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(Research Article)

Assessment of supply chain efficiency through a sustainable supply chain management strategy in the textile sector

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Abstract

The textile industry processes fiber into yarn or fabric. Problems often faced by textile companies are delays in raw materials, which result in the production and distribution of fabrics not reaching the target, so consumers are unsatisfied and switch to competing companies. In addition, solid waste from the production process is still disposed of, potentially polluting the environment. This study uses the Green Supply Chain Operation Reference (Green SCOR) approach to evaluate the performance of green supply chain management (GSCM) in textile companies located in Yogyakarta. The findings of this study could significantly impact the textile industry as they provide a comprehensive evaluation of GSCM performance. Twenty-two performance indicators have been validated using the Item-Content Validity Index (I-CVI) method and weighted using the Analytical Hierarchy Process (AHP) method. Based on the calculation results, the GSCM performance value is 60.208. Improvement recommendations are given for three indicators that need to be prioritized based on Importance Performance Analysis (IPA) matrix mapping and the actual condition of the company. Improvements can be made by using the Vacuum Flash Evaporation method so that recycled PVA can be reused, using natural materials or alternative auxiliary materials that are more environmentally friendly, increasing cooperation with companies engaged in processing weaving waste or textile waste appropriately and effectively, checking the concentration of starch solution not only when changing construction but every beam change, and forming a checklist form that is filled in for monitoring after machine settings and preparation of the production process.

Keywords: Textile industry; Delay; waste; Green supply chain management

1. Introduction

Environmental issues began to emerge in the 1960s as a response to the deteriorating quality of the environment and the growing impact of global warming, much of which was caused by industrialization [1]. People are beginning to realize the importance of using environmentally friendly products, requiring businesses to run their business processes with concepts that pay attention to the environment, including conducting supply chain management. All processes in the supply chain affect environmental change, from resource extraction, production processes, product delivery, product utilization, waste disposal, and other activities [2]. Environmental risks include using high amounts of water and energy without conservation, contamination, pollution, hazardous chemicals, etc [3].

Green supply chain management combines green procurement, manufacturing, material management, marketing and distribution, and reverse logistics [4]. Green Supply Chain Management integrates environmentally friendly concepts with raw material procurement activities, production and processing of raw materials, distribution and marketing systems, and reverse logistics [5]. The goal is to care about the environmental impact of every process carried out and

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the products produced. The development of the GSCM concept must continue through evaluations realized by measuring the performance of environmentally friendly supply chains on an ongoing basis [6].

Performance measurement is critical to the successful implementation of supply chain management. If performance measurement is ineffective, it will never be known what improvements are needed in the supply chain. A green supply chain must balance environmental aspects and corporate strategy [7]. In the textile industry, air emissions due to CO2 from the production process and waste management significantly affect GSCM [8]. Adoption of GSCM practices is still relatively rare, especially in the textile sector in Indonesia [9]. The GSCM method is used to see the company's performance achievements, map the problems, and help management model environmental topics in the supply chain and manage their impacts [10].

Problems often faced by textile companies are delays in raw materials, which result in the production and distribution of fabrics not reaching the target, so consumers are unsatisfied and switch to competing companies. In terms of the environment based on SIPSN KLHK (Sistem et al.), in 2021, 2.3 million tonnes of textile or fashion waste was generated in Indonesia during 2021, equivalent to 12% of the total waste generated in Indonesia. The production process of textile companies generates yarn waste from the production process that will be disposed of if it cannot be reused. In addition, textile companies also produce production process liquid waste that has the potential to contain NH3-N, TSS, TDS, COD, and Phenol due to the use of chemicals to help process yarn raw materials such as starch, acrylic, PVA, wax, antifungal and antiseptic. The use of these chemicals produces hazardous waste that will be disposed of in hazardous waste disposal sites, so the higher the use of dangerous materials, the more waste will be generated and disposed of in hazardous waste disposal sites. In addition, air emissions due to the high use of electrical energy are also generated from the production unit in the form of CO2, CH4, and N2O, which have the potential to pollute the environment and result in global warming.

This research focuses on identifying indicators of green supply chain management performance assessment and supply chain evaluation that consider economic efficiency and environmental aspects to determine the level of performance achievement with the green SCOR approach in textile companies in Yogyakarta. Based on the evaluation results, recommendations for improvement will be made on indicators with low performance that need to be prioritized for improvement in company development.

2. Research Methods

The research was conducted at a company in Yogyakarta's textile industry. The research begins with identifying the problems in the company; based on the existing issues, research questions are obtained, and then objectives are set. Preliminary studies in the form of field studies were carried out by observing the company's supply chain processes and interviews with company stakeholders to obtain information about the company's supply chain, and literature studies to find information related to green supply chain management, content validation with the I-CVI method, and Analytical Hierarchy Process (AHP).

The variables in this study were adopted from previous research and APICS 2017. The compilation of research variables can be seen in Table 1.

Table 1 Proposed Performance Indicators

Process	Indicator	Code	Source
Plan	Accuracy of production plan with production realization	PRL1	[8], [11], [10]RL 3.49
	NOx and SOx air emissions resulting from the shipping process	PSS1	[12], [8], [10] SS 3.048
Source	Percentage of suppliers with EMS and ISO14001 certification	SRL1	[7], [3], [10] RL 3.17
	Percentage of raw material orders received on time	SRL2	[7], [11], [10] RL 3.20
	Percentage of raw materials received damaged-free	SRL3	[1], [7], [11], [10] RL 3.24
	Percentage of recyclable raw materials	SAM1	[1], [7], [8], [12], [10] AM 3.3
Source	Percentage of product damage during storage	SAM2	[1], [12], [10] AM 3.28
	Source flexibility	SAG1	[1], [11], [8], [10] AG 3.9

Process	Indicator	Code	Source
Make	Percentage of products with proper environmental labeling	MRL1	[8], [10] RL 3.15
	% Yield	MRL2	[1], [7], [8], [12], [10] RL 3.58
	Percentage of hazardous materials used	MAM1	[1], [12], [10] AM 3.14
	Percentage of material reuse	MAM2	[1], [8], [12], [10] AM 3.5
	Make flexibility	MAG1	[1], [11], [8], [10] AG 3.38
	Total liquid waste	ME1	[10], [12], [7] SS 1.024
	Total solid waste	ME2	[12], [10] SS 1.025
Make	Total water used	ME3	[1], [7], [12], [11], [10] SS 2.070
	Total energy used	ME4	[1], [7], [8], [12], (APICS, 2017) SS 2.020
Delivery	Deliver quantity accuracy	DRL1	[1], [10] RL 3.35
	Shipping document accuracy	DRL2	[1], [7], (APICS 2017) RL 3.50
	Percentage of on-time delivery products	DRS1	[1], (Hapsari et al., 2021), (APICS 2017) RS 3.24
	Fuel cost	DCO1	[1], [7], [11], [10] CO 3.15
	Percentage of eco-friendly vehicle use	DSS1	[1], [10] SS 2.006
	Selecting the shortest route to minimize fuel	DSS2	[1], [10] SS 2.021
	Delivery schedule to maximize transportation capacity	DSS3	[1], [10] SS 2.2021
Return	Percentage of complaints regarding missing environmental requirements from product	RRL1	[1], [7], [11], [12], [10] RL 3.1
	Defective product replacement	RAG1	[1], [10] AG 3.3
	Products returned	RAM1	[1], [7], [11], [8], [10] AM 3.26
Enable	Percentage of employees trained in the environment	ERL1	[1], [7], [12], [10] HS 0041

The research variables will be validated by distributing questionnaires to eligible respondents and calculated using the I-CVI method. This research collects data through questionnaires, interviews, and company historical data. Performance measurements will be normalized with de Boer Storm to find and equalize score parameters on performance indicators. The weight and performance score will be used to find the supply chain performance score and assessment category index. Then, mapping will be done using Importance Performance Analysis to determine which indicators need improvement. Recommendations will be given on indicators that are focused on improvement.

2.1. Green Supply Operation Reference Model

The SCOR model is a model that describes the business activities of each supply chain component, from suppliers to consumers, to achieve goals and fulfill customer demands [13]. The SCOR model was developed to describe all phases of supply chain activities to fulfill customer demands [14]. This model can describe supply chains that are very simple to complex. The aim is to create an analysis that will provide an overview of the relationship between supply chain functions and environmental aspects to improve management performance [15]. The SCOR reference model consists of 4 main components. [10].

2.1.1. Performance

Performance focuses on measuring and evaluating the results of supply chain process implementation. Different process elements and metric hierarchies represent different aspects or dimensions of performance. The following are the performance attributes.

- *Reliability* is the ability to perform a task as expected.
- *Responsiveness* is the speed at which the supply chain provides products to customers. Examples include cycle time.
- *Agility* is responding to market changes to gain or maintain a competitive advantage.
- *Costs are* the cost of operating the supply chain process.
- *Asset Management Efficiency (Assets)* is using assets efficiently.

2.1.2. Processes

The process part of SCOR is a series of activities to achieve pre-defined objectives to run the supply chain effectively. Here are the six SCOR processes [16].

- *The plan is the initial stage of balancing* supply and demand, minimizing resource consumption, and storage and waste disposal mechanisms.
- *Source* focuses on the raw material procurement process.
- *Make* sure the product manufacturing process considers its effect on the environment.
- *Deliver* fulfills customer demand, including order management, transport, and distribution.
- *Return* is the activity of returning products for various reasons.
- *Enable* possible processes to support the realization and governance of supply chain planning and execution.

2.1.3. Practices

The practices section provides a collection of industry-standard practices recognized by companies for their value. A practice is a unique way to configure a process or set of processes.

2.1.4. People

The people part of SCOR provides standards to describe the skills required to perform tasks and manage processes.

2.2. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a decision support model developed by Thomas L. Saaty. AHP will decompose complex multi-factor or multi-criteria problems into a hierarchy. Analytical Hierarchy Process (AHP) is a method that can formulate complex and unstructured problems or situations into several components in a hierarchical arrangement. The relative importance of each variable will be subjectively rated, and it will be determined which variables have the highest priority that can affect the outcome of the problem situation [17]. The primary tool of the Analytical Hierarchy Process (AHP) is a functional hierarchy, with the primary input being human perception. AHP has the advantage of combining objective and subjective elements of a problem [18].

3. Result and Discussion

3.1. Supply Chain Process of Textile Company

A business process is a collection of activities to realize business objectives, starting from input and adding value (value added) to get output in consumer results [19]. The business process begins with a product request from a customer to a textile company; then, the company will plan raw materials and production processes based on the incoming request. After receiving customer orders, the first party involved in supply chain activities is the supplier of raw materials for the product. There are two suppliers, namely yarn suppliers, which are the essential ingredients for making fabrics, and suppliers of auxiliary materials for the weaving process. The yarn is received as a roll of yarn, calculated in units of weight (Kg). Yarn raw materials are sent from several company suppliers. The production process is carried out after the company receives the raw materials. The production process includes warping, sizing, leasing, reaching, weaving, inspecting, finishing, and folding.

3.1.1. Warping and Sizing

The warping process will merge the yarn from a slight roll into a more significant roll (beam). The rolled yarn then goes through a sizing process to strengthen the yarn so it does not break easily.

3.1.2. Leasing

The leasing process checks the amount of yarn so that weaving can be done correctly.

3.1.3. Reaching

The yarn rolled on a large spool will be inserted into the needle (gun) according to the fabric pattern to be produced.

3.1.4. Weaving

The yarn from the previous process will be processed into fabric using a weaving machine.

3.1.5. Inspecting

The finished fabric will go through an inspection process to detect defects in the product and determine the quality of the fabric.

3.1.6. Finishing dan Folding

The following process is the finishing process and folding of the fabric using a folding machine, and then the product packaging process is carried out.

The finished product will be stored in the finished product storage warehouse before being sent to the customer. Customers can request that products be sent by third-party services or sent directly by the company. If through a distributor or third party, the company will order product delivery to the distributor. After the distributor receives the delivery order, the products will be loaded into the distribution vehicle and delivered to the customer.

3.2. Validation of Performance Indicators

Indicator validation was carried out through a survey of 28 performance indicators by five respondents from the company who have worked for at least two years at the company consisting of the Head of Internal Planning and Control, Head of the Commercial Unit, Head of the Production Unit, and Head of Preparation, and one academic from Faculty of Engineering Diponegoro University. The data processing results using the I-CVI method show six indicators with an I-CVI value ≤ 0.83, so these six indicators are not used in this study. The validated indicators can be seen in Table 2.

Table 2 Validated Performance Indicators

No	Code	Unit	No	Code	Unit
1	PRL1	%	12	ME1	m^3
2	SRL2	%	13	ME2	Kg
3	SRL3	%	14	ME3	m^3
4	SAM1	%	15	ME4	Kwh
5	SAM2	%	16	DRL1	%
6	SAG1	%	17	DRL2	%
7	MRL1	%	18	DRS1	%
8	MRL2	%	19	RRL1	%
9	MAM1	%	20	RAG1	%
10	MAM2	%	21	RAM1	%
11	MAG1	%	22	ERL1	%

3.3. Snorm de Boer Normalization

Normalization is used to homogenize different scales of data. Each indicator weight is converted into a value interval of 0-100 in this measurement. Zero (0) is defined as the worst, and one hundred (100) is defined as the best so that the parameters of each indicator are the same and the results can be analyzed. There are two assessment categories: Large is Better for indicators with higher values the better, and Lower is Better for indicators with lower values the better. The normalization calculation is done using the following formula [7]:

Larger is Better

$$S(norm) = \frac{(S_i - S_{\min})}{(S_{max} - S_{min})} \ x\ 100 \ldots\ldots\ldots\ldots\ldots(1)$$

Lower is Better

$$S(norm) = \frac{(S_{max} - S_{\mathrm{i}})}{(S_{max} - S_{min})} \ x\ 100 \ldots\ldots\ldots\ldots\ldots(2)$$

Keterangan

- Si = Actual indicator value achieved
- Smin = Worst performance achievement score of performance indicators
- Smax = The value of achieving the best performance of the performance indicator

The summary of indicator normalization can be seen in Table 3.

Table 3 Indicator Normalization Summary

Code	Smin	Actual (Si)	Smax	Score
PRL1	84.65%	90.06%	92.97%	64.997
SRL2	75.0%	90.8%	100%	63.121
SRL3	99.4%	99.9%	100%	87.953
SAM1	74%	85%	90%	71.227
SAM2	0%	0.27%	2%	88.212
SAG1	0%	100%	100%	100
MRL1	0%	0%	100%	0
MRL2	88%	94.33%	98%	66.708
MAM1	7.33%	8.56%	9.87%	51.739
MAM2	8%	11.95%	20.12%	31.090
MAG1	0%	50%	100%	50.000
ME1	7710	14589.58	17697	31.115
ME2	412.3	558.93	712.87	51.216
ME3	23.956	36.225	42.949	35.400
ME4	885.314	1.299.922	1.413.381	21.486
DRL1	0%	100%	100%	100
DRL2	0%	100%	100%	100
DRS1	86.7%	95%	100%	61.268
RRL1	0%	0%	100%	100
RAG1	0%	100%	100%	100
RAM1	1%	1.46%	2.9%	72.369
ERL1	0%	0%	100%	0

From the normalization results, it is known that six indicators fall into the poor category because they have a score of less than equal to 40, 7 indicators in the average category with a score between 40-50, and 4 indicators in the excellent category with a score between 50-70, and 5 indicators in the superb category with a score of more than 90.

3.4. Weighting of Performance Indicators

Indicator weighting was carried out by giving AHP questionnaires to company management, namely the Head of the Internal Planning and Control Unit, Head of the Commercial Unit, Head of the Weaving Unit, Head of the Finishing Unit, and Head of the Preparation Unit. The AHP questionnaire consists of 3 sessions: the first is a pairwise comparison between processes, the second is a pairwise comparison between attributes, and the third is a pairwise comparison between performance indicators. The questionnaire data obtained is processed using Expert Choice V 11 software so that the level of importance of each indicator will be known. The results of the indicator weighting calculation can be seen in Table 4.

Table 4 Indicator Weighting Results

No	Code	Global Weight	No	Code	Global Weight
1	PRL1	0.197	12	ME1	0.043
2	SRL2	0.058	13	ME2	0.049
3	SRL3	0.027	14	ME3	0.027
4	SAM1	0.023	15	ME4	0.023
5	SAM2	0.035	16	DRL1	0.020
6	SAG1	0.029	17	DRL2	0.009
7	MRL1	0.029	18	DRS1	0.032
8	MRL2	0.149	19	RRL1	0.015
9	MAM1	0.047	20	RAG1	0.037
10	MAM2	0.054	21	RAM1	0.039
11	MAG1	0.030	22	ERL1	0.027

3.5. Calculation of Supply Chain Performance Value

The performance value of the performance indicator is obtained from the calculation of the multiplication of the normalization score and the weight of each performance indicator. [7]. The results of the calculation of the value of supply chain performance can be seen in Table 5.

Table 5 Calculation of Supply Chain Performance

Code	Weight	Normalization Score	Value
PRL1	0.197	64.997	12.804
SRL2	0.058	63.121	3.665
SRL3	0.027	87.953	2.381
SAM1	0.023	71.227	1.620
SAM2	0.035	88.212	3.061
SAG1	0.029	100.00	2.941
MRL1	0.029	0.00	0.000
MRL2	0.149	66.708	9.955
MAM1	0.047	51.739	2.425

Code	Weight	Normalization Score	Value
MAM2	0.054	31.090	1,677
MAG1	0.030	50.00	1,492
ME1	0.043	31.115	1,351
ME2	0.049	51.216	2,487
ME3	0.027	35.400	0,971
ME4	0.023	21.486	0,503
DRL1	0.020	100.00	1,964
DRL2	0.009	100.00	0,916
DRS1	0.032	61.268	1,973
RRL1	0.015	100.00	1,520
RAG1	0.037	100.00	3,676
RAM1	0.039	72.369	2,825
ERL1	0.027	0.00	0,000
	GSCM Performance		60.208

Based on the results of the above calculations, it is known that the company's supply chain performance is 60.208 and falls into the average category. Therefore, it is still necessary to evaluate and improve to improve the company's supply chain performance.

3.6. Importance Performance Analysis

The IPA matrix is developed to identify the indicators that need the most improvement. [20]. IPA consists of coordinate axes where the 'importance' (y-axis) and 'performance' (x-axis) of the various indicators involved are compared. In this study, the importance of indicators is expressed by the weight of each indicator, and each indicator's score represents the indicator's performance. The mapping of the IPA matrix concerning indicator scores and weights can be seen in Figure 1.

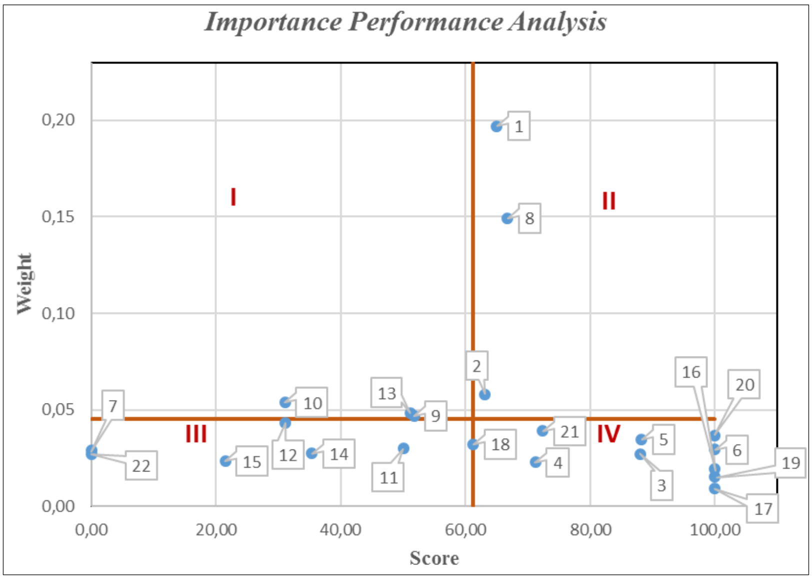

Figure 1 Importance Performance Analysis

The analysis of the IPA matrix diagram can be seen in Table 6.

Table 6 IPA Matrix Analysis

No	Code	Quadrant
1	PRL1	I *Keep Up the Good Work*
2	SRL2	I *Keep Up the Good Work*
3	SRL3	IV *Possible Overkill*
4	SAM1	IV *Possible Overkill*
5	SAM2	IV *Possible Overkill*
6	SAG1	IV *Possible Overkill*
7	MRL1	III *Lower Priority*
8	MRL2	I *Keep Up the Good Work*
9	MAM1	I *Concentrate Here*
10	MAM2	I *Concentrate Here*
11	MAG1	III *Lower Priority*
12	ME1	III *Lower Priority*
13	ME2	I *Concentrate Here*
14	ME3	III *Lower Priority*
15	ME4	III *Lower Priority*
16	DRL1	IV *Possible Overkill*
17	DRL2	IV *Possible Overkill*
18	DRS1	III *Lower Priority*
19	RRL1	IV *Possible Overkill*
20	RAG1	IV *Possible Overkill*
21	RAM1	IV *Possible Overkill*
22	ERL1	III *Lower Priority*

Quadrant I (Concentrate Here) of the IPA matrix shows indicators that are considered priorities for improvement [21]. Indicators that will be focused on improvement are indicators that have a high level of importance for the company but have low performance; this also considers the actual condition of indicator performance based on company historical data.

The recommendation for improving the indicator of the percentage of hazardous materials used (MAM1) is to use the vacuum flash Evaporation method so that recycled Polyvinyl Alcohol (PVA) can be reused. The widespread use of VFE to recover and reuse PVA will help minimize water pollution and the consumption of chemicals, energy, and water in the global textile industry, thereby contributing to a greener and cleaner world [22], [23]. In addition, it can use natural ingredients or alternative auxiliary materials that are more environmentally friendly to reduce the use of hazardous chemicals in the production process. According to research [24], tapioca has the potential to be a sizing agent that is more environmentally friendly and economical. Research by [25] also explains that tapioca or cassava starch performs well in sizing. For this reason, it is necessary to develop the sizing process through sizing to obtain a sizing composition that suits the company's needs. Using less chemical composition for sizing with the sizing recipe EKACELL DT-250 - 1 kg, EKAVIOL BEZ - 0.5 kg, EKAWAX - 0.3 kg, and water - 10 L can result in reasonably good sizing performance and cost-effectiveness [26]. Besides that, another alternative that can be done is to use Triethanolamine (TEA) modified soy protein can be used as a substitute for PVA; this soy protein has a relatively similar adhesion to PVA and is easily decomposed, so it is more environmentally friendly [27].

For the indicator of the percentage of material reuse (MAM2), insisting on using leftover material will affect the quality of the products produced, not according to company standards. It can cause problems in the spinning process, where the company prioritizes quality according to company standards. Therefore, this still needs to be done. In addition, the leftover yarn material that is not used anymore will be returned to the trading department and sold to other businesses that process the leftover yarn. Increased cooperation with companies engaged in the proper and effective processing of weaving or textile waste, such as producing recycled yarn and processing it into fabric products, napkins, pouches, and so on, can continue to be carried out so that the remaining material does not become waste.

The recommendation for the total solid waste indicator (ME2) is to check the concentration of the starch solution during construction changes and every beam change to avoid incorrect mixing or condensation entering the starch solution. The operator can check on duty [28]. Avoiding errors in machine settings or production preparation by operators can be done by forming a checklist form filled in for monitoring after machine settings and production process preparation. Checklists can help ensure that the performance carried out, with the standards that must be met, is by the standards [29]. Which checklist can manage and reduce the risk of errors and omissions [30]? Special spinning machines can reuse fabric fiber waste products to produce yarns as secondary products such as carpets, non-woven products, coarse yarns, etc [31].

4. Conclusion

The value of supply chain performance based on 22 validated indicators is 60.208 and falls into the average category. Improvements that can be made to improve the performance of green supply chain management in textile companies are to recycle PVA, use environmentally friendly natural alternative materials, increase cooperation with weaving or textile waste processing companies appropriately and effectively, and check the concentration of the weaving solution every time the weaving beam changes, and form a checklist form to monitor after machine setting and production preparation.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest is to be disclosed.

References

[1] H. Munawir, P. R. Mabrukah, M. Djunaidi, and Suranto, Analysis of green supply chain management performance with green supply chain operation reference at the batik enterprise, Econ. Ann., vol. 187, no. 1–2, pp. 139–145, 2021, doi: 10.21003/EA.V187-14.

[2] T. Somboonwiwat, T. Supeekit, and P. Punta, Green supply chain assessment to operations improvement for can packaging industry, Lect. Notes Electr. Eng., vol. 349, pp. 575–584, 2015, doi: 10.1007/978-3-662-47200-2_61.

[3] I. Adriant, A. Ariffien, and R. A. Pratiwi, Green Supply Chain Management Performance Framework (Case Study in Defense Company in Indonesia), Proc. 1st Paris Van Java Int. Semin. Heal. Econ. Soc. Sci. Humanit. (PVJ-ISHESSH 2020), vol. 535, pp. 6–10, 2021, doi: 10.2991/assehr.k.210304.002.

[4] R. Warasthe, M. Brandenburg, and S. Seuring, Sustainability, risk and performance in textile and apparel supply chains, Clean. Logist. Supply Chain, vol. 5, no. August 2021, p. 100069, 2022, doi: 10.1016/j.clscn.2022.100069.

[5] M. A. Dzikriansyah, I. Masudin, F. Zulfikarijah, M. Jihadi, and R. D. Jatmiko, The role of green supply chain management practices on environmental performance: A case of Indonesian small and medium enterprises, Clean. Logist. Supply Chain, vol. 6, no. March 2022, 2023, doi: 10.1016/j.clscn.2023.100100.

[6] K. Y. Tippayawong, N. Niyomyat, A. Sopadang, and S. Ramingwong, Factors affecting green supply chain operational performance of the Thai auto parts industry, Sustain., vol. 8, no. 11, pp. 0–9, 2016, doi: 10.3390/su8111161.

[7] F. Pulansari and A. Putri, Green Supply Chain Operation Reference (Green SCOR) Performance Evaluation (Case Study: Steel Company), J. Phys. Conf. Ser., vol. 1569, no. 3, 2020, doi: 10.1088/1742-6596/1569/3/032006.

[8] V. D. Cruz, J. D. German, and M. E. G. Fenix, Green supply chain operations reference (G-SCOR): An application for small garment manufacturers in the Philippines, Proc. Int. Conf. Ind. Eng. Oper. Manag., no. 2019, pp. 4187–4198, 2021.

[9] S. Srisawat and N. Srisawat, The Effect of Green Supply Chain Management Practices on the Sustainable Performance of the Textile Industry, Sustain., vol. 15, no. 8, pp. 300–308, 2020, doi: 10.3390/su15086677.

[10] APICS, Supply Chain Operations Reference Model, Apics, vol. 10, no. 2, pp. 62–67, 2017.

[11] P. W. Hapsari, H. Santoso, and D. Nurkertamanda, SCOR and ANP methods for measuring supplier performance with sustainability principle of green supply chain management in furniture company PT. XYZ, Proc. Int. Conf. Ind. Eng. Oper. Manag., pp. 2203–2211, 2021, doi: 10.46254/sa02.20210698.

[12] U. Effendi, C. F. Dewi, and S. A. Mustaniroh, Evaluation of supply chain performance with green supply chain management approach (GSCM) using SCOR and DEMATEL method (case study of PG Krebet Baru Malang), IOP Conf. Ser. Earth Environ. Sci., vol. 230, no. 1, 2019, doi: 10.1088/1755-1315/230/1/012065.

[13] F. F. Febrianti et al., Application of the Green SCOR Model to Measure Green Supply Chain Management Performance at PT. XYZ, vol. 3, no. 3, pp. 39–43, 2018.

[14] E. Nugraha, R. M. Sari, and A. Yunan, Development Strategies Analysis Using the SCOR Method Approach: A Case Study from Medical Device Company, J. Manaj. Teor. dan Terap. | J. Theory Appl. Manag., vol. 15, no. 1, pp. 91–106, 2022, doi: 10.20473/jmtt.v15i1.34441.

[15] M. Rosyidah, N. Khoirunnisa, U. Rofiatin, A. Asnah, A. Andiyan, and D. Sari, Measurement of key performance indicator Green Supply Chain Management (GSCM) in palm industry with green SCOR model, Mater. Today Proc., vol. 63, pp. S326–S332, 2022, doi: 10.1016/j.matpr.2022.03.158.

[16] D. N. Heitasari, I. L. Pratama, and N. Farkhiyah, Supply Chain Performance Analysis using the SCOR Method and Discrete System Simulation: Case Study of Engineer-to-Order (ETO) Products at PT. Boma Bisma Indra (Persero), INOBIS J. Inov. Bisnis dan Manaj. Indones., vol. 2, no. 4, pp. 573–585, 2019, doi: 10.31842/jurnal-inobis. v2i4.113.

[17] T. L. Saaty, Models, Methods Concepts and Applications of The Analytic Hierarchy Process (2nd ed), 2nd ed. Newyork: Springer, 2012.

[18] R. R. Chotimah, B. Purwanggono, and A. Susanty, Measuring Supply Chain Performance Using the SCOR and AHP Methods at the Urea Fertilizer Bagging Unit of PT. Dwimatama Multikarsa Semarang, Ind. Eng. Online J., vol. 6, no. 4, pp. 1–8, 2017.

[19] L. Setiyani, G. T. Liswadi, and A. Maulana, Sales Transaction Business Process Development Process at the Erni Karawang Store, vol. 16, pp. 39–45, 2022.

[20] A. Susanty, S. R. P. N. Hidayatika, and F. Jie, Using GreenSCOR to measure the performance of the supply chain of the furniture industry, Int. J. Agil. Syst. Manag., vol. 9, no. 2, pp. 89–113, 2016, doi: 10.1504/IJASM.2016.078573.

[21] N. A. Lingga and P. Sembiring, Implementation of Importance Performance Analysis to Analyze Customer Satisfaction in PT. Bank Tabungan Negara KCP Simalingkar Medan, J. Math. Technol. Educ., vol. 1, no. 1, pp. 63–76, 2021, doi: 10.32734/jomte.v1i1.7334.

[22] K. K. Gupta, Polyvinyl Alcohol Size Recovery and Reuse Via Vacuum Flash Evaporation Polyvinyl Alcohol Size Recovery and Reuse Via, 2012.

[23] A. Backman, M. Skoog, A. Backman, and T. Larsson, Replacing waste streams in the healthcare industry by applied technology Developing technology for a circular economy, Blekinge Institute of Technology, 2020.

[24] A. Subagyo and T. M. Amin, The Potential of Tapioca as Biosizing Agent for Cotton Yarn, Maj. Ilm., vol. 32, no. 1, p. 9, 2015, doi: 10.22322/dkb.v32i1.2641.

[25] S. Temesgen, B. Murugesan, and R. K. Gideon, Performance Evaluation of Cotton Yarn Sized With Natural Starches Produced From Native Corn, Cassava and Potato Starches, J. Text. Sci. Eng., vol. 09, no. 01, pp. 1–5, 2019, doi: 10.4172/2165-8064.1000389.

[26] T. Ahmed et al., Evaluation of sizing parameters on cotton using the modified sizing agent, Clean. Eng. Technol., vol. 5, 2021, doi: 10.1016/j.clet.2021.100320.

[27] Y. Zhao, Y. Zhao, H. Xu, and Y. Yang, A sustainable slashing industry using biodegradable sizes from modified soy protein to replace petro-based poly(vinyl alcohol), Environ. Sci. Technol., vol. 49, no. 4, pp. 2391–2397, 2015, doi: 10.1021/es504988w.

[28] H. K. Khasbullah., Sizing Process / Proses Penganjian, 2013. .

[29] A. Concha-Torre, Y. D. Alonso, S. Á. Blanco, A. V. Allende, J. Mayordomo-Colunga, and B. F. Barrio, The checklists: A help or a hassle?, An. Pediatría (English Ed., vol. 93, no. 2, pp. 135.e1-135.e10, 2020, doi: 10.1016/j.anpede.2020.05.003.

[30] L. Conroy et al., Medical physics practice guideline 4.b: Development, implementation, use and maintenance of safety checklists, J. Appl. Clin. Med. Phys., vol. 24, no. 3, pp. 1–20, 2023, doi: 10.1002/acm2.13895.

[31] T. Mutia et al., Utilization of Cotton Fiber Waste From Spinning Industry for Felt and Fiber Board, Arena Tekst., vol. 33, no. 1, pp. 37–46, 2018.