JISO: Journal Of Industrial And Systems Optimization
Volume 8, Nomor 1, Juni 2025, 17-26
ISSN 2622-8971 online
ISSN 2522-898X print

SUPPLY CHAIN PERFORMANCE MEASUREMENT USING SUPPLY CHAIN OPERATIONS REFERENCE, BEST WORST METHOD, OBJECTIVE MATRIX, AND TRAFFIC LIGHT SYSTEM AT DOMESTIC INVESTMENT COMPANY

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ABSTRAK

Perkembangan industri di era globalisasi berjalan sangat pesat dan diiringi dengan meningkatnya persaingan antar perusahaan. Untuk mempertahankan daya saing yang tinggi dalam memenuhi kebutuhan pasar, kinerja operasional suatu perusahaan harus terus ditingkatkan. Penelitian ini menggunakan model *Supply Chain Operations Reference* (SCOR) yang diberikan bobot dengan *Best Worst Method* (BWM) serta diukur dengan *Objective Matrix* (OMAX) dan *Traffic Light System* (TLS) untuk evaluasi kinerja pada salah satu perusahaan penanaman modal dalam negeri di Indonesia. Perusahaan telah menetapkan target bisnis kinerja rantai pasok pada sektor pelapis dan aksesoris pipa. Pengukuran kinerja diperlukan untuk meningkatkan kinerja rantai pasok. Pengolahan data menghasilkan 17 indikator kinerja untuk mengukur kinerja rantai pasok. Berdasarkan pengukuran OMAX, kinerja berada pada angka 5,496 yang menunjukkan kategori 'rata-rata' namun memerlukan peningkatan pada masing-masing indikator. Peningkatan kinerja rantai pasok dilakukan dengan cara mengatasi empat indikator yang masuk kategori 'buruk' dan meningkatkan enam indikator yang masuk kategori 'rata-rata'.

Kata kunci: BWM, OMAX, pengukuran kinerja, SCOR, TLS

ABSTRACT

Industrial development during globalization is rapid and is accompanied by increasing competition among companies. To maintain high competitiveness in meeting market needs, a company's operational performance must continuously improve. This research utilizes the Supply Chain Operations Reference (SCOR) model, weighted using the Best Worst Method (BWM), and measured using the Objective Matrix (OMAX) and Traffic Light System (TLS) for performance evaluation at a domestic investment company in Indonesia. The company has set business targets for supply chain performance in the coating and pipe accessories sector. Performance measurements are necessary to enhance supply chain performance. Data processing yields 17 performance indicators for measuring supply chain performance. According to the OMAX measurements, the performance is rated at 5.496, indicating a 'average' category but requiring improvement in each indicator. Improving supply chain performance involves addressing the four indicators in the 'poor' category and enhancing the six indicators in the 'average' category.

Keywords: *BWM, OMAX, SCOR, supply chain performance, TLS*

INTRODUCTION

In the era of globalization, industrial development is highly competitive, leading to increased competition among companies. For a company to maintain high competitiveness in meeting market needs, its operational performance must continually improve. One effective approach to enhancing operational performance is by measuring the performance of all departments within the company. Within a company's operational processes, departments do not operate in isolation but rather are interconnected internally and externally, forming what is known as a supply chain.

The supply chain is a cohesive unit comprising production processes and activities that begin with raw materials acquired from suppliers, undergo value addition processes transforming raw materials into finished products, involve inventory storage, and culminate in the delivery of finished goods to customers (Pujawan & Er, 2024). All entities within the supply chain must collaborate to fulfill market demands. Supply chain management is essential for companies as it enables them to develop and attain success (Prasetyo et al., 2021). In a supply chain, performance measurement is essential.

Performance measurement involves assessors evaluating job performance by comparing it with job descriptions within a specified period, typically at the end of each year (Sastrohadiwiryo, 2002).

The purpose of performance measurement is to assess the performance of each job in order to develop and enhance the quality of work. This enables effective actions to be taken, such as ongoing coaching or corrective measures for tasks that do not align with the job description. When measuring the performance of a job, assessors utilize performance indicators to evaluate performance based on predetermined targets (Prasetyo et al., 2021).

Measuring performance serves several purposes, including direct and indirect performance control, ensuring that the company stays on course to achieve the goal of enhancing the supply chain, and ultimately improving supply chain performance. Incorrect measurement methods could cause supply chain performance to decline. Performance measurement can provide direction for a supply chain (Hidayat et al., 2014).

The supply chain performance measurement model commonly used in many studies is the Supply Chain Operations Reference (SCOR) model. SCOR is a process-oriented model. The SCOR model is then continued with various decisions making methods or the Multi Criteria Decision Making (MCDM) approach to measure performance. Several commonly used MCDM methods ranging from simple to complex include Analytical Hierarchy Process (AHP), Fuzzy Analytical Hierarchy Process (F-AHP), Analytic Network Process (ANP), Objective Matrix (OMAX), Best Worst Method (BWM), Data Envelopment Analysis (DEA), Technique for Others Preference (TOPSIS), etc. (Khan et al., 2018).

There is a lot of research on measuring supply chain performance. Measuring supply chain work can cover several fields such as the furniture industry, chemical industry, food processing industry, agricultural industry, etc. Research in the furniture industry was conducted by Puspita et al. (2022). This research used the SCOR model followed by F-AHP. The F-AHP method is an improvement on the AHP method because F-AHP integrates the principles of fuzzy set theory and the AHP process to enable more comprehensive decision making. The aim of this research is to assess the company's supply chain performance, identify existing problems, and propose performance improvements (Puspita et al., 2022).

Research on performance measurement in chemistry industry field could be found in research by Stifany et al. (2020) which used the SCOR model followed by two methods: ANP and OMAX. The ANP method improves the weaknesses of the AHP method by determining the level of importance based on the relationship between criteria and sub-criteria. The OMAX method could carry out partial performance measurements (Stifany et al., 2020).

Research in the food processing industry is shown in the research of Saragih et al. (2021). This research uses the SCOR model followed by AHP to identify supply chain activity segments with lower performance values (Saragih et al., 2021). Another study using the AHP method to evaluate supplier performance based on the Vendor Performance Indicator (VPI) in a company is research by Noviani et al. (2021). This research produces a ranking of the main raw material suppliers based on their respective weights, starting from the highest to the lowest (Noviani et al., 2021).

Research by Arjuna et al. (2022) conducted a performance assessment of green supply chains in the agricultural industry. The SCOR model used is directed towards a green approach. The method used for performance measurement in this research is AHP followed by OMAX and TLS (Arjuna et al., 2022).

In this research, performance measurement was carried out using a case study of a domestic investment company located in a city in Indonesia. This company is engaged in the production and management of oil and gas coatings and pipe accessories. Companies have performance measurement targets and supply chain performance indicators that must be achieved to maintain their operations. However, despite efforts to address performance indicators that did not meet the targets, there has not been a significant improvement in the company's supply chain performance. To effectively enhance its supply chain performance, the company needs to prioritize the improvement of specific performance indicators. This strategic approach ensures that the company's efforts are directed towards areas that require enhancement, resulting in a substantial improvement in overall supply chain performance.

The question research is how the overall performance of the supply chain can be evaluated based on the prioritized performance indicators of the company. The objectives of this research are to determine the priority order of supply chain performance indicators that could enhance performance, assess the overall performance of the supply chain based on the overall priority of performance indicators, and provide strategic recommendations for improving supply chain performance. A limitation of this research is that cost attributes were not included, as the related data is confidential.

RESEARCH METODOLOGY

This research utilizes the SCOR model, followed by the BWM, OMAX, and Traffic Light System (TLS) methods as shown in Figure 1.

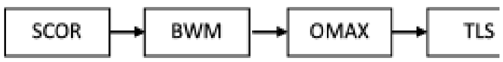

Figure 1. Research framework

The SCOR model, as a process framework, integrates leading concepts such as business process design, benchmarking, and best practice analysis into a cross-functional framework (Paul, 2014). The SCOR model is capable of analyzing supply chains using a systematic framework, incorporating criteria, attributes, and performance indicators that comprehensively represent the supply chain system as a whole.

The SCOR model consists of four levels. The first level, being the highest, offers a general definition of six processes: plan, source, make, deliver, return, and enable. The second level, often referred to as the configuration level, involves configuring a company's supply chain model based on core processes that contribute to the source, make, and deliver criteria. The third level, known as the decomposition stage or process element level, encompasses five attributes: reliability, responsiveness, agility, costs, and assets. Finally, the fourth level comprises highly specific processes tailored to the company's type of business, products, business targets, and technology employed (Paul, 2014).

This research utilizes only three levels of the SCOR model, specifically levels one through three. The outcome of preparing criteria and attributes for performance indicators in the company case study is the SCOR construct questionnaire, which will subsequently be weighted using the BWM method as the MCDM weighting method.

BWM is a decision-making technique developed by Jafar Rezaei (2016). BWM utilizes two pairwise comparison vectors to establish criteria weights. The decision maker identifies the best (e.g., most desirable, most important) and worst (e.g., least desirable, least important) parameters.

Next, the best parameters are compared with other parameters, while the other parameters are compared with the worst parameters (Rezaei, 2016).

There are two reasons for using the BWM method in this research. The first reason is that the BWM method can function as an effective initial screening tool for the SCOR variable because it is able to capture experts' interpretations (Kurniawan & Hasibuan, 2022). The second reason is that the BWM method, compared to other methods in MCDM, can facilitate structured comparisons through pairwise assessments based on the best and worst parameters obtained from determining weight level priorities (Rezaei, 2016).

The OMAX method is a method for measuring company performance with productivity parameters or targets determined objectively by the company (Iskandar & Sudiar, 2022). The OMAX method can function as a partial productivity measurement system which aims to monitor productivity in various parts of the company according to predetermined criteria (Stifany et al., 2020). Within OMAX, there is a TLS implemented to facilitate the analysis of processed data. TLS comprises three colors: red, yellow, and green. Each representing different levels, as outlined in Table 1, where 'n' denotes the scale for measuring performance indicators.

Tabel 1. TLC classification (Arjuna et al., 2022)

Level	Category
$8 \le n \le 10$	Excellent
$3 < n \le 7$	Average
$0 < n \le 2$	Poor

The OMAX method was chosen for this research because it allows for the integration of measurement parameter scales with different levels, effectively incorporating both higher and lower levels within a single parameter scale sequence. Performance measurement using the OMAX method aims to elucidate the significance of each performance indicator, facilitating the identification of areas where targets have been met but improvement is possible to enhance the company's supply chain performance. Moreover, the OMAX method enables the utilization of existing performance measurements based on predetermined indicators to enhance the performance process further (Fithri & Firdaus, 2016).

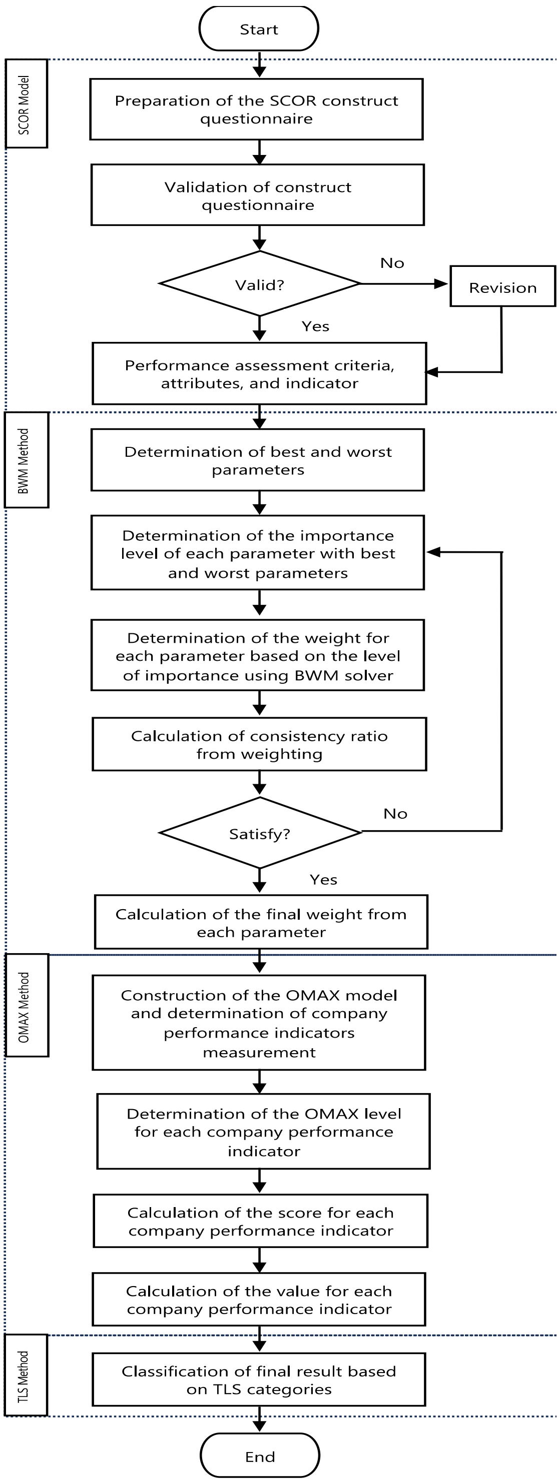

Figure 2. Data processing

After performing performance measurements using the OMAX method, it is necessary to analyze the measurement results to facilitate understanding. This analysis employs TLS method, aiding companies in identifying groups of company performance indicators that require attention and improvement. Clearer data processing steps could be seen in Figure 2.

RESULT AND DISCUSSION

The construction of the questionnaire is founded on the company's existing performance indicators known as Quality, Health, Safety, and Environment (QHSE) Objectives. These indicators, outlined in the QHSE Objectives by the company, represent the business targets tailored to fit the company's business model.

The SCOR model used is V.12, which helps assemble criteria and attributes for each indicator of the company's supply chain performance according to its specific needs and goals. When measuring actual performance, companies often lack a framework of performance indicators with defined criteria and attributes. This model allows for the assembly of performance indicators based on their roles in the company's supply chain process. The initial questionnaire consisted of 12 performance indicators, validated through interviews with six experts.

According to the validation results, Table 2 displays six criteria, attributes, 17 performance indicators. Six criteria are utilized: plan, source, make, deliver, return, and enable. The only attribute employed is reliability.

Weighting of criteria, attributes, and company performance indicators is conducted using BWM, specifically pairwise comparison weighting. BWM employs two pairwise comparison vectors to determine criteria weights: the first represents the best, such as the most desirable or important among the other criteria, and the second represents the worst, such as the least desirable or important among the others. Interviews with companies with the best and worst parameter questionnaires were conducted to identify the best and worst parameters.

Table 2. Performance measurement criteria, attributes, and performance indicators

Criteria	Attributes	Performance Indicator	Definition
Plan (C1)	Reliability (R1)	Total Sales Amount (I1)	% of sales target achievement
		Production Plan (I2)	% of production realized from the production plan
		Material Plan (I3)	% of material requirements realized from the material requirements plan

Criteria	Attributes	Performance Indicator	Definition
Source (C2)	Reliability (R1)	Incoming Quality Pass Rate (I4)	% of raw materials that meet quality standards according to orders
		On Amount Raw Material (I5)	% of frequency of arrival of raw materials in the correct quantity according to order
		On Time Raw Material Delivery (I6)	% of frequency of arrival of raw materials on time according to orders
Make (C3)	Reliability (R1)	Production Time Utilization (I7)	% of effective use of time
		Setting Up Trial (I8)	The number of finished product shots required to determine the condition of the machine is ready to operate
		Process Quality Pass Rate (I9)	% of finished products that meet quality standards
		On Time Production Schedule (I10)	% of frequency of timeliness of production according to the production schedule
Deliver (C4)	Reliability (R1)	On Time Product Delivery (I11)	% of frequency of delivery of finished products on time to customers
		On Amount Product Delivery (I12)	% of frequency of delivery of finished products in the correct quantity to customers
		Outgoing Quality Pass Rate (I13)	% of the number of good products received by customers
Return (C5)	Reliability (R1)	Customer Complaint (I14)	Number of complaints regarding finished products that have been sent
		On Time Customer Complaint Response (I15)	% of frequency of timeliness of responding to and resolving customer complaints
		Product Return (I16)	% of returns of defective products in the form of good products to customers
Enable (C6)	Reliability (R1)	QHSE Training (I17)	% of training realized from total scheduled training

Determining the company's best and worst parameters produces two pairwise comparison vectors. These vectors were then processed using Microsoft Excel BWM Solver software.

The processing result is the weight of each parameter. The results of data processing using the Microsoft Excel BWM solver format include the weight values for criteria, attributes, and company performance indicators, as well as the Consistency Ratio value to validate the consistency of the weights.

Consistency ratio (CR) ranges between 0 and 1. A lower CR, closer to 0, indicates greater consistency and reliability in the comparison. A CR ≤ 0.1 is considered a very high level of consistency (Rezaei, 2016). The final weight is the product of the criteria weight, attribute weight, and performance indicator weight. The final weight results of the BWM method could be seen in Table 3.

Next step in data processing involves measuring performance indicators using the OMAX method, based on the weights assigned to the performance indicators derived from the BWM process. The OMAX method comprises 11 levels, ranging from level 0 to level 10. Level 0 represents the company's pessimistic target, while level 10 represents the optimistic target. Level 3 corresponds to the target set by company regarding the performance indicators obtained from the company targets. Each measurement of company performance indicators varies; for instance, the highest level corresponds to the highest value (where higher is better), while the lowest level corresponds to the lowest value (where lower is better).

OMAX model for simplifying the measurement of company performance indicators is presented in Table 4. An example of measuring supply chain performance based on enable criteria using OMAX could be seen in Table 5. Results of the OMAX method for performance indicator I17 (QHSE Training) yield a score of 4.050. This score will be utilized to calculate the value of the performance indicator, taking into account its weight, resulting in a QHSE Training performance indicator value of 0.895.

Table 3. Criteria weight and consistency ratio

Criteria	Weight	Attributes	Weight	Performance Indicator	Weight	Final Weight
C1	0.111	R1	1	I1	0.205	0.023
				I2	0.718	0.080
				I3	0.077	0.009
C2	0.053	R1	1	I4	0.708	0.038
				I5	0.083	0.004
				I6	0.208	0.011
C3	0.379	R1	1	I7	0.119	0.045
				I8	0.064	0.024
				I9	0.521	0.197
				I10	0.297	0.113
C4	0.089	R1	1	I11	0.240	0.021
				I12	0.100	0.009
				I13	0.660	0.059
C5	0.148	R1	1	I14	0.660	0.098
				I15	0.100	0.015
				I16	0.240	0.036
C6	0.221	R1	1	I17	1.00	0.221

Table 4. OMAX

Performance Indicator	Pessimistic	Target	Optimistic	Performance Data	Unit	Measurement
I1	60%	75%	95%	60	%	Higher is better
I2	60%	75%	95%	76%	%	Higher is better
I3	80%	90%	100%	100%	%	Higher is better
I4	80%	90%	100%	99.99%	%	Higher is better
I5	60%	80%	100%	98.89%	%	Higher is better
I6	80%	90%	100%	97.57%	%	Higher is better
I7	85%	96%	100%	97.94%	%	Higher is better
I8	15	10	0	5	Shoots	Lower is better
I9	90%	95%	100%	98.40%	%	Higher is better
I10	90%	95%	100%	99.2%	%	Higher is better
I11	90%	95%	100%	94.44%	%	Higher is better
I12	85%	90%	100%	90%	%	Higher is better
I13	95%	98.5%	100%	96.53%	%	Higher is better
I14	5	2	0	4	Complaint	Lower is better
I15	100%	100%	100%	100%	%	Higher is better
I16	100%	100%	100%	100%	%	Higher is better
I17	60%	80%	100%	83%	%	Higher is better

Table 5. Performance measurement enable criteria (C6)

KPI		I17
Performance		83%
Scale	10	100%
	9	97.143%
	8	94.286%
	7	91.429%
	6	88.571%
	5	85.714%
	4	82.857%
	3	80%
	2	73.333%
	1	66.667%
	0	60%
Score		4.050
Weight		0.221

KPI	I17
Value	0.895

The measurement results of performance indicators using the OMAX model will be categorized using the TLS method. The classification results of performance indicator measurements based on the TLS method could be found in Table 6.

Table 6. Criteria weight and consistency ratio

Performance Indicator	Final Weight	Value	Score	Category
I1	0.023	0	0	Poor
I2	0.080	0.267	3.4	Average
I3	0.009	0.085	10	Excellent
I4	0.038	0.375	9.993	Excellent
I5	0.004	0.042	9.612	Excellent
I6	0.011	0.091	8.299	Excellent
I7	0.045	0.288	6.395	Average
I8	0.024	0.158	6.5	Average
I9	0.197	1.532	7.76	Average
I10	0.113	1.000	8.88	Excellent
I11	0.021	0.057	2.664	Poor
I12	0.009	0.027	3	Average
I13	0.059	0.077	1.311	Poor
I14	0.098	0.098	1	Poor
I15	0.015	0.148	10	Excellent
I16	0.036	0.355	10	Excellent
I17	0.221	0.895	4.05	Average
Total Value		5.496		Average

In the classification of performance indicators using the TLS method, each indicator's category is determined based on its score, whereas the category for the company's overall supply chain performance is determined by the total value. The results of this classification reveal that, overall, the company's performance indicators demonstrate 'average' performance, totaling 5.496. Nevertheless, based on these values, companies should further enhance their supply chain performance by prioritizing the importance of performance indicators. For instance, they could focus on increasing the QHSE Training indicator, which carries the highest weight among all the supply chain performance indicators.

There are four performance indicators in the 'poor' category, six in the 'average' category, and seven in the 'excellent' category. Performance indicators such as I1 (Total Sales Amount), I11 (On Time Product Delivery), I13 (Outgoing Quality Pass Rate), and I14 (Customer Complaint) fall into the 'poor' category, indicating the need for significant improvement.

Indicators including I2 (Production Plan), I7 (Production Time Utilization), I8 (Setting Up Trial), I9 (Process Quality Pass Rate), I12 (On Amount Product Delivery), and I17 (QHSE Training) are classified as 'average', indicating that they meet the company's targets but still require enhancement to maintain current performance levels.

Meanwhile, I3 (Material Plan), I4 (Incoming Quality Pass Rate), I5 (Raw Material Inventory), I6 (On Time Raw Material Delivery), I10 (On Time Production Schedule), I15 (On Time Customer Complaint Response), and I16 (Product Return) are classified as 'excellent', indicating that performance in these areas needs to be sustained. The company's improvements involve addressing performance indicators that do not meet targets and enhancing those that have already achieved them. Four performance indicators require attention and improvement strategies for these indicators could be found in Table 7.

I14 (Customer Complaint) with a score of 1 indicates that the performance indicator falls into the 'poor' category, necessitating attention. Improvement measures could be focused on enhancing the quality control and shipping departments, as customer complaints often cite dissatisfaction with delivery timeliness and product quality. Similarly, I13 (Outgoing Quality Pass Rate) with a score of 1.311, falls into the 'poor' category, requiring intervention. Interviews conducted with the company revealed that the root cause of this issue had not been identified. Upon analysis identified that human error and delivery process issues as contributing factors. An improvement strategy involves reviewing the quality control department's procedures for ensuring product quality prior to delivery.

The interviews with the company also revealed that there was no inspection of the finished product before dispatch, which could be the primary cause of poor-quality finished products being shipped. Additionally, improvements could be implemented in the shipping department by providing training to delivery drivers to ensure careful handling of the delivery vehicles.

I1 (Total Sales Amount) with a score of 0 indicates that the performance indicator falls into the 'poor' category, requiring attention.

According to interviews with the company, the focus is primarily on low-value orders due to their ease of production, while high-value orders, needing special tools, receive less attention. Similarly, I11 (On Time Product Delivery), with a score of 2.664, falls into the 'poor' category, necessitating intervention. Interviews revealed that delivery delays often stem from production delays. The shipping department typically takes one to two days to pack finished products for shipping, suggesting the need to adjust production schedules to avoid close proximity to delivery deadlines.

Table 7. Performance indicators require attention and improvement strategies

Performance Indicator	Weight	Score	Improvement	Strengths	Weakness
I14	0.098	1	Improvements to the Quality Control and Shipping departments, responsible for delivering finished goods, can be achieved by assessing the performance of relevant departmental indicators	The performance indicators for customer complaints depend on delivery performance indicators and establish criteria	It is difficult to determine if a performance indicator does not meet the target, especially when related performance indicators have already met their targets
I13	0.059	1.311	It efficiently conveys the action of reviewing the Quality Control department by inspecting finished products during the packing process	The action of reducing the frequency of shipments with defective products	Additional processes need to be reviewed, as they consume time and incur costs, potentially impacting the efficiency of the supply chain process
			Regular training should be conducted for Quality Control department staff on assessing the quality of finished products before shipment	Increase the expertise of Quality Control department staff in checking finished products	Additional training needs to be reviewed, as it entails both training time and costs
			Conducting a review of the Shipping department involves providing training for drivers responsible for delivering finished products to customers	The need to enhance the skills of drivers in delivering finished products to customers	Additional training needs to be evaluated, as it entails both time and costs
I1	0.023	0	Giving priority to orders with high selling value	The idea that sales targets are reached at a faster pace	The need for adjustments to machines and tools to accommodate orders with high sales value
I11	0.021	2.664	Establishing a deadline for the production department to ensure that finished products are ready before the delivery schedule	Delays in the production process will not disrupt delivery schedules	Storing finished products before shipping will increase costs

The following strategies can help improve the six performance indicators: I17 (QHSE Training) with a score of 4.05, indicates that the performance indicator falls into the 'average' category, but further improvement is needed. Enhancements could be achieved by assessing the training needs of each department and prioritizing training programs aimed at improving performance indicators that require attention. I9 (Process Quality Pass Rate) with a score of 7.76, indicates that the performance indicator falls into the 'average' category, yet further improvement is needed. Enhancements could be achieved by reviewing the responsible departments and providing training.

I7 (Production Time Utilization) with a score of 6.395, falls into the 'average' category but requires further improvement. Enhancements could be made by reviewing the responsible departments and providing training. A score of 3 for I12 (On Amount Product Delivery) places the performance indicator in the 'average' category, but further improvement is needed. Enhancements could be achieved by providing training to the responsible department.

CONCLUSION

The SCOR model, followed by the BWM, OMAX, and TLS methods, helps determine the priority order of supply chain performance indicators to enhance performance. It assesses the overall performance of the supply chain based on the overall priority of these indicators.

In the case study, six criteria, 17 performance indicators, and one attribute are used to assess company performance. The measurement results of the company's overall supply chain performance, based on the priority of its performance indicators, yield a score of 5.496, indicating that the company falls within the 'average' category. However, further improvement is needed to consistently achieve a 'excellent' category rating for the company's supply chain performance.

Based on the results of measuring the company's overall supply chain performance, the strategy for improving the overall performance involves addressing four performance indicators that have not reached the target and enhancing six performance indicators that have reached the target. To address the four performance indicators that have not reached the target, several actions could be taken. Firstly, implementing a product inspection process to be conducted by the quality control and shipping departments could improve the outgoing quality pass rate and address customer complaints. Secondly, prioritizing customer orders with high selling value can expedite the achievement of performance indicators such as total sales amount. Additionally, reviewing the production schedule to ensure it does not coincide closely with the delivery schedule can improve on time delivery performance indicators.

The weakness in measuring the performance of this research lies in the complexity of the proposed performance measurement process, which necessitates the use of four methods and involves complex calculations to obtain overall performance measurement results. In practical applications, simpler and more straightforward methods are often preferred. Future research could explore performance indicators involving cost and flexibility factors.

ACKNOWLEDGEMENT

Authors expresses gratitude to Universitas Kristen Maranatha for funding the research and to domestic investment companies for granting permission to conduct research and collect data.

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