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Monitoring and evaluation of socioeconomic impacts under the project "Enhancing value addition to sugarcane products through BCG principles to create a prototype of self-sustainable, integrated sugarcane farmer community enterprises"

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Abstract

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This research aims to evaluating the success of a project within the framework of sustainable development, specifically through alignment with the Sustainable Development Goals (SDGs), Environmental, Social, and Governance (ESG) principles, and the Bio-Circular-Green Economy (BCG) model. The case study focuses on the project entitled "Enhancing the Value of Sugarcane Products through BCG Principles to Establish a Prototype of a Self-Sustaining, Integrated Sugarcane Farmers' Community Enterprise." The findings results that the project successfully addressed existing challenges and enhanced effectiveness in alignment with sustainability objectives. However, in the long term, the evaluation of the project's impact revealed a lack of efficiency, as evidenced by the Social Return on Investment (SROI) analysis, which yielded a ratio of only 0.64. This case study underscores the importance of selecting appropriate conceptual approaches for problem-solving and project development, as well as the need for comprehensive strategies for long-term impact monitoring and valuation.

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1. Introduction

The contemporary concept of sustainability has gained prominence in response to the increasing complexity and urgency of various global and local challenges. It has been developed to encompass collaborative and integrated efforts at both international and national levels. In Thailand, the concept of sustainability has been adopted primarily through the Sustainable Development Goals (SDGs), which serve as an evidence-based framework for planning and implementing sustainable development initiatives at national, regional, and global levels from 2015 to 2030 [1]. This framework aligns with the principles of Environmental, Social, and Governance (ESG), which originated from responsible investment practices. ESG aims to integrate these dimensions into investment decision-making and active ownership. It evaluates corporate behavior and anticipates future financial performance through environmental, social, and governance lenses. This approach is considered essential for investment analysis and decision-making by

assessing the sustainability and social impact of business activities [2].

Thailand has also developed a key conceptual framework known as the Bio-Circular-Green (BCG) Economy Model, which was formulated to address both external and internal drivers, such as technological advancement and demographic shifts associated with an ageing population. The government aims to promote this emerging economic paradigm, which is characterized by three core features: (1) a novel model shaped by dynamic changes in economic, social, political, and technological landscapes; (2) a reliance on knowledge management and new technologies that leverage Thailand's unique comparative advantages—such as its geographic location, biodiversity, and sectoral strengths, particularly in fields like medical sciences; and (3) the model's significant economic impacts and adaptive capacity [3, 4]. The BCG framework has been adopted as a guiding principle that aligns with the national development strategy and is being implemented in parallel with other national initiatives.

Consequently, the concepts of SDGs, ESG, and BCG have been utilized in the formulation of objectives, goals, and implementation strategies at multiple levels, ranging from international policy frameworks to operations within large corporations, including in the context of Thailand. The interrelation among these three frameworks has given rise to diverse and complex approaches to evaluation, depending on specific sustainability indicators or criteria, which often vary across contexts. Nevertheless, the convergence of these concepts fundamentally centers on the core dimensions of sustainability economic, social, and environmental [5]. In order to understand the roles these frameworks play in project development, project evaluation approaches serve as accessible tools for assessing success through the integrated lens of all three concepts.

However, determining whether a project achieves sustainable success involves more than simply assessing whether its outputs align with a particular conceptual framework. A more comprehensive set of criteria must be applied specifically, whether the project can sustain itself or continue its operations independently over time, as well as how efficiently and effectively it delivers outcomes. These considerations form the rationale for this study. To gain a deeper understanding of how these conceptual frameworks influence project development, the researcher selected a case study entitled "Enhancing value addition to sugarcane products through BCG principles to create a prototype of self-sustainable, integrated sugarcane farmer community enterprises", which was designed based on the integrated application of the SDGs, ESG, and BCG frameworks in setting its objectives and operational guidelines.

The case study project is an activity conducted in Sak Ngam Subdistrict, Kamphaeng Phet Province, with a duration of 10 months from August 2022 to May 2023. The project has objectives to develop and enhance value of the sugarcane farmer groups and communities. The project's management and implementation strategies are designed to respond to the SDGs using the BCG approach. The project activities begin with the selection of farmer groups, as shown in Fig. 1.

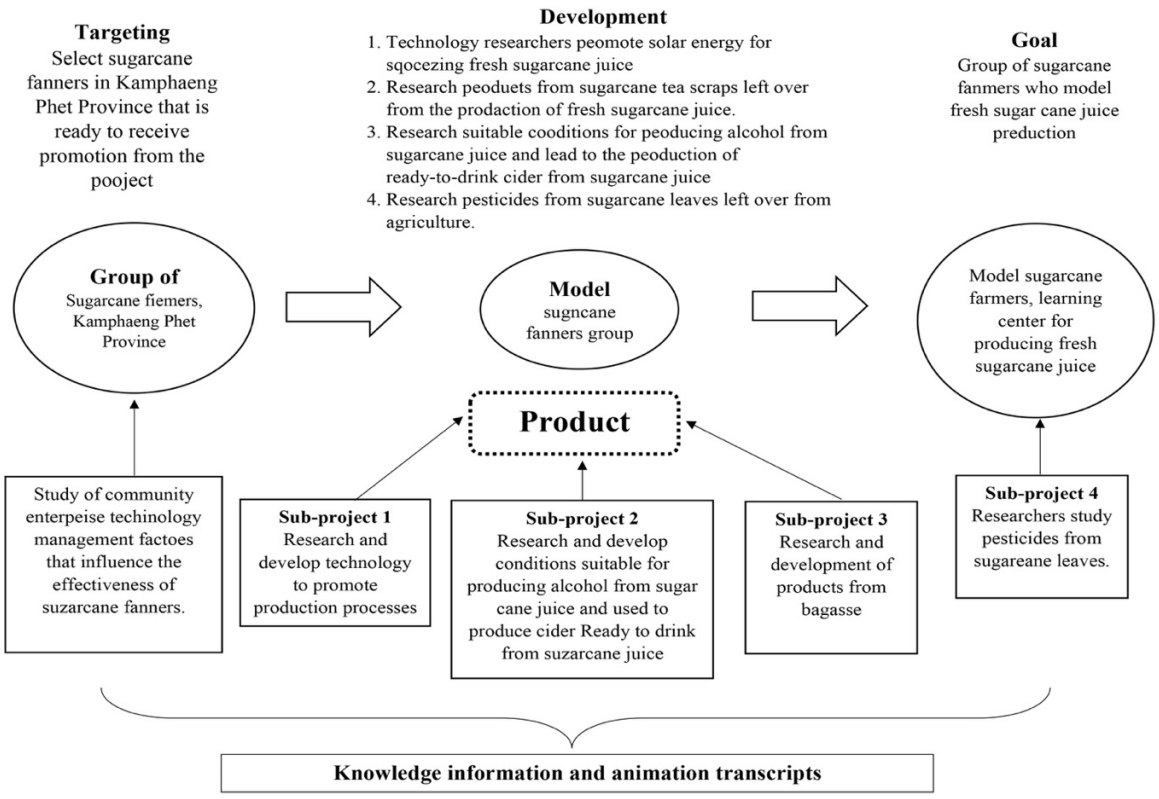

Fig. 1 Project implementation framework

Accordingly, the evaluation framework employed in this study encompasses two principal dimensions. The first concerns the assessment of the project's success by examining the alignment between the achieved results and the conceptual frameworks that underpin the project. This includes identifying the key factors that drive success across the three dimensions of sustainability—economic, social, and environmental. The second dimension focuses on evaluating the project's efficiency and effectiveness in terms of value for money, employing the Social Return on Investment (SROI) approach as a comprehensive impact evaluation tool. SROI enables the measurement of the project's social value by quantifying the impact generated across sustainability dimensions in monetary terms, thereby reflecting the project's overall contribution to society.

Objectives

1. Evaluating the success of project changes based on the concepts of SDGs, ESG and BCG
2. Evaluating the impact of the project on social values.

2. Materials and Methods

Conceptual Framework

This research framework integrates qualitative and quantitative methods. Resources was collected from May 1-5, 2024, after the project completion, to evaluate the outcomes and impact that indicate the project's sustainability over time. The operational approach involves "project success evaluation," considering the project's alignment with SDG, ESG, and BCG principles. For SDGs, the focus is on ensuring activities and objectives align with the intended impacts. For ESG, the emphasis is on evaluating the project's operations, activities, and outcomes. Finally, BCG serves as the main framework, providing a comprehensive evaluation of the achieved results. The evaluation framework is illustrated in Fig. 2.

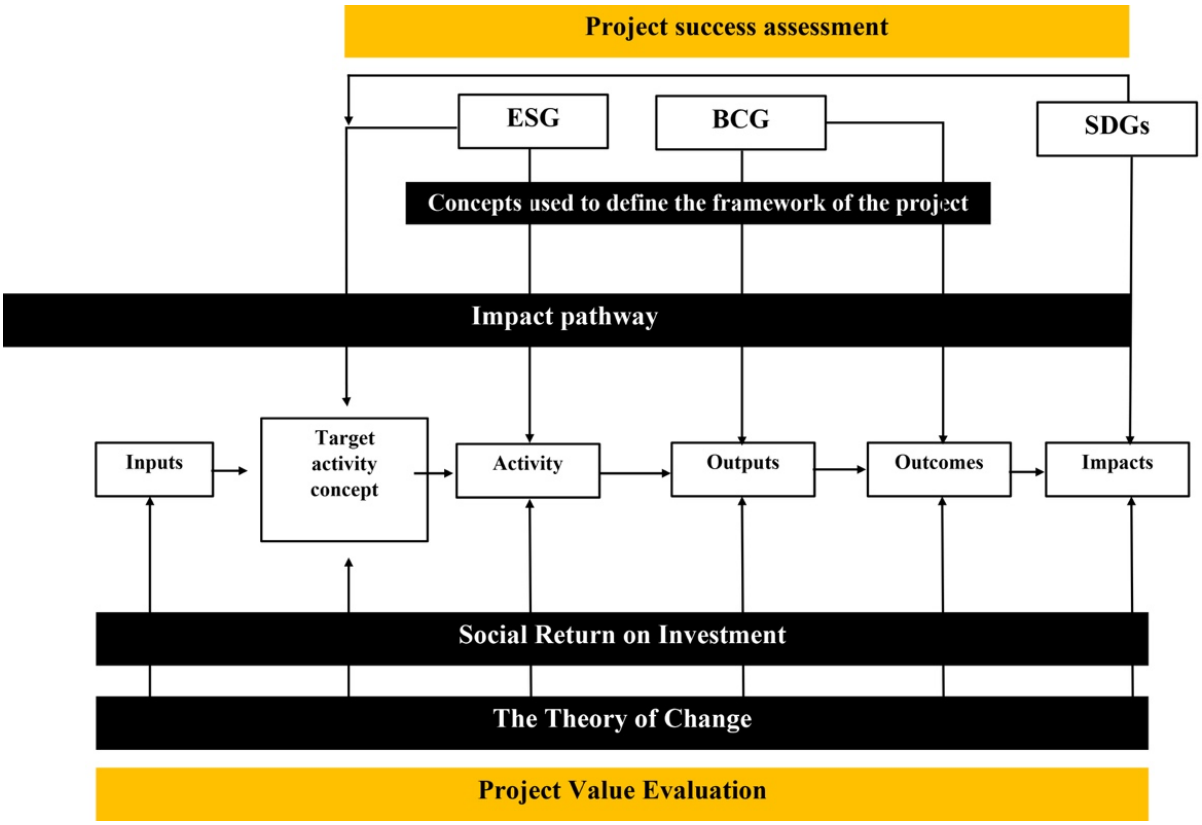

Fig. 2 Conceptual Framework

Next, the "social value impact assessment of the project" is conducted using the SROI (Social Return on Investment) analysis process under the Theory of Change (ToC) framework. This framework is a concept used to understand the project's intervention process on concrete changes, from Inputs, Activities, Outputs, Outcomes, and Impacts. These changes will then be valued using SROI analysis [6].

Project Success Analysis

To investigate alignment with the SDGs, ESG, and BCG frameworks, diverse resources collection methods were employed, prioritizing documents and informants for time-phased analysis. This process was divided into three stages: Before project implementation, data from draft budget documents and interviews with 20 project target beneficiaries (sugarcane farming community enterprises) analyzed the alignment of the project's concept and objectives—whether stemming from problems needing resolution or aspirations for regional development; During project implementation, resources from progress reports and interviews with 4 Sub-project implementers analyzed the alignment of project activities and objectives with the generated outputs; and After project implementation, resources from interviews with project target beneficiaries analyzed outcomes, emphasizing the project's sustainability or its ability to self-operate, which relates to the context of long-term viability and alignment with all three frameworks.

The assessment of project sustainability and alignment with these frameworks reflected as impacts led to an analytical approach focusing on factors related to long-term sustainability. The process involved selecting beneficiaries as the sample group, administering a closed-ended questionnaire, and analyzing the data using an Ordinary Least Squares (OLS) regression model.

$$Y_{Econ} = \beta_0 + \beta_{Nec}X_{Nec} + \beta_{Abi}X_{Abi} + \beta_{Expec}X_{Expec} + \beta_{Sex}X_{Sex} + \beta_{Age}X_{Age} + \beta_{Edu}X_{Edu} + \beta_{Inc}X_{Inc} + \beta_{Know}X_{Know} \quad (1)$$

$$Y_{Soc} = \beta_0 + \beta_{Nec}X_{Nec} + \beta_{Abi}X_{Abi} + \beta_{Expec}X_{Expec} + \beta_{Sex}X_{Sex} + \beta_{Age}X_{Age} + \beta_{Edu}X_{Edu} + \beta_{Inc}X_{Inc} + \beta_{Know}X_{Know} \quad (2)$$

$$Y_{Envi} = \beta_0 + \beta_{Nec}X_{Nec} + \beta_{Abi}X_{Abi} + \beta_{Expec}X_{Expec} + \beta_{Sex}X_{Sex} + \beta_{Age}X_{Age} + \beta_{Edu}X_{Edu} + \beta_{Inc}X_{Inc} + \beta_{Know}X_{Know} \quad (3)$$

The analysis aims to determine the relationship between the project's changes according to the ToC and the concepts of SDGs, ESG, and BCG. The framework for (Y) encompasses broad changes in the economic (Y_{econ}), social (Y_{soc}), and environmental (Y_{envi}) aspects. The independent variables (X) include: Necessity of the Project (X_{Nec}): Indicates the extent to which the project is necessary for the population. Ability to Implement the Project (X_{Abi}): Reflects the effectiveness of project management. Expectations of the Project (X_{Expec}): Describes the sustainability of the project after the implementers have completed their roles. To further explain the benefits achieved, the analysis considers basic population information, including variables such as: Gender (X_{sex}), Age (X_{Age}), Education (X_{Edu}), Income (X_{Inc}) and Knowledge (X_{Know})

Social Return on Investment (SROI) Analysis

The SROI analysis will use qualitative research methods, specifically semi-structured interviews with stakeholders who are knowledgeable about and involved in the project. The sample will consist of 5 groups of stakeholders, including: 1 member from the community enterprise group, 3 sugarcane farmers, 4 researchers from various sub-projects, 4 students, and 2 consumers. The qualitative responses will be converted into monetary values, both positive and negative. The SROI process is related to changes based on empirical evidence according to ToC. The SROI analysis involves the following five steps: 1) Key Stakeholders 2) Mapping Outcomes 3) Evidencing Outcomes and Giving Them a Value 4) Establishing Impact and 5) Calculating Social Return on Investment [7].

3. Results and Discussion

Project Success

The project's success is evaluated based on its alignment with seven specific Sustainable Development Goals (SDGs). Subproject 1 focuses on research and development of technologies to enhance production processes, aligning with SDGs 7, 9, and 12. Subproject 2 involves research on producing ethanol from sugarcane juice for drinking purposes, aligning with SDGs 1 and 8. Subproject 3 concerns the development of products from sugarcane leaves, aligning with SDGs 3 and 9, while Subproject 4 focuses on creating plant protection products from sugarcane leaves, also aligning with SDGs 3 and 9. All four subprojects aim to establish a learning center for community enterprise groups within the province to disseminate knowledge, aligning with SDG 4. The approaches and activities demonstrate strong alignment with the principles of ESD and the BCG framework.

Table 1 Alignment between project activities.

Definitions consistent with the project	**Before project implementation**				**During project implementation**				**After project implementation**			
SDGs	**P1**	**P2**	**P3**	**P4**	**P1**	**P2**	**P3**	**P4**	**P1**	**P2**	**P3**	**P4**
Goal 1 End poverty		(-)				(+)				(+)		
Goal 3 Good health and well-being			(o)	(o)			(+)	(+)			(o)	(o)
Goal 4 Quality education	(o)	(o)	(o)	(o)	(+)	(+)	(+)	(+)	(o)	(o)	(o)	(o)

Table 1 (Continued)

Definitions consistent with the project	**Before project implementation**				**During project implementation**				**After project implementation**			
SDGs	**P1**	**P2**	**P3**	**P4**	**P1**	**P2**	**P3**	**P4**	**P1**	**P2**	**P3**	**P4**
Goal 7 Affordable and clean energy	(o)				(+)				(+)			
Goal 8 Decent work and economic growth		(-)				(+)				(+)		
Goal 9 Industry, Innovation and infrastructure	(o)		(o)	(o)	(+)		(+)	(+)	(+)		(o)	(o)
Goal 12 Responsible consumption and production	(o)				(+)				(+)			
ESG	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
Environmental	(o)		(o)	(o)	(+)		(+)	(+)	(+)		(o)	(o)
Social		(o)				(+)				(+)		
Governance		(o)				(+)				(+)		
BCG	P1	P2	P3	P4	P1	P2	P3	P4	P1	P2	P3	P4
Bioeconomy		(o)				(+)				(+)		
Circular Economy	(o)		(o)	(o)	(+)		(+)	(+)	(+)		(o)	(o)
Green Economy	(o)		(o)	(o)	(+)		(+)	(+)	(+)		(o)	(o)

P1 'Sub-project 1', P2 'Sub-project 2', P3 'Sub-project 3', and P4 'Sub-project 4'. (o) 'No significant change or status quo before project implementation', (-) 'Resulted from encountered issues', (+) 'Improved change'

When evaluating the project's alignment with the SDGs, ESG, and BCG frameworks, all four projects demonstrated strong integration, leading to significant changes during the implementation phase. However, only Sub-projects 1 and 2 maintained their impact after the implementation period and resulting changes.

The projects that were able to sustain their operations were primarily those that involved participatory improvement of existing practices, addressed specific problems, or reduced costs. In contrast, projects aimed at developing entirely new approaches did not achieve success. This was largely due to technical challenges, including difficulties in comprehension, the requirement for advanced knowledge and skills, or approaches that, although environmentally beneficial, were less efficient compared to traditional chemical-based methods.

Table 2 Significance of benefits resulting from factors of change.

Variable	$Intercep$	X_{Nec}	X_{Abi}	X_{Expec}	X_{Sex}	X_{Age}	X_{Edu}	X_{Inc}	X_{Know}
Y_{Econ}	0.4559	0.0422 **	0.0931 *	0.2447	0.5634	0.1591	0.6130	0.7113	0.2701
Y_{Soc}	0.0808 *	0.1073	0.0490 **	0.0675 *	0.8025	0.0882 *	0.1174	0.8573	0.0387 **
Y_{Envi}	0.6253	0.6253	0.6229	0.3018	0.0983 *		0.1095	0.0765 *	0.5698

The significance levels of each variable are indicated as follows: * '0.1' ** '0.05'.

Impact of the Project on Economic and Social Efficiency

Key stakeholders

The main stakeholders directly involved in the project's impact or activities are those who have known about the project and its impact on themselves the selection of key stakeholders is partly subjective, based on expert judgment and analysis of stakeholder relationships. Similarly, interviews revealed that the Knowledge Society "Common Knowledge" was not considered a key stakeholder, as the project was not central to their activities [8]. They are classified according to Table 3.

Table 3 Table showing the main and additional stakeholders.

Key stakeholders	Description
Community Enterprise Group	A community enterprise group that collaborates to produce fresh sugarcane and process products from sugarcane juice.
Sugarcane Farmers	A group of farmers in Kamphaeng Phet Province who supply pesticide-free sugarcane to the project for product manufacturing.
Consumers	Consumers of products from the community enterprise group.
Researchers	Researchers of the 4 projects from Kamphaeng Phet Rajabhat University who propose assistance guidelines, initiate, and implement projects in terms of knowledge and investment.
Students	Participants and co-implementers of the projects alongside the researchers.

Mapping outcome

This section helps identify and understand the anticipated outcomes and impacts of the project, clarifying the causal relationships between components and methods that contribute to the overall impact [6]. It references the ToC, emphasizing how specific impacts can be achieved under certain conditions, using empirical evidence and systematic findings from relevant sectors or target groups. Additionally, the Logic Model outlines the connections between inputs, activities, outputs, outcomes, and impacts [9], as illustrated in Fig. 3.

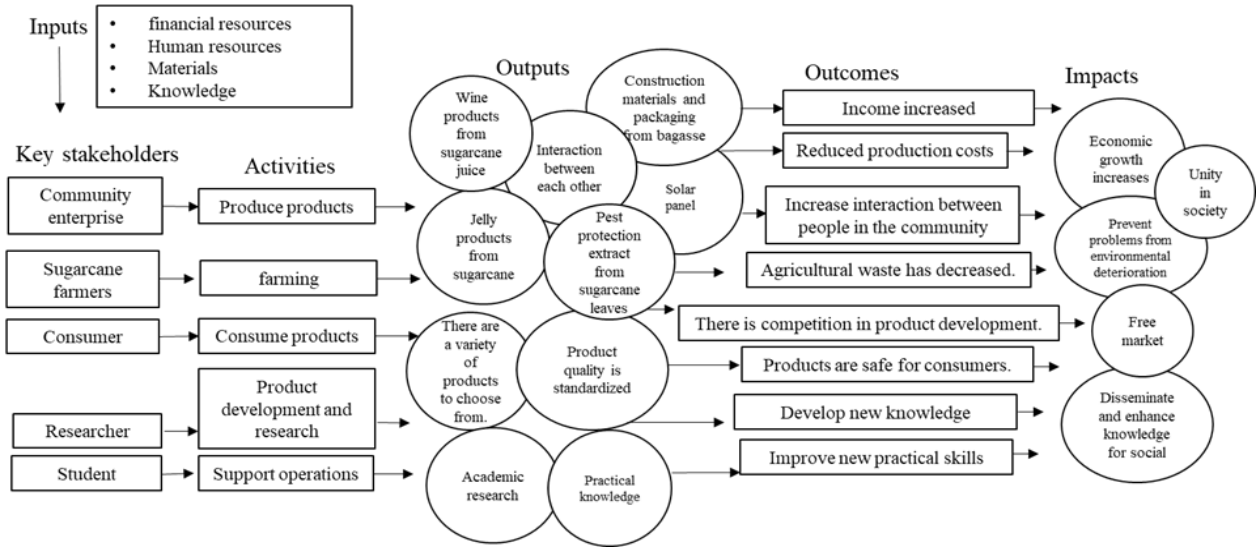

Fig. 3 Mapping outcomes

Evidencing Outcomes

The methodology for outcome valuation primarily relies on monetary valuation data from stakeholders and empirical monetary evidence (accounting records). In cases where outcomes have clear market prices, these are directly applied. However, when outcomes cannot be directly valued, researchers will ascertain their value from stakeholders by inquiring about equivalent alternatives with clear market prices, or the opportunities stakeholders would have pursued in the absence of the generated outcomes, as presented in Table 4.

Table 4 Table showing the conversion of outcome values.

Key stakeholders	Outcomes	financial proxy	Value of Outcomes (THB)
Community Enterprise Group	Increased Income	The increase in income from annual product sales involving the project minus the reduced production costs (to prevent double counting) from Project 2	113,500
	Reduced Production Costs	The reduction in production cost per unit from Project 1	3,383.77
	Increased Interaction in Community	The opportunity cost per number of community enterprise group members interacting	3,426.8
	Reduced Agricultural Waste	The financial equivalent of market products with comparable efficiency and properties: 1) Pesticides compared to market products based on effectiveness. 2) Bagasse paper used as packaging with comparable properties to market products. 3) Fiber cement mixed with bagasse with comparable properties to market products	16,320
Consumers	Promote Product Development Competition	Promoted through purchasing products and services considering the increased income (to prevent double counting)	0
Sugarcane Farmers	Increased Income	Income from cultivation and labor from sugarcane farming	15,720
Researchers	Development of New Knowledge	The amount of benefit from publishing academic work	20,000
		Opportunity Cost for Research	273,000
Students	Skills Training	Opportunity cost used to support the project	67,900

When considering the three most significant issues (Economic, Social, and Environmental) through a sustainable development approach, the social outcome from "Development of New Knowledge" has the highest value. This is followed by the economic value from "Increased Income," and finally, the environmental value from "Reduced Agricultural Waste" has the lowest value among these three considerations.

Establishing Impact

Understanding the impact of activities is important in assessing the significance of the activities and preventing overvaluation. In

calculating the impact values, the SROI framework includes processes to separate the role of other intervening factors on the impact [6]. These processes include: Deadweight, Attribution, Displacement [10]. and Drop-off. All of these discount rates are used to calculate the reduced impact values, as shown in Table 5.

Table 5 Table showing the impact ratio calculation.

Outcomes	Value of Outcomes	Deadweight	Attribution	Displacement	Drop-off	Value (THB)
Increased income of the community enterprise group	113,500	0%	30%	0%	0%	79,450.00
Reduced production costs	3,383.77	0%	30%	0%	3%	2,368.64
Increased interaction among community members	3,426.8	0%	0%	0%	25%	3,426.80
Promoted competition in product development	0	0%	0%	0%	0%	0.00
Reduced agricultural waste	16,320	0%	17.5%	70%	70%	13,464.00
Increased income of farmers	15,720	0%	0%	0%	0%	15,720.00
Development of new knowledge	20,000	0%	0%	0%	0%	20,000.00
	255,000	0%	0%	0%	0%	255,000.00
Skills training	67,900	0%	0%	0%	0%	67,900.00

Calculating Social Return on Investment

This project comprises four sub-projects, with a total investment cost of 2,000,000 baht. The anticipated impacts are evaluated over a period from year 0 to year 5, applying a cumulative discount rate of 3% per annum [11]. The estimated value of the project's impact amounts to 1,274,578.20 baht, indicating the effectiveness achieved by the project. However, when considering efficiency through the SROI ratio, which stands at 0.64, it reflects an unfavorable return within the evaluated and projected timeframe.

This finding aligns with the sustainability of the sub-projects, where only sub-projects 1 and 2 are able to continue operations. Beyond technical challenges, the efforts to create a fully sustainable approach aimed at zero agricultural waste in sub-projects 3 and 4 resulted in inefficiency. This is primarily due to the low valuation of waste disposal in the area, rendering the high investment required for developing solutions and problem-solving capacity economically unjustifiable.

4. Conclusion

Overall, although the project was able to address issues and improve the effectiveness of the target group in measurable terms—aligning with the activities guided by the SDGs, ESG, and BCG concepts, and achieving its set objectives, which can be considered the project's output—when looking at the broader picture sometime after the project's completion, it was found that certain activities were not sustained. This was due to the difficulty in understanding the techniques and developmental approaches,

considering the foundational characteristics of the project's target group.

This challenge becomes apparent when evaluating the value of impacts over time, particularly through SROI analysis. The results indicated that the return was not worthwhile, suggesting that the project was not as effective as expected in relation to the investment made in developing sustainability strategies—especially regarding environmental aspects. While it is possible that the valuation tools and market pricing for environmental benefits are generally low in Thailand or in the case study area, the overall impact evaluation from this research suggests the lowest feasible baseline under data limitations. For example, preventing agricultural waste burning often carries lower perceived value than the damage cost of pollution from such waste, especially in terms of public health.

The study results, while emphasizing the necessity of understanding the implementation context including development factors, problem-solving approaches, efficiency, effectiveness, and cost-effectiveness—also highlight the future direction for integrating SDGs, ESG, and BCG concepts. These should be aligned and serve as guiding goals in all project activities. It is important to recognize that impact assessments and value measurements reflect outcomes at a single point in time and do not yet capture the potential long-term value that could be realized if the developmental knowledge and experiments are refined and scaled. Such value could be significantly higher in the future.

5. Suggestions

1) Factors that support the success of community enterprise development projects that align with the needs of the group, involve the participation of stakeholders from various sectors, including the government, private sector, civil society, and academia. The design of the methodology should be in line with the problems and needs, utilizing relevant knowledge.

2) To be a role model for community groups, it is important to emphasize sustainable self-reliant community enterprise models in five aspects: (1) Mental aspect: Members who come together in a group have the determination to create additional income to support themselves by utilizing the traditional knowledge passed down from their parents, such as distilling local liquor. They create opportunities for self-development by attending training on wine production methods. Additionally, they have a good conscience and a willingness to share for the benefit of the community. (2) Social aspect: The exemplary community enterprise group aims to bring together like-minded individuals in the community to help and support each other, share resources, and exchange knowledge, so that each member has a role and shares the benefits together. (3) Natural resources and environment aspect: The exemplary community enterprise group divides original agricultural land to create alternative career paths. They allocate a portion of the backyard, approximately 3 rai, to grow fragrant sugarcane for distillation and develop new products, maximizing the value of existing resources. They also consider environmental factors by practicing organic farming. (4) Technological aspect: Based on the idea of adding value to existing resources, the university supports and promotes the concept of a bio-based economy. They apply technology and innovation based on traditional knowledge. The group collaborates with researchers to select appropriate technologies for production, which they can continue to utilize even after the researchers have left.

3) Economic aspect: Although the researchers' goal is to increase income, the exemplary community enterprise group strives to develop existing resources and costs without seeking additional funding. They also aim to reduce production costs in research activities, following the principle of self-sufficiency and self-reliance.

4) Expanding the results from the exemplary community enterprise group, "Suan Phor Por Pheang" to the BCG community enterprise groups in various districts, including 10 districts, to create opportunities for other community enterprise groups to benefit from the research. This aims to distribute income throughout Kamphaeng Phet province and develop the Suan Phor Por Pheang community enterprise group into a "Enhancing Value Addition to Sugarcane Products Through BCG Principles." The four

sub-projects' researchers have developed a "Manual About Diffusion of Innovation and Technology from Research" and have a network of organizations to support the integration and driving force of the Learning Centre for Enhancing Value Addition to Sugarcane Products Through BCG Principles, following the "Sak Ngam Model."

6. Acknowledgement

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