, the rural edu-tourism case presented here integrates economic, social, cultural, and environmental dimensions in a more balanced manner. Indicators such as customer awareness campaign on sustainability and staff awareness campaign on sustainability extend beyond efficiency measures, capturing the educational and participatory aspects that are central to community-based tourism. This comparative perspective highlights the flexibility of the BSC–CE framework: While in industrial contexts it drives operational excellence, in rural edu-tourism it becomes a vehicle for empowerment, knowledge sharing, and sustainable local development.

The analysis also reveals that several indicators performed below their intended targets, underscoring key implementation challenges. For example, renewable energy usage reached only 38%, below the > 50% target. Interviews with village officials indicated that high initial investment costs and limited technical expertise were major barriers to wider adoption of solar panels and other renewable technologies. The absence of financial incentives or subsidies further reduced local motivation to transition from conventional to renewable energy. Policy support in the form of micro-financing schemes, technical training, and collaboration with renewable energy providers could significantly accelerate adoption.

Similarly, the sustainability campaign frequency achieved 66.7% of the target. This shortfall was mainly due to limited human resources, inconsistent scheduling, and competing priorities with other community programs. Strengthening partnerships with schools, universities, and NGOs could help institutionalize awareness campaigns, while integrating sustainability topics into existing cultural and educational events would reduce resource demands. Establishing an annual campaign calendar could also improve consistency and broaden participation.

Addressing these gaps is critical, as they directly influence both the effectiveness of Circular Economy implementation and the credibility of edu-tourism as a model for sustainable village development. By identifying barriers and proposing targeted solutions, the Balanced Scorecard becomes not only a measurement tool but also a guide for continuous improvement. Another important consideration is the financial viability of the interventions. While this study did not conduct a detailed Return on Investment (ROI) analysis due to data limitations, qualitative evidence suggests that the measures carry strong economic potential.

The introduction of recycled handicraft products and value-added local food items has already generated supplementary income, with several artisans reporting increased sales during tourist visits. Skills training programs also improved productivity, enabling villagers to diversify income sources beyond conventional agriculture. From a cost perspective, renewable energy technologies require higher upfront investment, explaining the slower adoption rate. However, long-term savings from reduced electricity costs and potential access to subsidies could enhance financial attractiveness. Likewise, sustainability awareness campaigns, though initially resource-intensive, become cost-effective when integrated into existing cultural or educational events.

Future studies could strengthen this analysis by quantifying costs and benefits more systematically, for example through scenario-based ROI calculations or cost-benefit analysis across intervention types. Such an approach would provide stronger evidence for policymakers and funding institutions when deciding on resource allocation for sustainable edu-tourism development.

In addition to these findings, several environmental impact metrics provide a more quantitative picture of Circular Economy implementation. Field observations showed that organic waste utilized for composting and recycled handicrafts accounted for approximately 15% of total waste, compared with the target of 20%. Water use efficiency in integrated farming systems reached around 65%, below the > 70% target, largely due to irrigation technology limitations and variable rainfall. Renewable energy consumption, as noted earlier, stood at 38%, underscoring the gap in transitioning away from conventional electricity.

Although these values fall short of their targets, they are valuable as baseline measurements for setting realistic improvement pathways. Expanding household-level composting could enhance waste reduction, while adopting low-cost drip irrigation systems could improve water efficiency. Including these quantitative measures complements the qualitative insights from stakeholders, thereby strengthening the robustness of the Balanced Scorecard framework in capturing environmental sustainability outcomes.

The digitalization of strategic management through the BSC Designer platform significantly reinforces sustainability-oriented planning and execution. By providing real-time monitoring, automated data visualization, and dynamic feedback loops, the software enables continuous performance assessment across all sustainability dimensions. Managers can promptly identify underperforming indicators, trace their root causes, and implement corrective actions based on updated evidence. This real-time adaptability strengthens organizational responsiveness and ensures that strategy implementation remains aligned with circular economy principles. Moreover, the integration of digital dashboards fosters transparency and participatory governance, as stakeholders can collectively track progress, share insights, and co-create improvement plans. In this way, digitalization transforms the Balanced Scorecard from a static reporting tool

into an interactive, learning-oriented system that promotes continuous improvement and adaptive sustainability management.

The implementation of the Circular Economy–based Balanced Scorecard generated measurable improvements across economic, social, and environmental dimensions. Economically, local micro and small enterprises recorded an average 12% increase in sales following the introduction of recycled handicrafts and value-added agri-food products, while tourism revenues became more diversified through training-based activities. Socially, the frequency of community-led sustainability campaigns achieved 66.7% of the annual target, and participation rates in educational workshops rose significantly, indicating growing local engagement and awareness. Environmentally, 15% of total organic waste was processed into compost or recycled crafts, and renewable energy usage reached 38%, establishing a baseline for future improvements. Although some indicators remain below targets, these outcomes collectively demonstrate tangible progress toward a data-driven and inclusive sustainability model in rural edu-tourism.

Alignment with the UN Sustainable Development Goals (SDGs)

In line with the overall aim of promoting sustainable rural development, the findings of this study are closely aligned with several United Nations Sustainable Development Goals (SDGs). First, the emphasis on skill development, community participation, and income diversification contributes to SDG 8 (Decent Work and Economic Growth) by fostering inclusive and sustainable local economies. Second, the focus on strengthening community-based edu-tourism and cultural heritage preservation directly supports SDG 11 (Sustainable Cities and Communities) by promoting sustainable rural settlements that are resilient and socially cohesive. Third, the integration of waste reduction, composting, and renewable energy initiatives corresponds to SDG 12 (Responsible Consumption and Production), encouraging resource efficiency and minimizing environmental impact. Finally, efforts to increase renewable energy usage and improve water efficiency relate to SDG 13 (Climate Action), highlighting local contributions to global climate mitigation. In this regard, the initiative aligns with emerging global efforts toward Net-Zero Emissions, as outlined by Rosen et al. (2025), emphasizing the importance of localized renewable energy adoption, carbon reduction strategies, and resource circularity in achieving carbon neutrality. Through the progressive introduction of solar panels, organic waste composting, and sustainable farming practices, Pancasan Village demonstrates an incremental pathway toward a low-carbon and climate-resilient rural tourism model.

These findings reinforce the argument of Kioumarsi et al. (2022), who emphasize that sustainable development requires integrating economic, social, and environmental priorities in a manner consistent with the SDGs. By explicitly linking the CE-based BSC framework to the SDGs, this study underlines its relevance beyond the local case, showing how rural edu-tourism initiatives can advance both national development priorities and international sustainability agendas.

CONCLUSION

This study demonstrates that integrating Circular Economy (CE) principles into the Balanced Scorecard (BSC) framework offers an effective strategic approach to advancing sustainability in village-based edu-tourism. Using a qualitative approach, evidence-based strategies were formulated to balance economic, social, and environmental objectives.

Strategic objectives were mapped across four BSC perspectives (financial, customer, internal processes, and learning and growth) each supported by performance indicators derived from field findings and categorized as result or inducer. The indicators were operationalized using BSC Designer software to evaluate their relevance and implementation performance.

The findings reveal that the BSC framework not only enables measurable strategy formulation but also strengthens the alignment between sustainability goals and operational efficiency. Indicators such as renewable energy adoption, customer satisfaction, and environmental awareness campaigns effectively translate CE values into tangible practices. Moreover, the model fosters adaptive and transparent monitoring, accelerating evidence-based decision-making. Overall, the CE-based BSC model developed in this study provides a replicable framework for other rural edu-tourism initiatives seeking to integrate sustainability and community empowerment into their strategic management practices.

IMPLICATION

This research enriches the literature on the integration of the Balanced Scorecard (BSC) and Circular Economy (CE) principles in the context of agriculture-based edu-tourism. By embedding sustainability indicators into the four BSC perspectives, it provides a theoretical contribution to the development of strategic management frameworks that are responsive to environmental and social challenges, particularly in rural areas. The study also affirms the relevance of CE as a theoretical foundation for designing strategic performance measurement systems in the sustainable tourism sector.

From a practical standpoint, the findings offer guidance for village governments, edu-tourism managers, and other stakeholders in formulating and implementing CE-based development strategies. The BSC model developed here can serve as a periodic monitoring and evaluation tool to ensure economic, social, and environmental sustainability. The integration of BSC Designer software further highlights the potential of digitalization in strategic management at the local level, improving the effectiveness and efficiency of decision making.

Moreover, while this study is rooted in the case of Pancasan Village, the framework is conceptually transferable to other regions with different socio-economic and cultural contexts. The flexibility of the BSC allows indicators and targets to be tailored to local priorities, such as renewable energy adoption

in resource-rich communities or sustainability awareness campaigns in culturally vibrant areas. This adaptability makes the CE-based BSC not only a monitoring tool but also a replicable and scalable model for fostering sustainability and community empowerment across diverse rural settings. However, successful replication requires contextual adaptation and empirical validation to ensure alignment with local governance structures, stakeholder capacities, and resource conditions.

LIMITATION

This research has several limitations. First, the limited number of respondents (41 people) and the focus on only one village restrict the generalizability of the findings. Second, although the performance values presented in **Figures 1** and **2** reflect actual field data, they are confined to a single case study and a relatively small respondent base. These indicators capture real conditions, but they should be interpreted with caution, as broader generalization requires validation across multiple sites and over longer time periods. Third, the measurement of several indicators still relies on perception and manual reporting, which may introduce bias.

Further research is recommended to conduct comparative studies in several tourist villages with different geographical and social characteristics to test the replication and validity of the model developed. In addition, the development of real-time data-based models through integration with IoT technology and environmental sensors needs to be explored to increase the accuracy and precision of measuring circular economy indicators. Quantitative research using the Structural Equation Modeling (SEM) approach could also be applied to examine causal relationships between indicators and strategic variables in greater depth.

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