

GREEN SUPPLY CHAIN OPTIMIZATION FOR SME SUSTAINABILITY

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ABSTRACT

Green Supply Chain (GSC) integrates environmental considerations into supply chain practices to achieve sustainable outcomes across environmental, social, and economic dimensions. SMEs in Indonesia and Malaysia face unique challenges in adopting GSC due to limited resources, fragmented supply chains, and varying levels of government support. GSC training is needed to enhance participants' knowledge and skills in optimizing green supply chains, which will ultimately enhance the sustainability of SMEs in Malaysia and Indonesia. The evaluation of the activity revealed that most participants were very satisfied with the activity and gained improved knowledge and skills in managing GSC.

Keywords: Green Supply Chain, Small Medium Enterprise.

1. INTRODUCTION

Small and Medium Enterprises (SMEs) are the backbone of the economy in both Indonesia and Malaysia. However, many SMEs still face challenges in adopting environmentally friendly supply chain practices. Key challenges include: (1) Low Awareness: Lack of understanding of the benefits of implementing an environmentally friendly supply chain for business continuity, (2) Limited Access to Technology: Lack of access to modern technology that supports efficiency and desirability, (3) Financing Issues: Limited capital to invest in infrastructure that supports sustainable supply chains, and (4) Lack of Collaboration: Lack of synergy between business partners, both locally and internationally, to support the implementation of joint solutions.

Green supply chain (GSC) integrates consideration environment to in practice supply chain for reach sustainable results across the board dimensions environmental, social, and economic. Small and medium enterprises (SMEs) in developing regions, such as Indonesia and Malaysia, face challenge unique in adopt GSCM because limitations source power, chain fragmented supply, and various level support government. Challenges This enlarged by need for balancing three matter important (TBL)— sustainability environmental, social, and economic — in competitive and limited context source Power.

Malaysian SMEs emphasize factor adoption, such as influence stakeholders' interests, incentives economy, and compliance to certification environment such as ISO 14001 [1], [2], [3]. Drivers including support management peak and pressure external (e.g., competitive and regulatory) are often identified, in addition to challenge like source Power limited finances and level moderate adoption [3], [4]. For example, Rasit et al. [1] reported that design friendly environment and work the same environment impact positive on performance sustainability, but other practices such as purchase green and logistics backwards show results that are not consistent. Similarly, Lin et al. [3] uses a Diffusion model Innovation (DOI) and Technology-Organization-Environment (TOE) for connect factor adoption with repair operational and environmental, although studies they No discuss sustainability social or economy in a way explicit.

Analysis comparative Still rare; however, Zainal Abidin et al. [5] provided outlook about role finance green to sustainability financial, offering one of the from A little studies comparison empirical between Indonesia and Malaysia. Research This identify supported incentives government as things that matter in Malaysia, temporarily pressure external and sensitivity cost dominate booster adoption in Indonesia. Indonesian SMEs often focus on regional or international challenges. sectoral, such as fragmentation chain supply, limitations source power, and variability regulation [6], [7], [8], [9]. Hanumsari et al. [6] emphasized role manufacturing green and education in increase results environment and economy, however, sustainability social Still not enough handled. Research by Setyawan et al. [7] connect adoption of GSCM with alignment strategic and support government, but highlight enforcement and implementation that is not evenly distributed, especially in fragmented areas in a way geographical such as Central Java. In addition, studies like The Wise et al. [10] and Chalarhena and Hendayani [9] focused on the industry. certain sectors (for example, food SMEs, manufacturing), identify subtraction cost operational and collaboration local as important thing for profit environment. Although There is progress in context local, a little a study that combines more regional comparisons wide or cross TBL analysis dimensions.

Malaysian SMEs get benefit from framework institutions and schemes more finances strong [6], [11], but level its implementation Not yet consistent. On the other hand, Indonesian SMEs face obstacle more logistics and finance big but show innovation specific context, such as collaboration local in chain fragmented supply [6], [7], [9].

To address these challenges, this program is designed with an integrated approach, covering aspects of education, technology, and collaboration: (1) Workshop and Training: Providing an understanding to MSMEs regarding the concept of green supply chain and its benefits for business sustainability. Training will cover waste management techniques, energy efficiency, and green logistics strategies, (2) Technology Enhancement: Supporting MSME partners to access environmentally friendly technologies, such as cost-effective digital-based supply chain management software, (3) Financing Support and Strategic Cooperation: Building partnerships with local financial institutions and organizations to provide capital assistance and encourage collaboration between MSMEs in Indonesia and Malaysia, (4) Ongoing Monitoring and Evaluation: Developing concrete success indicators to monitor program implementation, such as operational efficiency, waste reduction, and increased competitiveness.

Based on condition implementation of GSCM in SMEs in Malaysia and Indonesia, then required GSCM training for SMEs aims for increase knowledge and skills participant in optimize chain supply green for support achievement sustainability Good economic, social and environmental aspects of SMEs.

2. METHOD

The implementation of this green supply chain training will be held in Penang, Malaysia. and will be held on May 4, 2025. The audience consisted of 30 people who were members of PERMAI PENANG, which is a small and medium business actor in Malaysia.

The methods used in this training are:

1. Presentation of training material
At this stage, the instructor will deliver the training material to the participants. This material can include theories, concepts, and best practices in the topic discussed; in this case it may be related to the green supply chain in SMEs.
2. Case study of implementation of green supply chain in SME
This stage involves analyzing real cases or simulations related to the implementation of green supply chains in small and medium enterprises (SMEs). Participants will be given a case that they must study, analyze, and discuss to understand the challenges and solutions that may be faced in the implementation.
3. Discussion of training material
After the presentation and case study, participants will evaluate the material that has been delivered and discuss it. This stage aims to ensure that participants have understood the material and can apply the knowledge they have gained in a real context. Discussion also allows participants to share their experiences and thoughts on the topic discussed.

Evaluation of this activity uses a questionnaire consisting of 12 questions. The questions are as follows:

1. The material for service activities is in accordance with existing problems in society
2. The community service method used is appropriate to the theme and objectives of the community service program
3. Suggestions and supporting infrastructure for service activities, such as places or buildings for service activities, tools and materials, other supporting facilities, are adequate
4. The team implementing the service program looks united in carrying out activities
5. The team implementing the service program is competent with the material provided
6. The implementing team is very interesting in packaging the service program
7. The community enthusiastically participates in service activities
8. The community really feels the benefits of the service program provided
9. The community is very interested and enthusiastic about service activities
10. The community as a whole is satisfied with the community service program carried out
11. The service program is in line with what the community expects
12. The term of the service program is in accordance with what the community expects).

3. RESULTS AND DISCUSSION

This green supply chain training was held on May 4, 2025, from 9 a.m. to 3 p.m., on Penang Island, Malaysia, and was attended by 25 PERMAI members. Documentation of the training can be seen in Figure 3.



Figure 3. Green Supply Chain Training in Penang, Malaysia

4.2. Training Materials

4.2.1. Supply Chain

A supply chain is a network of companies that work together to create and deliver a product to the end user [13]. These companies typically include suppliers, factories, distributors, stores or retailers, and supporting companies such as logistics services. In a supply chain, there are three flows that need to be managed: goods/materials, money, and information, which can flow from upstream to downstream and also downstream to upstream. Industry players' awareness of the importance of better coordination between various parties in creating and delivering affordable, high-quality, and fast products gave rise to the concept of Supply Chain Management (SCM).

The main activities of Supply Chain Management are: (1) designing new products (Product Development), (2) procuring raw materials (Procurement, Purchasing, or Supply), (4) planning production and inventory (Planning & Control), (5) carrying out production (Production), (6) carrying out delivery/distribution (Distribution), (7) returning products/goods (Return).

According to Mentzer (2001) in Azari (2018), the basic elements of supply chain management include: (1) An integrated approach, namely a set of coordinated supply chain management activities; (2) Mutual information sharing; (3) Mutual sharing of risks and rewards; (4) Collaboration; (5) Having the same goals and focus on customer service; (6) Integrated processes; and (7) Partnering to build and maintain long-term relationships [14].

4.2.2. Green Supply Chain Management (GSCM)

Green Supply Chain Management is a modern take on the traditional supply chain, where various activities, such as green purchasing, green design, resource conservation, reduction of hazardous materials, and product recycling, are implemented to minimize environmental impacts [15]. GSCM practices apply environmental management principles to the entire supply chain, including design, procurement, manufacturing, assembly, packaging, logistics, and distribution [6].

Reference [16] classifies GSCM practices into five categories based on their activities:

- 1) Intra-organizational environmental management: refers to intra-organizational practices such as top management support, environmental compliance programs, and interdepartmental collaboration for environmental improvement.
- 2) Product eco-design: a structural process that incorporates ecological attributes into products and processes, as well as stakeholder demands within the company for product design and development.

- 3) Green supplier integration: involves collaboration for environmental goals between a host company and its suppliers in managing cross-company business processes, including information sharing and strategic partnerships.
- 4) Green customer cooperation: involves strategic information sharing and collaboration between companies and their customers, aimed at increasing visibility and enabling joint environmental planning.
- 5) Reverse logistics: related to the three "Re"s of the circular economy: recycling, reusing, and reducing the amount of raw materials in the production and post-consumer phases.

4.2.3. GSCM implementation in SMEs is as follows:

PR - Green Purchasing

- PR1 provides environmental design specifications to suppliers for purchased goods
- PR2 collaborates with suppliers to design environmentally friendly products
- PR3 collaborates with suppliers for environmentally friendly purposes
- PR4 conducts environmental audits of suppliers' internal management
- PR5 evaluates environmentally friendly practices at supplier companies
- PR6 is one of the criteria for supplier selection

KP - Customer Cooperation with Environmental Requirements

- KP1 receives input from customers on environmentally friendly product designs
- KP2 collaborates with customers for cleaner production
- KP3 collaborates with customers for environmentally friendly packaging
- KP4 collaborates with customers to use less energy during transportation

PI - Investment Recovery

- P1 sells excess inventory
- P2 sells used materials
- P3 sells excess capital equipment
- P4 implements a recycling system for defective products

D - Green Design

- D1 products to reduce material/energy use
- D2 products to reuse and recycle
- D3 products to avoid the use of hazardous materials
- D4 Processes to minimize waste

M - Internal Environmental Management

- M1. Top company management is committed to environmental management.
- M2. Company managers/supervisors support environmental management.
- M3. All units/departments within the company collaborate to make improvements to reduce environmental impact.
- M4. The company conducts environmental management.

4.3. Activity Evaluation

Evaluation of the community service activities was conducted by distributing questionnaires to training participants. The 12 questions covered the materials, methods, facilities, team delivery, and participant satisfaction with the activity. Twenty respondents completed the questionnaires, and the results are shown in the table.

Tabel 1. Questionnaire Result

No.	Question	Measurement Value	1	2	3	4
1	The material for community service activities is in accordance with existing problems in society	Expectation (Important)	3%		9%	88%
		Performance (Satisfaction)		3%	22%	75%
2	The community service method used is appropriate to the theme and objectives of the service program	Expectation (Important)	3%		22%	75%
		Performance (Satisfaction)		3%	25%	72%
3	Facilities and infrastructure supporting service activities, such as places or buildings for service activities, tools and materials, and other supporting facilities, are adequate	Expectation (Important)		3%	19%	78%
		Performance (Satisfaction)			28%	72%
4	The team implementing the service program looks united in carrying out activities	Expectation (Important)		3%	16%	81%
		Performance (Satisfaction)		3%	19%	78%
5		Expectation (Important)		3%	16%	81%

	The team implementing the service program is competent with the material provided	Performance (Satisfaction)	3%	16%	81%
6	The implementing team is very interesting in packaging the service program	Expectation (Important)	3%	9%	88%
		Performance (Satisfaction)	3%	13%	84%
7	The community is enthusiastic about participating in service activities	Expectation (Important)	6%	9%	84%
		Performance (Satisfaction)	6%	9%	84%
8	The community really feels the benefits of the service program provided	Expectation (Important)	3%	6%	91%
		Performance (Satisfaction)	3%	13%	84%
9	The community is very interested and enthusiastic about service activities	Expectation (Important)	3%	3%	13%
		Performance (Satisfaction)	3%	3%	19%
10	The community as a whole is satisfied with the community service activity program carried out	Expectation (Important)	6%	19%	75%
		Performance (Satisfaction)	6%	19%	75%
11	The Community Service Program is in line with what the community expects	Expectation (Important)	6%	13%	81%
		Performance (Satisfaction)	6%	9%	84%
12	The term of the service program is in accordance with what the community expects	Expectation (Important)	3%	3%	13%
		Performance (Satisfaction)	3%	6%	16%
		Expectation (Interest)	1%	3%	14%
	AVERAGE	Performance (Satisfaction)	1%	4%	17%
					78%

The average questionnaire results in the table above indicate that 82% of participants were very satisfied with the training, and 78% stated that it was very important. Question 8, regarding the benefits received by participants, was the most highly satisfied (91%), while questions 2 and 10, regarding the method and overall satisfaction, received the least satisfaction (75%).

Based on importance, questions 6, 7, 8, and 11, regarding team presentation, participant enthusiasm, the benefits of the activity, and meeting expectations, were considered very important by most participants (84%), while questions 2 and 3, regarding the method, theme, and training facilities, were considered very important (72%). However, the questionnaire results also indicated that the satisfaction level for all questions was above the importance level.

4. CONCLUSION

The conclusion of the green supply chain training activities for the sustainability of SMEs is

1. The GSC for SMEs Sustainability training was held in Pinang, Malaysia on May 4, 2025.
2. This activity was organized in collaboration between the Research and Community Service Institute of Universitas Mercu Buana (UMB) and the Indonesian Community Organization (PERMAI).
3. The training participants, totaling 25 people, gained increased knowledge and skills regarding the implementation of GSC Management in SMEs.

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