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The Level of Green Manufacturing Implementation Using SWOT Analysis in The Local Garment Creative Industry in Bandar Lampung

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The garment industry dominates the micro, small, and medium-sized enterprises (MSMEs) in Lampung Province after the culinary industry. One of the products of the garment industry is batik, whose manufacturing processes can produce hazardous waste for the environment if they are not properly managed. The negative impact can be minimized through the implementation of Green Manufacturing. This study was conducted to measure the level of green manufacturing implementation using Key Performance Indicator (KPI) matrix that has been tested and modified from Supply Chain Operation Reference (SCOR) matrix. The KPI matrix comprises the planning, procurement, and manufacturing processes. This research also aims to provide alternative strategy recommendations to improve the implementation of green manufacturing in Batik XYZ in Lampung Province. The average value of the green manufacturing implementation in Batik XYZ is 52.7, indicating that Batik XYZ falls into the average category.. Based on the SWOT analysis, the recommended strategy is W - T (Weakness - Threat), which is to start a comprehensive evaluation of water and electricity usage efficiency in the production process, inspection and recording of the existing company's production waste output, and to practice proper waste management.

Keywords: Green Manufacturing, Key Performance Indicator, Supply Chain Operation Reference Batik Production, SWOT Analysis.

1. INTRODUCTION

The garment industry is a very important sector for the economies of many countries, contributing greatly to employment and economic growth and being the second most polluting industry after oil [1]. The manufacturing sector is one of the biggest generations of industrial waste and a contributor to environmental pollution, which threatens environmental sustainability. The manufacturing sector must adopt green innovation systems to ensure environmental sustainability [2]. The garment industry in Lampung Province is dominated by small and medium enterprises (MSMEs), focusing on the production of apparel and textile equipment [3].

The potential of the garment industry in Lampung Province is quite large, based on the results of the census in the range of 2016 to 2019 by the Creative Economy Agency (Bekraf) and the Central Statistics Agency (BPS) showing that the fashion sub-sector in Bandar Lampung is 14.87% and is the second largest creative industry after culinary [4].

One of the most widely recognized creative clothing industry players in Bandar Lampung is Batik XYZ, which makes batik products with new innovations. The development of the garment industry in Lampung will certainly have an impact on the environment. Waste from the batik making process can pollute the environment if not managed properly. To reduce the impact of the batik

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industry on the environment, good environmental management is needed, namely companies must have a strong and sustainable management strategy, and be able to adapt quickly to market and environmental changes.

One of the efforts to minimize environmental impacts on the creative industry of Lampung batik is to implement *Green Supply Chain Management* (GSCM), which is supply chain management that integrates environmentally friendly business practices in all aspects of procurement, production, distribution, and waste management [5]. Green manufacturing is one measure of the implementation of *Green Supply Chain Management* (GSCM). Green manufacturing practices have a significant positive effect on green supply chain integration, which in turn acts as an intermediary between GMP (Green Manufacturing Practices) and sustainable performance (economic, environmental, and social) among manufacturing MSMEs in Ghana [5]. The purpose of this study is to measure the level of green manufacturing implementation and recommend alternative strategies to improve green manufacturing implementation at Batik XYZ.

Measurement of the level of green manufacturing implementation is carried out using a *Key Performance Indicator* (KPI) matrix that refers to the *Supply Chain Operation Reference* (SCOR) matrix. The KPI matrix that has been tested for validity, reliability and normalization covers the manufacturing process, namely planning (*plan*), procurement (*source)*, manufacturing (*make*). The validity test is carried out using the Pearson's equation as follows:

$$r = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)\left(\sum y^2 - \frac{(\sum y)^2}{n}\right)} \quad (1)$$

The reliability test uses the *Cronbach Alpha* formula

$$r_x = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum \sigma t^2}{\sigma t^2}\right) \quad (2)$$

Normalization using the *Snorm De Boer* formula

$$S_{norm}\,(skor) = \frac{SI - Smin}{Smax - S\,min} \times 100 \quad (3)$$

The determination of alternative strategy recommendations to improve the implementation of green manufacturing at Batik XYZ uses SWOT analysis. The SWOT analysis model is to compare external factors of opportunities and threats with internal factors of strengths and weaknesses. The internal factors are entered into a matrix called the internal strategic factor matrix or IFAS (Internal Strategic Factor Analysis Summary). Meanwhile, external factors are entered into a matrix called the external strategic factor matrix EFAS (*External Strategic Factor Analysis Summary*) [5]

2. METHODOLOGY

The research was conducted in the range of September–November 2022 at CV. XYZ, a batik producer operating in the city of Bandar Lampung.

A. KPI

Data collection is divided into 2 categories, namely primary data in the form of questionnaires and interviews and secondary data in the form of document on the use of electricity, water, chemicals, waste and production process flow, where both data are used to design Key Performance Indicator (KPI) instruments. KPI matrix (Table 1) consisting of 13 indicators and tested for validity and reliability with 30 respondents and processed using SPSS. The significance test results on KPIs have a value of more than 0.05 on 14 indicators and are declared valid. The reliability test results on each variable averaged 0.92 respondents' answers related to all research variables were reliable (see Table I).

Table I. Matrix of KPIs and validated indicators

***Green* SCOR perspective/ variable**	**KPI Code**	**KPI**	**Destination**
Plan	**P1**	Production process electricity usage.	Implement efficient use of electrical energy in the production process.
	P2	Production process water usage.	Implement efficient use of water in the production process.
	P3	Efficient use of synthetic chemicals in the production process.	Implement the efficient use of synthetic (artificial/mixed) chemicals in the production process.
	P4	Hazardous material handling and storage planning.	Implement a material handling and storage plan for hazardous materials.
	P5	Disposal planning for ordinary waste and hazardous waste.	Implement disposal planning for ordinary waste and hazardous waste.
	P6	% of workers attending briefings/ training on the environment.	Increase labor knowledge of the environment.
Source/ Procurement	**S1**	% Raw materials that do not have defects.	Calculating the inventory of raw materials that do not have defects.
	S2	% Hazardous materials in inventory.	Calculating the quantity of hazardous materials in inventory.
	S3	Number of certified suppliers/total suppliers.	Having suppliers with ISO 14000 Environmental Management System (EMS) Certification.
Make/ production	**M1**	Inputs and outputs obtained in the production section.	Efficiency of materials used in the production process.
	M2	Liquid waste	Minimization of liquid

	generated from the production process.	waste.
M3	Solid waste generated from the rest of the production process.	Minimization of solid waste.
M4	Percentage of materials that can be recycled or reused for the production process.	Reuse of recycled materials for the production process.

Next, the weighting of each KPI item is carried out by quantifying the scale of importance of each KPI to the company's manufacturing process obtained from the assessment of experts in the company. After obtaining all the results of the calculation of the actual value (S_i), then the normalization value of snorm de boer is calculated. The normalized value is then multiplied by the weight to get the performance value of each KPI. (see Table II).

Table II. Classification of performance score categories

Value range	Performance Category
<40	*Poor*
40 - 50	*Marginal*
50 - 70	*Average*
70 - 90	*Good*
>90	*Excellent*

B. SWOT Analysis

Determination of strategies to improve the value of green manufacturing performance is done using SWOT analysis. Based on the results of the expert judgment questionnaire, the SWOT matrix is shown in Table III.

Table III. SWOT Matrix

	IFAS
Strength	1. The production process is carried out under the direct supervision of the company. 2. The production process is carried out with a partnership pattern. 3. There are electrical energy saving rules in the Production SOP. 4. There are water saving rules in the Production SOPs. 5. The level of understanding of the workforce on the SOP. 6. There is training for the workforce. 7. In training, the workforce is given knowledge about the needs related to the environment. 8. There is a *Quality Control* (QC) inspection. 9. There is reutilization of leftover materials. 10. Use of environmentally friendly (*biodegradable*) packaging.
Weakness	1. There are rules regarding waste in the Production SOP. 2. There is a check and record of electricity usage . 3. There is inspection and recording of water usage. 4. There is inspection and recording of waste output.
	EFAS
Opportunity	1. Standardized suppliers (ISO, etc.). 2. The emergence of technologically advanced means of production. 3. Strict regulation of textile industry waste and pollution management. 4. Implementation of Cleaner Production and Environmental Management System. 5. EIA. 6. Economic conditions. 7. Emerging consumer demand for green industry implementation.
Threats	1. Political situation. 2. The existence of similar competitors from outside the region who open markets in Lampung. 3. Existence of similar competitors with eco-labels.

3. RESULTS AND DISCUSSION

A. Measurement of the level of Green Manufacturing Implementation

In the planning aspect, the performance level measurement is calculated based on 6 indicators, namely: Use of electricity in the production process (P1); Use of water in the production process (P2); Use of synthetic chemicals in the production process (P3); Planning for the handling and storage of hazardous materials (P4); Planning for the disposal of ordinary waste and hazardous waste (P5); and the percentage of Production Workers who attended training on the environment (P6). Based on Figure 1, indicators in the planning aspect are divided into 3 performance categories, namely marginal 2 indicators (P1 AND P2), Good 2 indicators (P3 AND P5) and Excellent 2 indicators (P4 AND P6). The highest level is the Excellent category, obtained by KPI indicator P4 with a value of 90.16 because it has planning and handling of hazardous materials and KPI P6 with a value of 90.1 where all production workers have received training on the environment. The lowest category is Poor, obtained by KPI P1 with a value of 47.57 and KPI P2 with a value of 49.67 which means that the efficiency of water and

electricity usage in the company has not been fulfilled. In the Good category, KPI P3 and KPI P5 are obtained with the same value of 81.96 which means that the use of synthetic chemicals is said to be efficient and has a plan for the disposal of ordinary waste and hazardous waste in the production process.

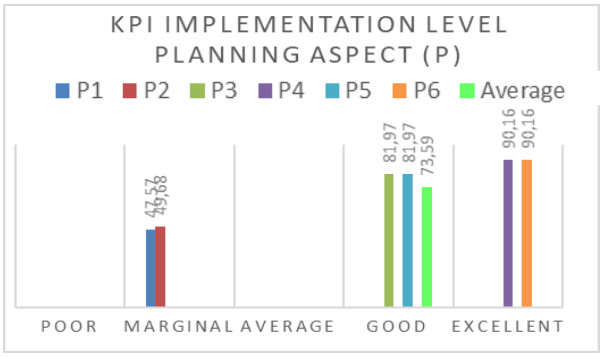

Figure 1. Diagram of the implementation level of planning aspect KPIs

Three indicators are used to assess the level of performance in the Procurement aspect: the percentage of raw materials that are not defective (S1), the percentage of hazardous materials in inventory (S2) and the number of certified suppliers per total suppliers (S3). Figure 3 shows 2 indicators in the Good category and 1 indicator in the Poor category. KPI S2 and KPI S1 with values of 81.96 and 73.77 respectively state that there are no hazardous materials in the raw material inventory and during the receipt of raw materials no defects are found. KPI S3 gets a performance category with a value of 0 because of the 2 suppliers are individual businesses that are not yet classified as large so that none of them are SNI or ISO certified. Overall, the procurement aspect is dominated by good performance, but the absence of certified suppliers causes a drop-in performance value so that it falls into the average category with an average value of 51.9. (Figure 2).

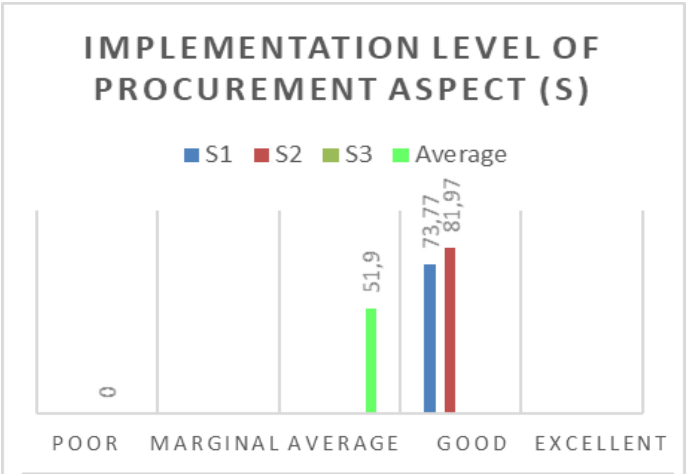

Figure 2. Diagram of the level of implementation of KPIs for procurement aspects

Performance measurement in the production aspect based on 4 indicators, namely Input and output obtained in the production section (M1), Liquid waste generated from the production process (M2), Solid waste generated from the rest of the production process (M3) and Percentage of recyclable materials (M4). Figure 3 shows

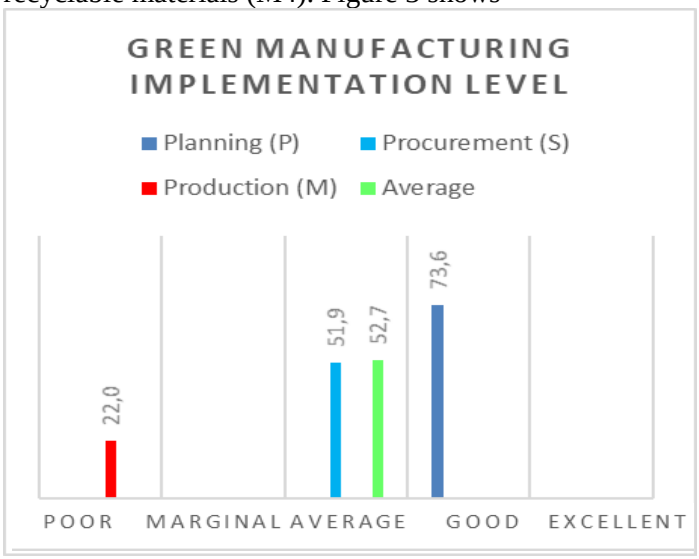

Figure 3. Diagram of the implementation level of production aspect KPIs

The results of the calculation of the average value of each aspect of green manufacturing, namely aspects of planning, procurement and production. The planning aspect has a value of 73.6 including the Good category, the procurement aspect has a value of 51.9 in the average category and the production aspect with a value of 22 falls into the Poor category. So that the average performance value of XYZ batik producers is 55.7 and falls into the average category for green manufacturing. Ignorance of the environment, barriers related to the business environment, social influences, technological barriers, financial barriers, organizational barriers, and regulatory or government barriers are significant barriers to the adoption of GMP (*Green Manufacturing Practices*) [5]. This suggests that strategies and recommendations are needed to improve performance values in the implementation of green manufacturing.

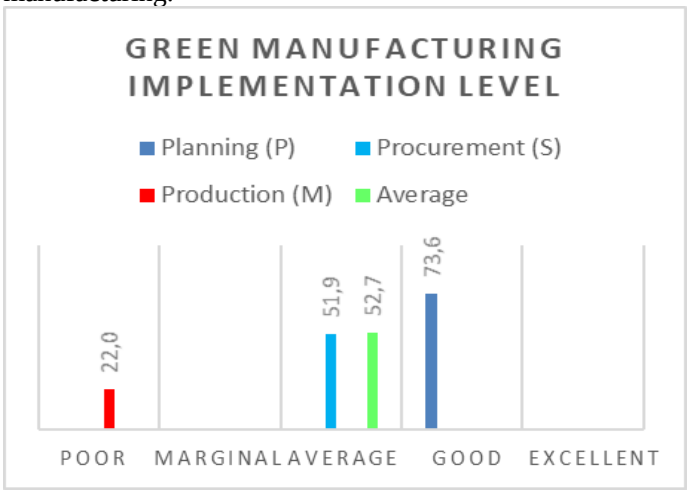

Figure 4. Diagram of the implementation level of Green Manufacturing

B. Alternative Strategy Recommendations to Improve the Implementation Manufacturing at Batik XYZ

Determination of strategies to improve the value of green manufacturing performance is done using SWOT analysis. Based on the results of the expert judgment questionnaire, the SWOT matrix is obtained. According to the calculation, the IFAS value is -0.17751 and the EFAS value is -0.18594. The combination of internal and external matrices is done by placing the points of each matrix into a SWOT diagram where the internal point is on the X (horizontal) axis and the external is on the Y (vertical) axis. The results of the IFAS and EFAS combination can be seen in the diagram in Figure 5. Internal factors such as strategic orientation and internal environmental management do not have a significant influence in encouraging MSMEs to consider green supply chain management. the implementation of green supply chain management is heavily influenced by outside variables, particularly laws. On the other hand, it has been proven that adopting green supply chain management practices can have a positive impact on the environmental performance of MSMEs. The results also show that internal factors do not directly affect environmental performance through green supply chain management. However, green supply chain management practices may serve as an intermediary factor in the relationship between government regulation and the improved environmental performance of MSMEs [6].

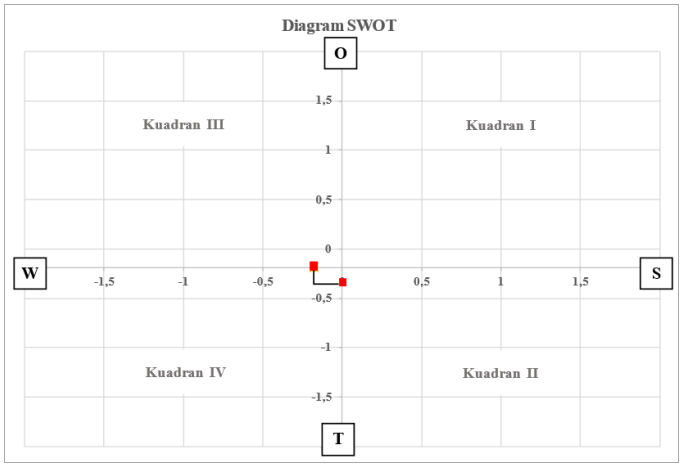

Figure 5. SWOT Diagram

This combination's results indicate that the W-T (Weakness - Threat) strategy with the "Defensive" or "Survive" phase, which is in quadrant IV, is the one that should be used. Based on the result of the SWOT analysis, 3 methods can be implemented, such as conducting a comprehensive evaluation of the efficiency of the use of water and electricity in the company's existing production process. This can be done by making a water balance for the production process to determine the amount of input and output of use, making policies for saving and efficient use of water and electricity, then - documenting and archiving the use of electricity and water using digital technology [7]. The second strategy is to begin performing a comprehensive assessment of the inspection and documentation of the business's current manufacturing waste output. This can be done by practicing *Good house Keeping* [8] or good internal management in the form of clean production efforts through simple actions with practical steps that can be immediately implemented by the company. The company can make a work plan along with targets for production waste output and plan a tank or reservoir so that periodic desludging and disposal to a centralized WWTP can be carried out if it has not been able to plan its own WWTP without discharging liquid waste into the drainage channel without first being neutralized by treatment. The third strategy is to examine the application of strategic efforts to manage batik industry waste in realizing environmentally friendly batik [8]. In dealing with environmental impact issues, companies in Indonesia can implement green innovation and green supply chain management to improve their company performance [9]. When manufacturing companies in Indonesia implement this model of managing environmental issues, society will gain more benefits in terms of reduced environmental degradation, availability of more environmentally friendly products and programs, increased resource efficiency and economic development, and improved quality of life [10]. The implementation of green supply chain practices, particularly green procurement and environmental collaboration with suppliers, contributes positively to the operational performance of manufacturing MSMEs in Indonesia, which in turn has a positive impact on sustainable supply chain practices [11]. This is done by participating in the Green Industry program by the Ministry of Industry (*Kemenperin*), although not targeting the award, but through the criteria and assessments held, it can be used as an annual benchmarking for a more measurable improvement in green manufacturing implementation.

4. CONCLUSION

The assessment of the level of implementation of green manufacturing in the XYZ batik industry consists of 3 aspects, namely the planning aspect, with a value of 73.6 in the Good category, the procurement aspect with a value of 51.9 in the average category and the production aspect with a value of 22 in the Poor category. So that the average value of green manufacturing implementation in the XYZ batik industry is 52.7 in the average category. Strategic recommendations that can be made to improve the value of green manufacturing implementation based on the results of SWOT analysis are W-T (*Weakness - Threat*) strategies, namely starting to conduct a thorough evaluation of the efficiency of the use of water, electricity

in the production process, checking and recording the company's existing production waste output and practicing good waste management.

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