# SC Performance Measurement_The Green SCOR Approach

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# SUPPLY CHAIN PERFORMANCE MEASUREMENT: THE GREEN SUPPLY CHAIN OPERATION REFERENCE (SCOR) APPROACH

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## ABSTRACT

**Purpose:** This study aims to design metrics and implement supply chain performance measurements of upstream textile companies in Indonesia using the Green Supply Chain Operation Reference (SCOR) perspective approach.

**Methods:** The design and measurement approach uses Green SCOR based on metrics developed by APIC. The weighting of level one and level two assessment metrics using the Analytical Hierarchy Process (AHP) method is based on the results of questionnaires from 20 upstream textile companies spread across the island of Java.

**Results and discussion:** The main findings show that supply chain performance in the upstream sector of textile companies in Indonesia can be classified as good if measured using a supply chain performance metric design with the Green Supply Chain Operations Referendum approach. Opportunities to improve performance in the plan, source, make, delivery, and return aspects using Green SCOR's best practices in the textile industry.

**Implications of the research:** The study's limitations did not include the financial aspects of the company, so it cannot provide a complete picture of the company's supply chain performance.

**Originality/value:** The knowledge gained from this study is an important reference for managers of upstream textile companies to improve the company's green supply chain performance in the future. Managers can set improvement priorities based on the results of performance measurements on the dimensions of reliability, responsiveness, flexibility, and environmental aspects based on the metrics designed by the researcher. In addition, the design of this metric can be used by companies in the medium and downstream textile industry to improve the overall green supply chain performance of the textile industry.

**Keywords:** Green SCOR, AHP, Performance Measurement, Metrics, Textile.

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# MEDIÇÃO DO DESEMPENHO DA CADEIA DE SUPRIMENTOS: A ABORDAGEM DE REFERÊNCIA DE OPERAÇÃO DA CADEIA DE SUPRIMENTOS VERDE (SCOR)

## RESUMO

**Objetivo:** Este estudo tem como objetivo projetar métricas e implementar medições de desempenho da cadeia de suprimentos de empresas têxteis upstream na Indonésia usando a abordagem da perspectiva de Referência de Operação da Cadeia de Suprimentos Verde (SCOR).

**Métodos:** A abordagem de projeto e medição usa o Green SCOR com base em métricas desenvolvidas pela APIC. A ponderação das métricas de avaliação de nível um e nível dois usando o método Analytical Hierarchy Process (AHP) baseia-se nos resultados de questionários de 20 empresas têxteis de upstream espalhadas pela ilha de Java.

**Resultados e discussão:** As principais conclusões mostram que o desempenho da cadeia de suprimentos no setor upstream de empresas têxteis na Indonésia pode ser classificado como bom se for medido usando um projeto de métrica de desempenho da cadeia de suprimentos com a abordagem Green Supply Chain Operations Referendum. Há oportunidades para melhorar o desempenho nos aspectos de planejamento, fornecimento, fabricação, entrega e devolução usando as melhores práticas do Green SCOR no setor têxtil.

**Implicações da pesquisa:** As limitações do estudo não incluíram os aspectos financeiros da empresa, portanto, ele não pode fornecer um quadro completo do desempenho da cadeia de suprimentos da empresa.

**Originalidade/valor:** O conhecimento obtido com este estudo é uma referência importante para os gerentes de empresas têxteis upstream para melhorar o desempenho da cadeia de suprimentos verde da empresa no futuro. Os gerentes podem definir prioridades de melhoria com base nos resultados das medições de desempenho nas dimensões de confiabilidade, capacidade de resposta, flexibilidade e aspectos ambientais com base nas métricas criadas pelo pesquisador. Além disso, a concepção dessa métrica pode ser usada por empresas do setor têxtil de médio e longo prazo para melhorar o desempenho geral da cadeia de suprimentos verde do setor têxtil.

**Palavras-chave:** SCOR verde, AHP, Medição de desempenho, Métricas, Têxtil.



## 1 INTRODUCTION

Supply chain performance measurement uses appropriate metrics to assess the health of an organization's supply chain. Performance management uses metrics set to support the company's strategic objectives (S. A. Khan et al., 2020; Elgazzar et al., 2019). On the other hand, measuring the performance of the eco-supply chain must be flexible and allow for changing industry or product priorities (Bulsara et al., 2016; Tundys & Wiśniewski, 2018). Each stage in the operation of supply chain partners results in pollution and environmental damage, which is why many academics have recently been researching green supply chains (M. Khan et al., 2023; Herrmann et al., 2021)

Environmental issues and supply chain management have been identified as the most growing issues, and organizations are focusing on minimizing their impact on the environment worldwide (Petljak et al., 2018). With the growing concern over environmental issues, especially in industrialized countries, there is a need to address sustainable green supply chain performance measurement (Assumpção et al., 2023; Panpatil, Lahane, et al., 2023). Developing nations, such as China and the nations of Southeast Asia (Malaysia, Indonesia, Thailand), have begun to concentrate on green supply chain management. Green supply chain management, or GSCM, is the subject of new research, with certified Malaysian businesses implementing the findings (Eltayeb et al., 2011), and other studies on the internal and external factors influencing performance from an eco-supply chain management perspective (Rosyidah et al., 2022).

The upstream textile industry is one of the largest contributors to the disposal of environmentally harmful production waste (Payet, 2021), the waste that pollutes the environment is manganese, chromium, zinc, and dyes, which decomposing microorganisms

cannot break down (Castillo-Suárez et al., 2023). In Indonesia, upstream textile companies also pollute the environment. However, the industry has been prioritized for development because of its significant impact on economic growth, employing 3.6 million people and contributing 6.38 percent to gross domestic product (GDP) by 2022 (Sugeng et al., 2022).

Improving upstream textile companies' green supply chain performance in Indonesia is necessary to increase competitiveness, especially against foreign competitors (Bui et al., 2023). In the management cycle, performance measurement is necessary to improve business performance (Behn, 2003). Furthermore, Suradi et al. (2020) explained that green supply chain performance measurement in the textile industry aims to improve the performance of the textile industry so that customers have environmentally friendly product choices and comply with legal regulations, which in turn can minimize environmental damage.

However, academics still need to be more successful in researching and measuring the green supply chain performance of upstream textile companies in Indonesia. Based on the previous description, the problem of this research is how to measure the supply chain performance of upstream textile companies in Indonesia in terms of a green supply chain. Thus, to answer the previously described problems, this study aims to design metrics and implement supply chain performance measurement of upstream textile companies in Indonesia with a Green Supply Chain Operation Reference (SCOR) perspective approach.

## 2 THEORETICAL FRAMEWORK

### 2.1 Supply Chain Operations Reference (SCOR) and Green Supply Chain Operations Reference (Green SCOR)

SCOR is a process-based reference model for supply chain operations that can be used to map the supply chain (Zhou, 2022). The SCOR model integrates three key management elements into a cross-functional supply chain framework: business process reengineering, benchmarking, and process measurement (Chopra et al., 2022). Furthermore, according to Sabri & Izadikhah (2022) and Chopra et al. (2022), at SCOR, processes consist of three levels. The top level includes five main processes - Plan, Source, Make, Deliver, and Return. This level describes performance from two points of view, one from the customer's perspective and the other from an internal perspective. At this level, there is a definition of primary competition and instructions on how to achieve it. The explanations of the five processes at level 1 are:

1) Planning: arranging supply and demand to fulfill production, delivery, and procurement requirements.
2) Sourcing: acquiring products or services to meet market demand. This process includes choosing suppliers and assessing their performance, scheduling supplier deliveries, receiving items, and verifying and authorizing payment for goods provided by suppliers.
3) Make: the process of converting raw materials/components into products that meet customer needs.
4) Deliver: the processes involved in meeting consumer demand for products and services; these often involve distribution, transportation, and border control.
5) Return: the process of returning or receiving products for various reasons.

Furthermore, to measure supply chain performance, there are five categories: reliability, responsiveness, agility, cost, and asset management. The next step is selecting the Key Performance Indicator (KPI) criteria matrix. It is difficult for a company to perform well for all metrics, so only a few areas should be selected as top priorities (Huang & Keskar, 2007). The Green SCOR concept was created by modifying the SCOR model to incorporate environmental thinking into the SCOR principles. The aim is to improve green supply chain performance using analytical metrics that reflect the relationship between supply chain activities and green concepts (Rosyidah et al., 2022). Furthermore, Rosyidah et al. (2022) and Pulansari & Putri (2020) explained that Green SCOR is developed in four basic steps, namely:

1) Identify background practices and metrics for a green supply chain.
2) Evaluate available SCOR process models with environmental impact.
3) Customise the SCOR model by benchmarking best practices and using environmental metrics.
4) Describe the changes made and their impact on supply chain operations.

### 2.2 Green Supply Chain Management (GSCM) Performance Measurement.

A fundamental aspect of supply chain management is performance management and continuous improvement. Effective performance management requires a measurement system that can assess the performance of the supply chain as a whole. GSCM is the integration of environmentally friendly concepts into supply chain practices from the product idea, design, sourcing, production process, and distribution to the end of the product life cycle so that it can be recycled, reused, repaired, remanufactured or destroyed so that supply chains and living things can be sustainable (Cazeri et al., 2017). The green supply chain starts from the awareness of the impact of supply chain activities on the surrounding environment. In practice, a green supply chain encompasses the role of the environment in all value-added activities in the supply chain (Kumar et al., 2012).

According to APICS (2017), the Green SCOR metrics used to measure GSCM performance based on the objectives expected by each stakeholder include:
1) % of suppliers with ISO 14001 certification.
2) % of suppliers meeting environmental requirements.
3) % of hazardous materials in inventory.
4) % of vehicle fuel from alternative fuels.
5) Energy consumption.

The purpose of GSCM performance measurement is for external reporting, internal control, and internal analysis that affect sustainable performance in relation to supplier selection and development, mode and operator selection, vehicle routing, location decisions, packaging options, and others. Tools for measuring GSCM performance from various literatures and practices include analytical hierarchy process, activity-based costing, environmental analysis design, balanced scorecards, and life cycle analysis type tools (Panpatil, Lahane, et al., 2023).

### 2.3 Analytic Hierarchy Process (AHP)

AHP considers the opinions of experts with questionnaires to support decision-making by comparing criteria, sub-criteria, and alternatives. The pairwise comparison matrix assessed by experts shows the importance level between criteria, sub-criteria, and alternatives so that

weights are obtained, forming the basis for decision-making (Li et al., 2023). The steps of AHP are as follows (Panpatil, Prajapati, et al., 2023) :

1) Establish a hierarchy of the problem at hand. The problem to be solved is broken down into its elements, namely criteria and alternatives, which are then arranged in a hierarchical structure.
2) Evaluate the criteria and alternatives. Criteria and alternatives are evaluated using pairwise comparisons for different problems on a scale from 1 to 9 to express opinions.
3) Prioritisation. The relative comparative value is then processed to determine the ranking of alternatives.
4) Logical consistency. Knowing how good consistency is important because we want to make decisions based on something other than considerations with low consistency.

## 3 METHOD

The design and measurement approach in this study is to use Green SCOR based on the metrics developed by APICS (2017). After the metric measurement results are obtained, the scoring system is used to equalize the value scale of each evaluation metric. Each metric's achievement level can be measured and determined using De Boer's Snorm normalization formula.

Next, the weighting of the assessment metrics for level one and level two is obtained from the results of the AHP questionnaire. However, no weighting is applied to level three in the measurement hierarchy. This is due to the large number of metrics that need to be compared in pairs, so weighting at this level could produce better results. In addition, weighting at level three has little impact on the results of measuring supply chain performance. The importance weighting at levels one and two was carried out using the Analytical Hierarchy Process (AHP) method. In completing the AHP questionnaire, two respondents were selected, namely the Head of PPIC and the Head of Marketing, then the weight of each respondent's assessment for each indicator was combined into one value using the geometric mean calculation, namely a Combine in Expert Choice 11 processing. Performance of each main supply chain process (plan, source, make, deliver, and return) by multiplying the supply chain score by the weight of the performance targets.

The population of upstream textile companies in Indonesia was 87, while the sample consisted of 20 companies spread across Java. The company data obtained is confidential, and the company does not allow it to be published as it is related to business competition, except that only an average of 20 companies is presented.

## 4 RESULTS AND DISCUSSIONS

### 4.1 Calculation of Actual Value of Green Supply Chain Performance

Based on the average value of data from 20 upstream sector textile companies, the actual value for each metric can be calculated as follows:

a. Plan

1) Inventory Level for Packaging $= \frac{\text{average inventory}}{\text{average demand per month}} \times 100\% = \frac{[1{,}85 \text{ million pieces}]}{16{,}8 \text{ million pieces}} \times 100\% =$ 11,01%

2) % employee trainned on environmental requirement =

$$\frac{\text{Employees who attend training green SCM}}{\text{Total employee}} \text{ x } 100\% = (921/921) \text{ x } 100\ \% = 100\ \%$$

3) % waste dispotion =

$$\frac{\text{Weight of waste discharged into the environment}}{\text{Total weight of waste produced}} \text{ x } 100\% = \frac{0{,}982 \text{ Tons}}{127{,}60 \text{ Tons}} \text{ x } 100\% = 0{,}77\ \%$$

b. Source

1) Defect rate = $\frac{\text{The number of defective units}}{\text{The number of units shipped}} \text{ x } 100\% = \frac{115}{840.000 \text{ units}} \text{ x } 100\% = 0{,}01\%$

2) % of Suppliers with an EMS or ISO 14001 certification =

$$\frac{\text{The number of suppliers that meet environmental aspects}}{\text{Total suppliers that are company partners}} \text{ x } 100\% = \frac{15}{17} \text{ x } 100\% = 88{,}23\%$$

c. Make

1) % Failure in Process =

$$\frac{\text{The number of defective units}}{\text{Number of units produced}} \text{ x } 100\% = \frac{1400}{70.000 \text{ units}} \text{ x } 100\% = 2\ \%$$

2) Machine Material Efficiency =

$$\frac{\text{Number of products processed x standard time}}{\text{Available operating time}} \text{ x } 100\% = \frac{68.600 \text{ pieces x } 0{,}4 \text{ seconds}}{28.800 \text{ seconds}} \text{ x } 100\% = 95{,}27\ \%$$

3) % of hazardous material =

$$\frac{\text{Amount of hazardous materials in the production process}}{\text{Total material used}} \text{ x } 100\% = (2/17) \text{ x } 100\% = 11{,}7\%$$

4) % Materials that is biodegredable =

$$\frac{\text{The amount of biodegredable material used}}{\text{Total material used}} \text{ x } 100\% = \frac{20}{24} \text{ x } 100\% = 83{,}33\%$$

5) Waste produced as % of product produced =

$$\frac{\text{Total waste weight generated (liquid, solid)}}{\text{Total weight of finished goods}} \text{ x } 100\% = \frac{127{,}60 \text{ Tons}}{200 \text{ Tons}} \text{ x } 100\% = 63{,}8\%$$

6) % of recycleable/ reusable materials =

$$\frac{\text{The amount of waste that can be recycled}}{\text{Total material used}} \text{ x } 100\% = (20/23) \text{ x } 100\% = 86{,}9\%$$

d. Deliver

1) Fill rate = $\frac{\text{Number of products released}}{\text{Total products}} \text{ x } 100\% = \frac{11{,}08 \text{ jt pieces}}{16{,}8 \text{ jt pieces}} \text{ x } 100\% = 65{,}9\%$

2) % of vehicle fuel emissions derived from alternative fuels =

$$\frac{\text{The amount of reduced gas emissions}}{\text{Total gas emissions produced before the use of alternative fuels}} \text{ x } 100\%$$

$$= \frac{470{,}32 \text{ metric tons CO2/year}}{4.703{,}244 \text{ metric tons CO2/year}} \text{ x } 100\% = 10\ \%$$

e. Return

1) Return rate to supplier =

$$\frac{\text{The number of units returned}}{\text{The number of units received by the customer}} \text{ x } 100\% = \frac{0}{5490 \text{ pieces}} \text{ x } 100\% = 0\%$$

2) % of complaint regarding missing environmental requirenments from product =

$$\frac{\text{Number of customer complaints related to enviromental issues}}{\text{Total customers complaints}} \text{ x } 100\% = \frac{9}{15} \text{ x } 100\% = 60\%$$

### 4.2 Calculation of Green Supply Chain Performance Normalization Value

The normalization calculation for each metric uses the Snorm formula as follows:

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

An example of normalization calculation for Inventory level for packaging is as follows:

$$Snorm = \frac{11{,}01\text{-}25}{(5\text{-}25)} x100 = 69{,}95$$

The results of normalization calculations for other metrics are shown in the following tables.

a. Plan. Normalization results for each metric are shown in Table 1 as follows:

Table 1. Normalized Value of Plan Performance Metrics

| Dimension | No | Metrics | Actual Value (Si) | Worst Score (Smin) | Best Score (Smax) | Scor (Snorm) |
|---|---|---|---|---|---|---|
| Reliability | 1. | Inventory level for Packaging | 11.01 | 25 | 5 | 69.95 |
| | 2. | Internal meeting | 2 | 1 | 4 | 33.3 |
| Responsiveness | 3. | Planning schedule | 2 | 5 | 2 | 100 |
| Environmental aspects | 4. | % employee trainned on environmental requirement | 89.4 | 60 | 100 | 73.5 |
| | 5. | % waste disposition | 0.77 | 4.0 | 0.65 | 96.4 |

b. Source. Normalization results for each metric are shown in Table 2 as follows:

Table 2. Normalized Value of Source Performance Metrics

| Dimension | No | Metrics | Actual Value (Si) | Worst Score (Smin) | Best Score (Smax) | Scor (Snorm) |
|---|---|---|---|---|---|---|
| Reliability | 1. | Defect rate | 0.01 | 5 | 0 | 99.8 |
| | 2. | Source fill rate | 85 | 65 | 95 | 66.6 |
| | 3. | Number of meetings with Project Client | 4 | 2 | 4 | 100 |
| Responsiveness | 4. | Purchase order cycle time | 60 | 65 | 60 | 100 |
| | 5. | Source Responsiveness | 5 | 10 | 2 | 62.5 |
| Flexibility | 6. | Source Flexibility | 1 | 0 | 3 | 33.3 |
| Environmental aspects | 7. | % of Suppliers with an EMS or ISO 14001 certification | 88.23 | 76.4 | 88.23 | 100 |

c. Make. Normalization results for each metric are shown in Table 3 as follows:

Table 3. Normalized Value of Make Performance Metrics

| Dimension | No | Metrics | Actual Value (Si) | Worst Score (Smin) | Best Score (Smax) | Scor (Snorm) |
|---|---|---|---|---|---|---|
| Reliability | 1. | % Failure in Process | 2 | 10 | 1 | 88.8 |
| | 2. | Machine Material Efficiency | 95.27 | 0 | 97.2 | 98.01 |
| Environmental aspects | 3. | % of hazardous material | 11.7 | 17.6 | 11.7 | 100 |
| | 4. | % Materials that are Biodegradable | 83.33 | 0 | 83.33 | 100 |
| | 5. | Energy use | 4,871,888 | 7,862,631 | 4,871,888 | 100 |
| | 6. | Water usage | 5000 | 7300 | 5000 | 100 |
| | 7. | Waste produced as % of product produced | 63.8 | 100 | 63.8 | 100 |
| | 8. | % of recyclable/ reusable materials | 86.9 | 0 | 86.9 | 100 |

d. Deliver. Normalization results for each metric are shown in Table 4 as follows:

Table 4. Normalized Value of Deliver Performance Metrics

| Dimension | No | Metrics | Actual Value (Si) | Worst Score (Smin) | Best Score (Smax) | Scor (Snorm) |
|---|---|---|---|---|---|---|
| Reliability | 1. | Fill rate | 83 | 79 | 90 | 36.36 |
| | 2. | Number of visit to customer | 2 | 1 | 2 | 100 |
| Responsiveness | 3. | Delivery deadline (domestically) | 14 | 21 | 5 | 43.75 |
| | 4. | Delivery deadline (overseas) | 14 | 21 | 5 | 43.75 |
| Environmental aspects | 5. | % of vehicle fuel emition derived from alternative fuels | 10 | 0 | 10 | 100 |

e. Return. Normalization results for each metric are shown in Table 5 as follows:

Table 5. Normalized Value of Deliver Performance Metrics

| Dimension | No | Metrics | Actual Value (Si) | Worst Score (Smin) | Best Score (Smax) | Scor (Snorm) |
|---|---|---|---|---|---|---|
| Reliability | 1. | Customer complain | 1 | 2 | 0 | 50 |
| | 2. | Return rate to supplier | 0 | 2 | 0 | 100 |
| Responsiveness | 3. | Project Client Repaired Time | 60 | 90 | 30 | 50 |
| | 4. | Product replacement time | 30 | 90 | 30 | 100 |
| Environmental aspects | 5. | % of complaint regarding missing environmental requirenments from product | 0 | 1 | 0 | 100 |

### 4.3 AHP Importance Weighting for Green Supply Chain Performance

The weighting of the assessment metrics at level 1 is done by comparing the 5 main supply chain processes in pairs, including plan, source, make, deliver, and return. The weighting at Level 2 includes aspects of reliability, responsiveness, flexibility, and environment based on the requirement of each main supply chain process. Level 1 and Level 2 importance was weighed using the Analytical Hierarchy Process (AHP) method with Expert Choice version 11 software.

The results of processing respondent perception data processed with Expert Choice provide an inconsistency ratio value of 0.03, where this value is less than 0.1 (Figure 2). This means that the results of pairwise comparisons are consistent at level one.

**Compare the relative importance with respect to Goal;**
**Supply chain Performance with the Green SCOR approach**

| | Plan | Source | Make | Delivery | Return |
|---|---|---|---|---|---|
| Plan | | 1,41421 | 1,86121 | 1,18921 | 3,13017 |
| Source | | | 1,0 | 1,10668 | 3,30975 |
| Make | | | | 2,21336 | 2,05977 |
| Delivery | | | | | 2,0 |
| Return | Incon: 0,03 | | | | |

Figure 2. Weighted level one pairwise comparison matrix

The weighting value of each element at level 1 is shown in Figure 3.

**Priorities with respect to :**
**combined**
**Goal; Supply Chain Performance**

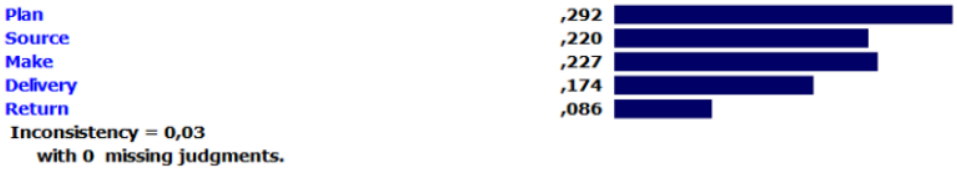


Figure 3. The weighting values for level 1 Green SCOR matrix elements

### 4.4 Calculation of the Final Value of Green Supply Chain Performance

The final supply chain performance score is calculated by multiplying each score obtained by the weight of each scope, aspect, and metric. The final supply chain performance calculation is shown in Table 6 as follows:

Table 6. Calculation of the final value of each measurement dimension

| Supply chain aspects (level 1) | No | Measuring dimensions (level 2) | Final score | Weight | Total | The total of each measurement dimension |
|---|---|---|---|---|---|---|
| Plan | 1. | Reliability | 51.62 | 0.301 | 15.54 | 62.04 |
| | 2. | Responsiveness | 100 | 0.318 | 31.8 | |
| | 3. | Environmental Aspects | 84.95 | 0.173 | 14.70 | |
| Source | 4. | Reliability | 88.56 | 0.189 | 16.73 | 75.48 |
| | 5. | Responsiveness | 81.25 | 0.375 | 30.46 | |
| | 6. | Flexibility | 33.3 | 0.231 | 7.69 | |
| | 7. | Environmental Aspects | 100 | 0.206 | 20.6 | |
| Make | 8. | Reliability | 93.01 | 0.689 | 64.08 | 94.88 |
| | 9. | Environmental Aspects | 99.06 | 0.311 | 30.8 | |
| Deliver | 10. | Reliability | 68.18 | 0.259 | 17.65 | 64.62 |
| | 11. | Responsiveness | 43,74 | 0.482 | 21.07 | |
| | 12. | Environmental Aspects | 100 | 0.259 | 25.9 | |
| Return | 13. | Reliability | 75 | 0.340 | 25.5 | 82.4 |
| | 14. | Responsiveness | 75 | 0.364 | 27.3 | |
| | 15. | Environmental Aspects | 100 | 0.296 | 29.6 | |

In addition, the Green Supply Chain Performance score can be calculated by multiplying the total score of each dimension by the weighted value of the Green SCOR Level 1 metric element shown in Table 7.

Table 7. Calculation of Supply Chain performance value

| No | Supply Chain aspect (level 1) | The total of each measurement dimension | Weight | Total |
|---|---|---|---|---|
| 1. | Plan | 62.04 | 0.292 | 18.16 |
| 2. | Source | 75.48 | 0.220 | 16.60 |
| 3. | Make | 94.88 | 0.227 | 21.53 |
| 4. | Deliver | 64.62 | 0.174 | 11.24 |
| 5. | Return | 82.4 | 0.086 | 7.08 |
| Total Performance Score | | | | 74.61 |

The final calculation shows that the Green Supply Chain performance score for upstream textile companies in Indonesia using the Green SCOR approach is 74.61.

### 4.5 Discussions

Essentially, level 1 metrics are aggregated assessments of level 2 metrics, and level 2 metrics are aggregated assessments of level 3 metrics. Thus, measuring supply chain performance starts with measuring processes at the lowest level, namely level 3 (APICS, 2017). The total performance score in Table 7 is 74.61, this value can be classified as “Good” according to APICS (2017) and Rosyidah et al. (2022). Thus, the average green supply chain performance of upstream textile companies in Indonesia can be categorized as good. However, there is still a great opportunity to improve upstream textile companies' Green Supply Chain performance in Indonesia.

Performance improvements can be identified by comparing the weighted value results for the Green SCOR level one metric element for Plan, Source, Make, Delivery, and Return (Panpatil, Lahane, et al., 2023). Therefore, based on the weighted value of the Green SCOR Level 1 metric element and the weight of Level 2, it can be illustrated in Figure 4. Figure 4 shows that the performance metrics at level 1, namely Plan, have the highest weight, followed by Make, Source, Delivery, and Return. Thus, the weight at level 2, which has the highest priority for improvement, is the reliability aspect of the Make activity. Improvements can be made to the failure of the production process and the inefficiency of the materials used in the production process. The priority for improvement with the lowest assessment weight is the Reliability aspect of the Source activity. Improvements can be made by reducing the percentage of damaged products during delivery, order processing, and training employees on material knowledge and raw material specifications from suppliers.

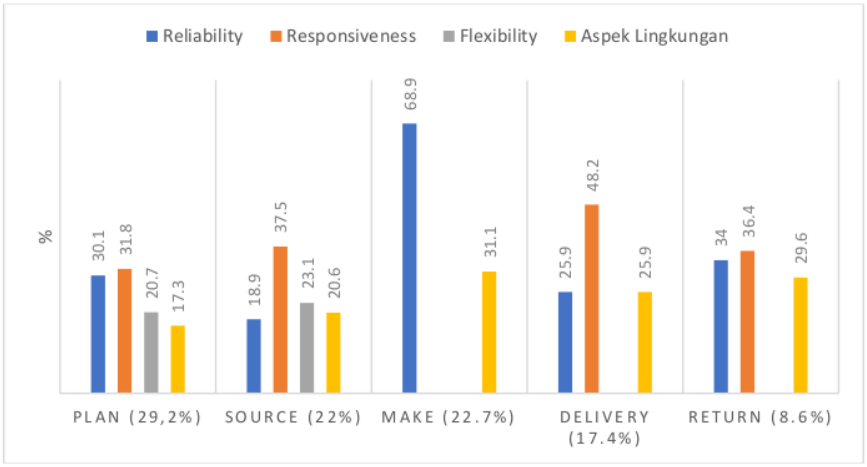

Figure 4. Weighted value for Green SCOR level one metric element

The follow-up improvements to improve the existing green supply chain performance can use the best practice approach in SCOR version 12.0 (Panpatil, Lahane, et al., 2023; APICS, 2017). More specifically, the best practice approach to improve the green supply chain performance of upstream textile companies in Indonesia is described in Table 8.

Table 8. Green SCOR Best Practices to Improve Performance green supply chain for upstream sector textile companies in Indonesia

| Green SCOR process | Best Practice |
|---|---|
| Plan | 1. Minimizing the use of energy and hazardous materials<br>2. Maintain an environmentally friendly product policy<br>3. Proper handling and storage of hazardous materials to avoid impact on the environment. |
| Source | 1. Obtain access to environmental management reports and compliance data from suppliers.<br>2. Cooperate with suppliers on environmental issues to help implement environmental requirements and sustainable business processes.<br>3. Increase energy use efficiency in lighting and production support systems through the efficient design of warehouse buildings and production areas. |
| Make | 1. Routine air emission measurements every time the production process ends.<br>2. Obtain information on MSDM (Material Sheet data System) for handling raw materials from suppliers.<br>3. Carry out routine daily inspections of hazardous waste storage. |

| Green SCOR process | Best Practice |
|---|---|
| | 4. Benchmarking similar companies with better environmental management quality.<br>5. Production scheduling considers the smallest possible energy requirements. |
| Deliver | 1. Using efficient and environmentally friendly packaging.<br>2. Planning the distribution so that it can take place optimally and effectively, which consists of route scheduling, route optimization, optimized shipments, and carrier selection to increase the efficiency of vehicle fuel use.<br>3. Choose a distributor company that has no record of violating environmental regulations.<br>4. The use of environmentally friendly alternative fuels in vehicles |
| Return | Maximizing product transport capacity at the time of product recall from consumers to reduce excess fuel consumption. |

Our study recommends to upstream textile managers how to improve their green supply chain performance in the future. By implementing these recommendations, companies will benefit from resource sustainability, carbon footprint reduction, cost savings, regulatory compliance, enhanced brand value, employee morale and motivation, and competitive advantage (Panpatil, Lahane, et al., 2023; Chopra et al., 2022; S. A. Khan et al., 2020; Bulsara et al., 2016). First, we recommend investing in green supply chain management practices based on the Green SCOR Best Practices to Improve the Performance of green supply chain for upstream sector textile companies in Indonesia, as shown in Table 8. Second, managers should continuously measure the company's green supply chain performance to evaluate the level of achievement of performance targets and make improvements based on the evaluation results.

## 5 CONCLUSIONS

The design of supply chain performance measurement metrics with the Green Supply Chain Operations Reference Approach produced in this study has been adequately used to measure the reliability, responsiveness, flexibility, and environmental dimensions in each SCOR Level 1 process in upstream sector textile companies in Indonesia. Although the overall value of supply chain performance in upstream textile companies in Indonesia can be classified as “Good”, there are still opportunities for improvement to enhance future performance. The most significant improvements are in planning, sourcing, making, delivering, and returning using Green SCOR's best practices in the textile industry.

This research has limitations that provide recommendations for future research. First, the design of supply chain performance measurement metrics can be developed on the financial aspects of the company so that it can provide a more comprehensive picture of the company's supply chain performance. Secondly, the measurement application is extended by including companies in the medium textile industry that produces fabrics and the downstream textile industry that produces garments, thus providing a complete picture of the textile industry.

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