

# Uncertain Supply Chain Management

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## Does implementing green operation management affect the Sustainability of port operations in Labuan Bajo?

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### ABSTRACT

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Labuan Bajo Seaport's maritime logistics ecosystem serves the marine logistics supply chain as an essential part of economics and social development in the region. It is one of the economic regions that need to be developed where green operations management must be applied to suppress the negative impact of port operations. The research aims to analyze the influence of green marketing, business, and operation management on Sustainability. A cross-sectional study has been conducted in this research with data processing using partial least squares (PLS) path modeling. The population is the stakeholder of Labuan Bajo seaport, and the samples are 100 with a purposive sampling method. Findings show that green marketing has influenced business, operation management, and Sustainability. However, the green industry also influenced green operation management and impacted Sustainability. The study indicates that Sustainability can be achieved when the seaport operates using green principles from planning to monitoring by the involvement of the stakeholder.

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### 1. Introduction

The maritime logistics ecosystem in Indonesia is supported by Pelindo, which manages the operations of ports in Indonesia as a synergy strategy of State-Owned Enterprises with business process efficiency since October 2021. The integration of operational business processes of ports using information technology is expected to impact economic improvement and social welfare through Pelindo Container Terminal, Pelindo Multi Terminal, Pelindo Maritime Services, and Pelindo Logistics Solutions. Sustainable port operationalization in Asia Pacific, the European Union, and North America implement environmental management policies and stakeholder engagement and invests proactively in solving environmental problems to address the negative impacts that maritime logistics ecosystems have caused (Hossaina et al., 2021; Hua et al., 2020; Yap et al., 2013; Lirn et al., 2012).

Seaports of shipping industries make up the most significant share of global trade (Ricardianto et al., 2023a; Hossaina et al., 2021; Lun et al., 2014.) and are central to loading and unloading services, storage warehousing, packing, and cargo transportation (Liong & Loo, 2009). In addition to positive contributions to economic growth, seaport activities also have an impact on the environment (Ricardianto et al., 2022a; Hua et al., 2020; Chen et al., 2020; Lam & Notteboom, 2014; Dinwoodie et al., 2012; Gupta et al., 2005; del Saz-Salazar et al., 2012). The results showed five main problems of environmental damage, namely, noise, habitat conservation, air quality, sewage disposal, and water quality (Gupta et al., 2005). Environmental damage in other forms, such as; resource reduction, emissions to soil, emissions to air, discharges to water, and biodiversity conservation (Puig et al., 2015).

The global challenges of the growth and development of the port industry as a result of global trade will increase the environmental impact on marine ecosystems and communities around the port (Hua et al., 2020; Yap et al., 2013).

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Environmental Sustainability in the operation of seaports needs to be maintained, and green operation management needs to be done to manage environmental problems effectively (Hossaina et al., 2021; Ashrafi et al., 2019; Puig et al., 2014;). Labuan Bajo has become a port and, simultaneously, super-priority maritime tourism where economic activities occur on the coast and sea. Therefore, research on the Sustainability of Labuan Bajo, using green operation management as a mediating variable, is essential considering that Labuan Bajo is now known to have polluted its marine environment with garbage problems plus dirty seas and beaches (Grifoll et al., 2011).

## 2. Literature Review

Port sustainability is a series of activity strategies carried out to meet stakeholders' needs by safeguarding natural and human resources from pollution (AAPA, 2007). So Sustainability covers economic, social, and environmental issues (Lu et al., 2016). In contrast, the green port is interpreted as proactive execution to reduce environmental impact supported by green policy (Ashrafi et al., 2020; Acciario, 2015; Chang & Wang, 2012). Proposed sustainable port operational strategies as a comprehensive framework include; sustainable operations and development, frugal environmental policies, green market innovation, and stakeholder engagement (Hart et al., 2016). The port's operational strategy to reduce negative impacts on the environment is part of regulatory compliance as well as to maintain Sustainability (Ricardianto et al., 2023b; Hua et al., 2020) and has competitiveness in international trade (Lam & Notteboom, 2014).

The operational management function of the industry aims to produce products and services (Slack & Lewis, 2015; Winnes et al., 2015) which are offered to individual consumers and businesses by providing added value in meeting customer needs and satisfying customers (Nusraningrum et al., 2021). Operations management includes operating management of the supply chain (SCM), which produces and distributes services and goods as a system to the end customers (Pahala et al., 2021; Gunasekaran & Ngai, 2005). While integrating environmental perspectives into supply chain management, from product design to finish product distribution to user and the post-management of the product's expiration, is called green supply chain management (Rohdayatin et al., 2018). Green supply chain management or green operation management favors environmental concerns to reduce unusable products that will impact the environment caused by industrial or chain of supply operations (Peng & Lin, 2008). Environmental concerns from nonfinancial aspects are essential in the Sustainability of all operations activity from raw materials usage to finished services and goods.

Green or environmentally friendly management systems can be understood as; Sustainability of the environment, eco-production, eco-procurement, eco-purchases, eco-management, eco-design, eco-architects, eco-culture, eco-productivity (Nusraningrum et al., 2021). The green thought of environment integration into SCM improves the balance between marketing performance and environmental problems that are oriented to long-term survival and impact long-term profitability, where the company's image and future competitive advantage will be improved (Azari et al., 2018).

Green marketing is an innovation designed to reduce negative environmental impacts by improving product quality and environmentally friendly marketing (Susanti et al., 2022; Nusraningrum et al., 2021). The purpose of eco-marketing is; to communicate that brands are environmentally concerned, influencing consumers to use (Mansur et al., 2021). The company carries out green marketing as an effort and strategic process to provide environmentally friendly products and services involving stakeholders so that consumers and the public get satisfaction (Hult et al., 2008). Green marketing develops products whose production, use, and disposal process has no adverse effect on the environment, has a positive impact on the environment, and sales proceeds are used for the environment (Dangelico & Vocellelli, 2017).

## 3. Research Methodology

This study is cross-sectional or one shot in which the data are gathered once every week. The data were collected using a questionnaire with purposive sampling, and the population is stakeholders of Labuan Bajo Seaport. Data were processed using Partial Least Square, which does not need a large sample, and normal multivariate data distribution (Simanjuntak et al., 2022). The samples are calculated using a formula formulated by Naing et al. (2006):

$$n = \frac{Z^2 P(1-P)}{d^2}$$

where n = total sample, Z = Z statistic of significant, P = prevalence or proportion expected, d = precision. In this study, the value Z is 1.96 for CI 95%; P value is 0.25; value d is 0.05; As a result of the calculation obtained, the number of samples needed (n) is 100 Labuan Bajo seaport's stakeholders.

## 4. Results

Table 1 shows the majority of respondents were male, 64.6%, respondents aged 40 – 50 as much as 37.4%, respondents in lower management as much as 35.4%, service companies as much as 49.5%, manufacturing companies as much as 50.5%, and working periods of 15-20 years as much as 36.4%.

**Table 1**  
Respondent Data

Characteristics	Respondents	Frequency	Percentage
Gender	Male	64	64.6
	Female	35	35.4
Age	< 30	11	11.1
	> 50	26	26.3
	30-39	25	25.3
	40-50	37	37.4
Management levels	others	16	16.2
	Low	35	35.4
	Middle	29	29.3
	Top	19	19.2
Type of company	Services	49	49.5
	Manufacture	50	50.5
Service periods (year)	< 5	11	11.1
	10-14	5	5.1
	15-20	36	36.4
	5-9	23	23.2
	> 20	24	24.2

Source: Output Processing with SPSS 26 (2023)

**Table 2**  
Green Marketing, Green Business, Green Operation Management, Sustainability

Indicator	N	Minimum	Maximum	Mean	Std. Deviation
GM1	99	3	5	4.25	0.459
GM2	99	4	5	4.44	0.499
GM3	99	4	5	4.45	0.500
GM4	99	4	5	4.47	0.502
GM5	99	4	5	4.51	0.503
GM6	99	3	5	4.44	0.519
GM7	99	4	5	4.45	0.500
GM8	99	3	5	4.47	0.522
GM9	99	3	5	4.52	0.541
GB1	99	3	5	4.22	0.442
GB2	99	4	5	4.35	0.480
GB3	99	4	5	4.42	0.497
GB4	99	4	5	4.49	0.503
GB5	99	3	5	4.44	0.557
GB6	99	3	5	4.42	0.536
GOM1	99	4	5	4.31	0.466
GOM2	99	2	5	4.31	0.547
GOM3	99	3	5	4.38	0.509
GOM4	99	3	5	4.35	0.540
GOM5	99	2	5	4.39	0.568
GOM6	99	4	5	4.46	0.501
GOM7	99	2	5	4.43	0.609
S1	99	4	5	4.26	0.442
S2	99	3	5	4.34	0.518
S3	99	3	5	4.45	0.520
S4	99	3	5	4.38	0.548
S5	99	3	5	4.36	0.524
S6	99	3	5	4.42	0.536
S7	99	4	5	4.46	0.501
S8	99	3	5	4.37	0.507
S9	99	3	5	4.42	0.536
S10	99	2	5	4.28	0.572
S11	99	3	5	4.35	0.501
S12	99	3	5	4.36	0.524
S13	99	2	5	4.34	0.538

Source: Output Processing with SPSS 26 (2023)

Table 2 shows that all indicators of the variables Green Marketing, green business, green operation management, and Sustainability have values above 4 with a standard deviation of 5% - 7%.

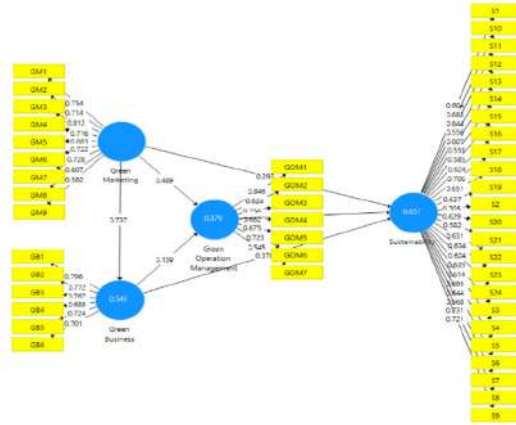


Fig. 1. Algorithm result

Source: PLS 3.0 (2022)

Fig. 1 shows that all indicators have met convergent validity; they have a loading factor value above 0.50.

**Table 3**  
Discriminant Validity (Cross Loading) Test

	Green Marketing	Green Business	Green Operation Management	Sustainability
GM1	0.754	0.697	0.580	0.661
GM2	0.714	0.438	0.323	0.363
GM3	0.812	0.573	0.530	0.526
GM4	0.716	0.512	0.436	0.514
GM5	0.683	0.523	0.329	0.416
GM6	0.722	0.502	0.437	0.575
GM7	0.728	0.514	0.302	0.421
GM8	0.607	0.367	0.390	0.514
GM9	0.582	0.458	0.306	0.546
GB1	0.653	0.796	0.523	0.630
GB2	0.519	0.772	0.434	0.500
GB3	0.434	0.767	0.378	0.464
GB4	0.519	0.688	0.326	0.422
GB5	0.576	0.724	0.353	0.626
GB6	0.544	0.701	0.262	0.550
GOM1	0.641	0.577	0.846	0.589
GOM2	0.305	0.214	0.624	0.309
GOM3	0.443	0.347	0.756	0.513
GOM4	0.292	0.227	0.682	0.398
GOM5	0.357	0.331	0.675	0.428
GOM6	0.515	0.463	0.723	0.482
GOM7	0.238	0.203	0.545	0.321
S1	0.652	0.647	0.581	0.604
S2	0.619	0.661	0.444	0.705
S3	0.455	0.520	0.364	0.635
S4	0.410	0.366	0.300	0.614
S5	0.481	0.449	0.361	0.695
S6	0.412	0.436	0.347	0.644
S7	0.419	0.317	0.339	0.568
S8	0.515	0.464	0.426	0.731
S9	0.559	0.465	0.474	0.721
S10	0.443	0.374	0.439	0.683
S11	0.469	0.428	0.485	0.644
S12	0.427	0.315	0.324	0.556
S13	0.462	0.478	0.393	0.607
S14	0.395	0.368	0.321	0.551
S15	0.369	0.381	0.348	0.585
S16	0.469	0.494	0.349	0.624
S17	0.450	0.462	0.404	0.706
S18	0.465	0.419	0.436	0.651
S19	0.402	0.480	0.424	0.637
S20	0.432	0.431	0.357	0.629
S21	0.414	0.359	0.321	0.582
S22	0.469	0.548	0.539	0.631
S23	0.428	0.480	0.512	0.634
S24	0.368	0.521	0.324	0.624

Based on table 3 shows the result of cross-loading. All indicators meet the requirement of discriminant validity, where each indicator has the highest score of others.

**Table 5**

Fornell-Larcker criterion result

	Green Marketing	Green Marketing	Green Marketing	Green Marketing
Green Marketing	0.742			
Green Business	0.737	0.705		
Green Operation Management	0.520	0.606	0.699	
Sustainability	0.727	0.730	0.641	0.638

Source: PLS 3.0 (2023)

The Fornell-Larcker Criterion table shows the roots of the AVE square that the requirement of validity discriminants.

**Table 6**

Collinearity Statistic

	Unstandardized coefficient		Standardized Coefficient $\beta$	t	Sig.	Collinearity Statistics	
	$\beta$	Std. Error				Tolerance	IF
Constant	15.384	7.154		2.150	0.034		
Green Marketing	0.735	0.239	0.294	3.079	0.003	0.431	2.320
Green Business	1.287	0.323	0.361	3.986	0.000	0.481	2.077
Green Operation Management	0.846	0.231	0.276	3.658	0.000	0.692	1.444

Dependent Variable: Sustainability

Source: PLS 3.0 (2023)

The collinearity statistics (VIF) test shows that all variables do not occur in multicollinearity.

**Table 7**

Reliability

Variable	Composite Reliability	Cronbach's Alpha
Green Marketing	0.898	0.872
Green Business	0.880	0.837
Green Operation Management	0.868	0.825
Sustainability	0.942	0.936

Source: PLS 3.0 (2023)

Table 7 shows that the test results of composite reliability and Cronbach's alpha all latent variables have been reliable, so it can be concluded that the questionnaire used for this study has been reliable or consistent.

**Table 8**

Average Variance Extracted (AVE)

Variable	Average Variance Extracted (AVE)
Green Marketing	0.497
Green Business	0.551
Green Operation Management	0.488
Sustainability	0.407

Source: PLS 3.0 (2023)

Table 8 shows that the convergent validity test requirements have met the requirements, where AVE is 0.4 with composite reliability higher than 0.6 (Huang et al., 2013).

**Table 9**

Coefficient of Determination

	R <sup>2</sup>
Green Business	0.543
Green Operation Management	0.379
Sustainability	0.657

Source: PLS 3.0 (2023)

Based on Table 9, the R-Square value of Sustainability can be explained by other variables in the model, namely Green Marketing, Green Business, and Green Operation Management of 65.7%. According to Hair (2014), they are testing the Goodness of Fit Structural model on inner models using predictive relevance (Q<sup>2</sup>) values. A Q-Square value > 0 indicates the model has a predictive relevance value.

$$Q^2 = 1 - (1 - R1)(1 - Rp) = 1 - (1 - 0.379)(1 - 0.657) = 1 - (0.621)(0.343) = 0.786997$$

The calculation results above show a score of predictive relevance  $0.786997 > 0$ . So, the independent variables explain 78.6997% of the Green Operation Management and Sustainability variables, and the model is feasible.

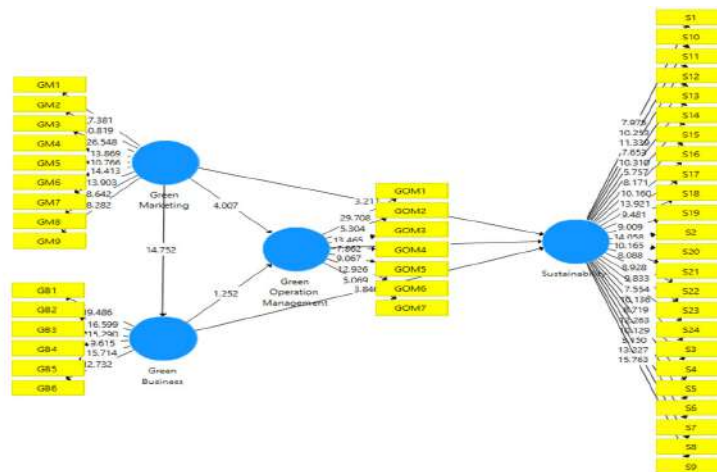
**Table 10**  
Hypothesis Testing Results (estimated path coefficient)

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ( O/STDEV )	P Values
Green Marketing → Green Business	0.737	0.746	0.050	14.752	0.000
Green Marketing → Green Operation Management	0.489	0.488	0.122	4.007	0.000
Green Business → Green Operation Management	0.159	0.174	0.127	1.252	0.211
Green Marketing → Sustainability	0.293	0.301	0.091	3.211	0.001
Green Business → Sustainability	0.370	0.364	0.096	3.846	0.000
Green Operation Management → Sustainability	0.271	0.274	0.079	3.446	0.001

Source: PLS 3.0 (2023)

Table 10 declares the results of the hypothesis testing of the research model:

- Hypothesis 1: Green Marketing toward Green Business shows the t-stat  $14.752 > 1.96$ , the original sample  $0.737$ , and p-value  $0.000 < 0.05$ , which found that green marketing has a positive and significant influence on green business.
- Hypothesis 2: Green Marketing toward Green Operation Management shows the t-stat  $4.007 > 1.96$ , the original sample  $0.489$ , and a p-value of  $0.000 < 0.05$ , which found that green marketing has a positive and significant influence on green operation management.
- Hypothesis 3: Green Business toward Green Operation Management shows t-stat  $1.252 > 1.96$ , the original sample  $0.159$ , and P value  $0.211 < 0.05$ , found that green business has a positive and insignificant influence on green operation management.
- Hypothesis 4: Green Marketing toward Sustainability shows the t-stat  $3.211 > 1.96$ , the original sample  $0.293$ , and P value  $0.001 < 0.05$  found that green marketing positively and significantly influences Sustainability.
- Hypothesis 5: Green Business toward Sustainability shows the t-stat  $3.846 > 1.96$ , the original sample  $0.370$ , and P value  $0.000 < 0.05$  found that green business has a positive and significant influence on Sustainability.
- Hypothesis 6: Green Operation Management towards Sustainability shows the t-stat  $3.446 > 1.96$ , the original sample  $0.271$ , and the P value  $0.001 < 0.05$  found that green operation management positively and significantly influences Sustainability.



**Fig. 2.** Bootstrapping test result

Source: PLS 3.0, 2022

## 5. Discussion

Based on the first hypothesis test result, Green Marketing has a positive and significant influence on Green Business. So, if Green Marketing rises, it will boost Green Business. This means that green marketing with environmentally friendly product innovation encourages consumers to increase their consumption, resulting in consumer satisfaction and encouraging environmentally-friendly business (Nusraningrum et al., 2021; Pahala et al., 2021). This marketing strategy is a process that involves consumers in running an environmentally friendly business (Hult et al., 2008; Setiawati et al., 2022).

Green Marketing has a positive and significant influence on Green Operation Management. This means that the higher the Green Marketing obtained, the higher the Green Operation Management. Environmentally-friendly operations management produces products and services to ensure customer satisfaction without damaging the environment (Slack & Lewis, 2015;

Nusraningrum et al., 2021). This means that environmentally friendly products and services will be marketed by the company in an environmentally friendly manner so that the company's supply chain as a whole supports environmentally friendly operating processes (Lu et al., 2016; Denktas-Sakar & Karatas-Cetin, 2012).

The third hypothesis results test that Green Business has a positive and insignificant influence on Green Operation Management. Environmentally-friendly business starts from environmentally friendly raw materials, environmentally production processes, environmentally management, environmentally product design, environmentally marketing, and environmentally packaging (Nusraningrum et al., 2021), so it can be said that green business and green operation management have a relationship without an effect because the entire port operations process from upstream to downstream applies environmentally friendly principles (Yang et al., 2013). This environmentally friendly process will benefit the company in the long run (Azari et al., 2018; Karagülle, 2012; Ricardianto et al., 2022b).

The fourth hypothesis, the effect of Green Marketing on Sustainability, is a positive and significant influence on Sustainability. If Green Marketing goes up, then it will boost Sustainability. This means that the marketing of environmentally friendly ports is currently an unavoidable necessity, where all activities carried out at ports must apply environmentally friendly principles to preserve the seaport environment (Lam & Notteboom, 2014; AAPA, 2007; Acciaro et al., 2014; Lu et al., 2016). Thus, the negative impact of port operations on the environment must be avoided (Ashrafi et al., 2020; Acciaro, 2015) by applying applicable rules and being obeyed by all business actors around the world (Hua et al., 2020; Lam & Notteboom, 2014). The Effect of Green Business on Sustainability is positive and significant; this reinforces the opinion (Hua et al., 2020; Yap et al., 2013) that global trade contributes the greatest to environmental destruction. This finding shows that the seaport management company does business as part of economic growth by applying environmentally friendly principles (del Saz-Salazar et al., 2012; Wahyuni et al., 2022). The strategy business of the green business will maintain the Sustainability of air, water, and land (Ezanee et al., 2017; Dinwoodie et al., 2012; Hailuddin et al., 2022).

The effect of green operation management on Sustainability is positive and significant, implying that if green operation management establishes, Sustainability will increase. This indicates that port management companies must implement operations management with environmentally friendly standards to create a sustainable environment and companies that support solving global environmental problems (Nusraningrum et al., 2021; Hua et al., 2020; Yap et al., 2013). The biggest challenge of port management is keeping the coastal ecosystem healthy and sustainable (Hossaina et al., 2021; Ashrafi et al., 2020; Hossain et al., 2019; Puig et al., 2014). The global challenges of the growth and development of the port industry as a result of global trade will increase the environmental impact on marine ecosystems and communities around the port (Hua et al., 2020; Yap et al., 2013). Environmental Sustainability in the operation of seaports needs to be maintained, green operation management (Hendricks, 2017; Kim & Chiang, 2014) needs to be done so that environmental problems can be managed effectively (Iraldo et al., 2009), and the business, community, environment, and economic growth will always sustain (Green et al., 2012).

## 6. Conclusion

Green Marketing by the company will automatically increase the company's business towards being environmentally friendly, as well as its effect on its operations management. Why? Products and services produced by environmentally friendly port operations management will increase environmentally friendly business and encourage companies to market their products and services in an environmentally friendly manner, improving the Sustainability of both the company and the environment. The service products produced by the port authority must positively impact the environment by not polluting the coast so that environmentally friendly raw materials are needed, and constantly monitoring the cleanliness of the air, water and keep the land from being polluted. On a strategic level, products and services must be developed in line with sustainable principles so that they will impact the environment, green marketing, and green business competitiveness. Not polluting the water, the air, and the land will produce a better quality of air, water, and land. In order to be successful in creating a green business and strategy, a company should not use raw materials that can damage the environment, and the company will contribute to good quality of business life.

The limitation of this research is that it only takes samples at the port of Labuan Bajo; for future research, it would be better if samples were taken from all ports under the responsibility of Pelindo. The findings imply that human survival depends on ecological balance by carrying out a business oriented towards protecting the environment to be sustainable. Sustainable development meets current, and future (sustainable) needs that link society, the economy, and the environment. This is intended so that the seaport operation is responsible for the impact of its operations on the community.

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