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Barriers and Enablers for Developing Sustainable Supply Chain at Traditional Shipyards in East Java, Indonesia

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Abstract

Traditional shipyards in Indonesia have produced lots of wooden fishing boats in various gross tonnage sizes. Efficiency in material costs has been concerned for creating competitive advantage. However, traditional shipyards encounter various barriers in developing sustainable supply chain. In this study, we investigate the barriers and enablers experienced by traditional shipyards when developing sustainable supply chain by using Analytical Hierarchy Process (AHP). The results show that the top five barrier factors are lack of information, fund constraints, high cost, and lack of visual and statistical control during green lean implementation, and poor quality of human resources. On the other hand, the top five enabler factors are risk mitigation, top management commitment and support, monitoring and auditing supply chain partners, availability of financial support, and recognition. By incorporating the sustainable supply chain principles into the traditional shipyards' business models, the owners agree that the recognition of environmentally friendly shipyards can increase their sales growth and reputation

Keywords
Sustainable supply chain, Shipyards, Barriers, Enablers, Analytical hierarchy process

1. Introduction

East Java province in Indonesia is set by government as one of shipbuilding industrial cluster. Most of fishermen build the wooden fishing boat. The supply chain of material used in the traditional shipyard has a critical role for developing sustainability. To the best of our knowledge, the sustainable supply chain in these traditional shipyards has not been studied.

Sustainable supply chain has become a challenge for the competitive advantages. Sustainability consists of economics, environment, and social benefits. In economics sector, there are financial benefits in the production process. In environment sector, there is an environmental friendly for greening the production ones. Meanwhile in social sector, there is a specific intervention to improve social well-being (Rizos et al. 2019, Miemczyk and Luzzini 2017).

In developing sustainable supply chain, there are barriers and enablers for the implementation. We review some literatures about those barriers and enablers from Rizos et al. (2016), Cherrafi, et. al. (2017), Piyathanavong et. al. (2019), and Kumar and Rahman (2017). Subsequently, we explore the traditional shipyards in building traditional fishing boats using those barriers and enablers. In this study, we aim to prioritize and analyze the barriers and enablers of sustainable supply chain in building the traditional fishing boats in East Java province, Indonesia. We

use analytical hierarchy process (AHP) to make the prioritization. We expect that the results can be used to develop the sustainable supply chain in traditional shipyards in Indonesia.

The remaining of the paper is organized as follows. Section 2 discusses the literatures about sustainability, barriers, and enablers factors. Meanwhile, research methodology is presented in Section 3. Section 4 describes the results and discussions of the barriers and enablers in traditional fishing boats building. Finally, conclusions and future research are presented in Section 5.

2. Literature review

Sustainability is related to the sustainable performance of products, processes, and policies. The sustainability assessment aims to sustainability improvement. Some new methods for measurement of sustainability and its improvement are required. In order to measure the sustainable performance, key performance indicators should be developed to assess the products, processes, policies, and also three dimensions of sustainability.

Product sustainability has some important criteria such as sustainable materials, sustainable way of manufacturing and resources, and can be reused, remanufactured, recycled. Process sustainability through process improvement identified waste elimination as an important criteria. Lean production system and green manufacturing are techniques in waste elimination. Policies sustainability is related to environmental and human resource management, technology and innovation, infrastructure, and social sustainability (Sangwan et. al., 2018).

Dimensions of sustainability consist of economic, environmental, and social. Economic dimension of sustainability is related to financial costs. Environment dimension has an environmental benefit from the achieved green solution. Social dimension impacts on social benefits by improving social well-being (Rizos et. al., 2016).

In the implementation of sustainability supply chain, there are barrier and enabler factors of all dimensions. Several barrier factors are poor quality of human resources, lack of expertise training and education, lack of government support to integrate green practice, lack of communication and cooperation between departments, lack of top management involvement in adopting green lean initiative, resistance to change, too much effort required, lack of environmental awareness, lack of technical know-how, lack of information, fear of failure, fund constraints, lack of statistical, lean, and green thinking; inappropriate identification of areas and activities to be "leaned and green" and unreliable "data collection system"; lack of Kaizen culture, lack of visual and statistical control during green lean implementation, high cost, poor cooperate culture separating environmental and continuous improvement decisions, administrative burden (Rizos et al., 2016; Cherrafi, et. al., 2017; Piyathanavong et. al., 2019).

The enabler factors for the implementation of sustainability supply chain in social sector are external pressure, top management commitment & support, resource sharing, capacity building and development, joint effort and planning, trust and commitment among partners, environmental awareness, company's policy and own initiative, compliance with environmental regulations and laws, promote company's reputation, minimize the environmental impact, pressure for environmentally friendly products and services, demand from customers and stakeholders, awareness, incentives and support from agencies, monitoring and auditing supply chain partners, competitive and marketing advantage, risk mitigation, availability of financial support, and recognition (Rizos, 2016; Kumar and Rahman, 2017; Piyathanavong et. al., 2019).

3. Research Methodology

Figure 1 shows the research methodology of sustainable supply chain at the traditional shipyard. Firstly, we review several literatures about barriers and enablers factors of sustainability. Secondly, we classify these entire barrier and enabler factors into environment, social, and economics sectors as can be seen in Tables 1-2. Thirdly, we did survey to the five largest traditional shipyards in Lamongan, East Java. We interviewed the owner and the project manager of these shipyards related to the barrier and enabler that they might face in building of fishing boats. Subsequently, we made a prioritization of the key barrier and enabler using analytical hierarchy process (AHP) method as shown in Figures 2-3. Finally, we analyzed the results of AHP and addressed the remarks.

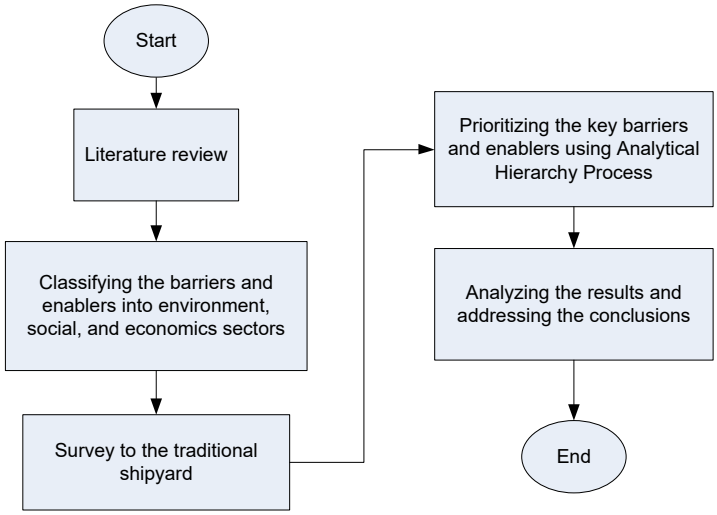

Figure 1. Research methodology

Table 1. The barrier factors of sustainability framework

Sustainability Framework	Barrier Factors	Index
Environment	Lack of environmental awareness	LEA
	Lack of technical know-how	LTKH
	Lack of information	LI
Social	Poor quality of human resources	PQHR
	Lack of expertise training and education	LETE
	Lack of government support to integrate green practice	LGIG
	Lack of communication and cooperation between departments	LCC
	Lack of top management involvement in adopting Green lean initiative	LMIG
	Resistance to change	RC
	Too much effort required	TMER
Economics	Fear of failure	FF
	Fund constraints	FC
	Lack of statistical, lean, and green thinking	LSLG
	Inappropriate identification of areas and activities to be “leaned and green” and unreliable “data collection system”	IIAA
	Lack of Kaizen culture	LKC
	Lack of visual and statistical control during green lean implementation	LVSC
	High cost	HC
	Poor cooperate culture separating environmental and continuous improvement decisions	PCC
	Administrative burden	AB

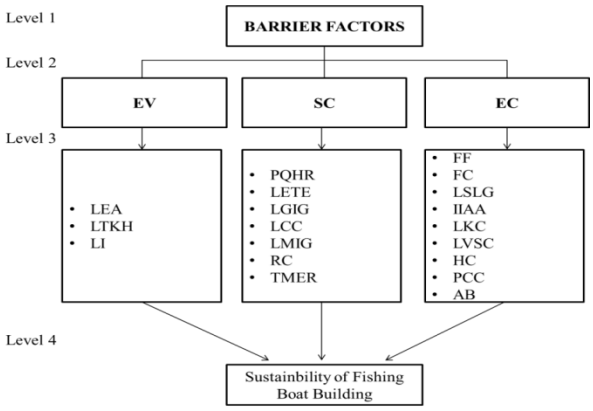

Figure 2. The hierarchy of barrier factors

Table 2. The enabler factors of sustainability framework

Sustainability Framework	Enabler Factors	Index
Environment	Environmental awareness	EA
	Company's policy and own initiative	CPOI
	Compliance with environmental regulations and laws	CERL
	Promote company's reputation	PCR
	Minimize the environmental impact	MEI
	Pressure for environmentally friendly products and services	PEFP
	Demand from customers and stakeholders	DCS
	Awareness	AW
Social	External pressure	EP
	Top management commitment & support	TMCS
	Resource Sharing	RS
	Capacity building and development	CBD
	Joint effort and planning	JEP
	Trust and commitment among partners	TCAP
Economics	Incentives and support from agencies	ISA
	Monitoring and auditing supply chain partners	MASC
	Competitive and marketing advantage	CMA
	Risk mitigation	RM
	Availability of financial support	AFS
	Recognition	RN

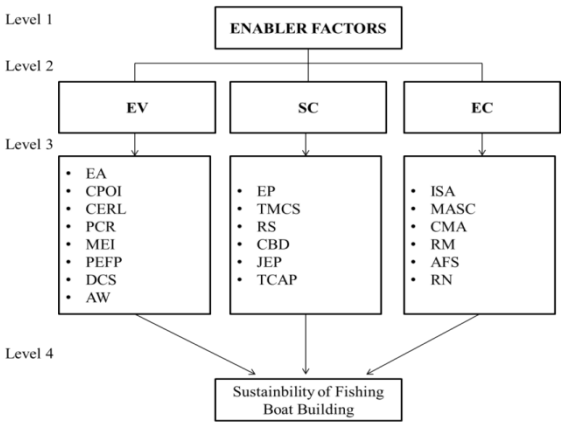

Figure 3. The hierarchy of enabler factors

4. Results and Discussions

Table 3. The results of barrier factor using AHP

Sustainability Framework	Weight	Barrier Factor	Weight	Global Weight	Rank
Environment	0.248	Lack of environmental awareness	0.15500	0.03844	10
		Lack of technical know-how	0.19100	0.04737	8
		Lack of information	0.65400	0.16219	1
Social	0.274	Poor quality of human resources	0.28300	0.07754	5
		Lack of expertise training and education	0.21700	0.05946	6
		Lack of government support to integrate green practice	0.08300	0.02274	14
		Lack of communication and cooperation between departments	0.10900	0.02987	13
		Lack of top management involvement in adopting Green lean initiative	0.12900	0.03535	11
		Resistance to change	0.05700	0.01562	18
		Too much effort required	0.12200	0.03343	12
Economic	0.478	Fear of failure	0.04000	0.01912	16
		Fund constraints	0.26000	0.12428	2
		Lack of statistical, lean, and green thinking	0.04700	0.02247	15
		Inappropriate identification of areas and activities to be “leaned and green” and unreliable “data collection system”	0.08900	0.04254	9
		Lack of Kaizen culture	0.12100	0.05784	7
		Lack of visual and statistical control during green lean implementation	0.16800	0.08030	4

Sustainability Framework	Weight	Barrier Factor	Weight	Global Weight	Rank
		High cost	0.21500	0.10277	3
		Poor cooperate culture separating environmental and continuous improvement decisions	0.03400	0.01625	17
		Administrative burden	0.02500	0.01195	19

Based on the Table 3, there are top five of barrier factors namely lack of information, fund constraints, high cost, lack of visual and statistical control during green lean implementation, and poor quality of human resources. All the traditional shipyards do not know about the law of waste treatment from fishing boat building. However, some of them know the benefit of recycle of wooden waste such as making the handy craft. Furthermore, most the traditional shipyards will invest on purchasing wooden logs whenever they receive down payment from the customers. This is because the wooden price is always increasing. Besides, they also will sell sheet wood in order to get more profit and can be used for buying nails and bolts. These are the strategies of traditional shipyards in encountering the fund constraints and high cost. During the green lean implementation, some of the traditional shipyards are less control of visual and statistics. It happens because they more focus on the boat building but not on the greening activities. Finally, the fifth barrier is poor quality of human resources. The workers will be trained to master all the boat building activities such as: cutting wood, hull construction, frame installation, hatch installation, the wheelhouse building installation, machines installation, and painting (Praharsi et. al., 2019). Moreover, rolling system is commonly practiced in the traditional shipyard. On the other hand, only training is not enough to equip the workers, but also the intelligent quotient is important.

Table 4. The results of enabler factor using AHP

Sustainability Framework	Weight	Enabler Factor	Weight	Global Weight	Rank
Environment	0.145	Environmental awareness	0.23400	0.03393	11
		Company's policy and own initiative	0.17000	0.02465	14
		Compliance with environmental regulations and laws	0.06000	0.00870	20
		Promote company's reputation	0.09600	0.01392	17
		Minimize the environmental impact	0.09600	0.01392	17
		Pressure for environmentally friendly products and services	0.12100	0.01755	16
		Demand from customers and stakeholders	0.14600	0.02117	15
		Awareness	0.07700	0.01117	19
Social	0.319	External pressure	0.12600	0.04019	10
		Top management commitment & support	0.34100	0.10878	2
		Resource Sharing	0.15200	0.04849	9
		Capacity building and development	0.09000	0.02871	13
		Joint effort and planning	0.09500	0.03031	12
		Trust and commitment among partners	0.19600	0.06252	7
Economic	0.536	Incentives and support from agencies	0.11400	0.06110	8
		Monitoring and auditing supply chain partners	0.16100	0.08630	3
		Competitive and marketing advantage	0.12000	0.06432	6
		Risk mitigation	0.34200	0.18331	1
		Availability of financial support	0.13300	0.07129	4
		Recognition	0.13000	0.06968	5

Based on the Table 4, there are top five enabler factors consisting of risk mitigation, top management commitment and support, monitoring and auditing supply chain partners, availability of financial support, and recognition. In mitigating risk, most of the traditional shipyards conveyed the education on waste treatment management and working accident insurance. Besides, the support and direction from the top management is very important to implement the environmentally friendly production process. In monitoring and auditing supply chain partners, all the traditional shipyards will evaluate the wooden supplier. If the wood quality does not meet their requirement, they will bargain the price or change to other supplier. Moreover, all the traditional shipyards have financial support availability, but some of them are reluctant to modernize the devices to support the greening production process. Meanwhile, they all agree that recognition of the society as environmentally friendly traditional shipyard affects to the sales growth and organization's reputation. By greening production process, the number of wooden needed is very efficient.

5. Conclusions

We have discussed the barrier and enabler factors for developing sustainable supply chain at traditional shipyards in Indonesia. By using AHP method, we found out that the top five barrier factors are lack of information, fund constraints, high cost, lack of visual and statistical control during green lean implementation, and poor quality of human resources. Meanwhile, the top five enabler factors are risk mitigation, top management commitment and support, monitoring and auditing supply chain partners, availability of financial support, and recognition. The insights derived from the barrier factors are most the traditional shipyards invest on wooden logs to anticipate the fund constraints and increasing material price. Furthermore, the intelligent quotient of workers and the number of training are important to master in all fishing boat building activities. On the other hand, the insights from the enabler factors are that the support and commitment from top management to implement the environmentally friendly production process is very necessary. Moreover, the traditional shipyards owners agree that the recognition of environmentally friendly shipyards can increase their sales growth and reputation. This is because the number of wooden material consumed will be less as the shipyards implement the greening production process. Future research can be done by modeling the industrial ecosystem of wooden fishing boat building.

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References

Kumar, D., and Rahman, Z., Analyzing enablers of sustainable supply chain: ISM and fuzzy AHP approach, *Journal of Modelling in Management*, vol. 12, no. 3, pp. 498-524, 2017.

Miemczyk, J., and Luzzini, D., Achieving triple bottom line sustainability in supply chains: the role of environmental, social, and risk assessment practices, *International Journal of Operations & Production Management*, vol. 39, no. 2, pp. 239-259, 2019.

Rizos, V., Behrens, A., Gaast, W.V.D., Hofman, E., Ioannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., and Topi, C., Implementation of circular economy business models by small and medium-sized enterprises (SMEs): barriers and enablers, *Sustainability*, vol. 8, pp. 1-18, 2012.

Sangwan, K.S., Bhakar, V., and Digalwar, A.K., Sustainability assessment in manufacturing organizations, *Benchmarking: An International Journal*, vol. 25, no. 3, pp. 994-1027, 2018.

Cherrafi, A., Elfezazi, S., Garza-Reyes, J.A., Benhida, K., and Mokhlis, A., Barriers in green lean implementation: a combined systematic literature review and interpretive structural modeling approach, Production Planning & Control-The Management of Operations, vol. 28, no. 10, pp. 829-842, 2017.

Piyathanavong, V., Garza-Reyes, J.A., Kumar, V., Maldonado-Guzman, G., and Mangla, S.K., The adoption of operational environmental sustainability approaches in the Thai manufacturing sector, *Journal of Cleaner Production*, vol. 220, pp. 507-528, 2019.

Praharsi, Y., Jami'in, M.A., Suhardjito, G., and Wee, H.-M., Modeling a traditional fishing boat building in East Java, Indonesia, *Ocean Engineering*, vol. 189, pp. 1-12, 2019.

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