BIS ENERGY AND ENGINEERING

Volume 3 2026 | DOI: 10.31603/biseeng.562
7th Borobudur International Symposium on Science and Technology (BIS-STE) 2025

UNIMMA PRESS
Universitas Muhammadiyah Magelang

Integrated supply chain management performance evaluation model in the manufacturing industry of PT XYZ

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Abstract

Material delays remain a critical bottleneck in the production process of PT XYZ, a manufacturing company highly dependent on supply chain reliability. This study aims to identify the root causes of these delays, evaluate supply chain reliability, and propose improvement strategies using the SCOR model integrated with AHP and analyzed through the Balanced Scorecard approach. The results indicate that overall supply chain reliability reaches 95.48%, suggesting good performance but still below the ideal target. Four key performance gaps are identified at level 3, with the most critical being a 31.72% deviation in Supplier Achievement to Original Organization Commit Date. This significant gap indicates systemic issues in supplier delivery timeliness, primarily caused by weak coordination, lack of real-time monitoring, and inadequate supplier performance control mechanisms. Unlike minor gaps (≤2.52%) related to quantity accuracy and product condition, this large deviation has a cascading impact on production scheduling, increases emergency logistics costs, and disrupts downstream operations. It also reflects structural weaknesses rather than isolated operational errors. Additional gaps are found in delivery quantity accuracy (2.52%), damage-free conformance (2.52%), and defect-free conformance (1.48%). These issues collectively contribute to increased operational costs, reduced customer satisfaction, and inefficiencies in internal processes. To address these challenges, this study recommends implementing barcode-based tracking systems, standardized packaging, an integrated procurement monitoring system, and supplier quality gates to enhance overall supply chain performance.

Keyword

Supply chain, SCOR, AHP, Balanced scorecard

Published:
May 04, 2026

Selection and Peer-review under the responsibility of the 7th BIS-STE 2025 Committee

Introduction

The manufacturing industry faces increasingly complex business dynamics due to rising consumer needs, quality demands, price pressures, and intense global competition. Companies are required not only to improve internal process efficiency but also to strengthen collaboration with suppliers and distribution partners within an integrated supply chain system. Since the 1990s, supply chain management has become a strategic component for ensuring supply continuity and increasing competitiveness [1].

PT XYZ is the only train manufacturer in Indonesia, producing trains for various needs, both domestically and for export. The complexity of the components produced makes supply chain management a critical aspect in supporting smooth production. A suboptimal supply chain can lead to material delays, disruptions to production flows, and even increased operational costs.

There are 6 things that must be considered in managing the supply chain, namely product development; procurement; planning and control; production; distribution; and returns [1]. In procurement activities, the timeliness of material supply plays a crucial role in maintaining the continuity of the production process. Inventory shortages have the potential to cause bottlenecks, while excess inventory can increase storage costs and the risk of obsolescence [2].

Material delays are closely related to supply chain resilience [3]. Resilience in the supply chain consists of three parts, namely reliability, responsiveness, and agility [4]. The existing problem is that the supply chain is unable to meet production targets, so the aspect that needs to be improved is reliability [5]. Reliability in the context of the supply chain is the ability of the supply chain to work according to plan, so this concept emphasizes the importance of consistency in performance where the results obtained must be in accordance with predictions and according to established standards [4]. This study aims to measure the level of supply chain reliability of PT XYZ using the Supply Chain Operations Reference (SCOR) method, Analytic Hierarchy Process (AHP) and provide recommendations for improvement through the Balanced Scorecard (BSC) approach, so that it can support the improvement of overall supply chain performance.

Method

This study applies a quantitative approach using the SCOR method to measure supply chain performance and AHP to determine the priority weights of the performance matrix. The measurement results are then analyzed using the Balanced Scorecard to formulate strategic recommendations. This integrated approach transforms performance measurement from a descriptive evaluation into a decision-support system, which is a clear advancement over studies that rely on only one or two of these methods

Determination of the SCOR matrix

The Supply Chain Operations Reference (SCOR) method is a supply chain performance measurement method developed by the Association for Supply Chain Management (ASCM). This method was chosen because it has been standardized by ASCM. The latest version, SCOR DS V14, includes a number of significant updates, particularly regarding performance indicators at levels 2 and 3 [4]. The SCOR method is widely used in measuring the performance of a company's supply chain because it is able to provide alternative solutions to problems effectively and efficiently [6]. In addition, SCOR can be applied to every stage of supply chain management by providing comprehensive performance indicators and a more detailed analytical framework for various industries [7].

The SCOR matrix used is a level 1, level 2, and level 3 SCOR matrix. The level 1 matrix contains overall supply chain diagnostics and includes key performance indicators (KPIs), the level 2 matrix functions as a diagnostic to identify the causes of performance gaps at level 1 and the level 3 matrix functions as a further diagnostic for the level 2 matrix and contains more specific details of operational activities.

AHP weighting

Analytic Hierarchy Process (AHP) is a decision-making method developed by Thomas L Saaty starting in 1993. AHP is used in multi-criteria decision-making and is based on three main principles, namely: decomposition, comparative judgment and logical consistency [8].

The AHP method was chosen because it is able to provide a systematic perspective on decision priorities that involve many criteria [9]. AHP can provide recommendations that take into account the initial preferences of the decision maker [10]. To facilitate the pairwise comparison process, a rating scale is used as shown in Table 1.

Table 1. AHP assessment scale [11]

Level of Importance	Definition	Explanation
1	Equally important	Two activities contribute equally to the goal.
3	Quite important	Slightly favoring one activity over another.
5	Important	Strongly favoring one activity over another.
7	Very important or proven to be important in practice	An activity is highly favored over other activities; its dominance is evident in practice.
9	The most important	Evidence supporting one activity over another is at the highest level of confidence.
The values 2, 4, 6, and 8 are values between the values described above.		

In this study, AHP weighting was applied to each level of the SCOR matrix based on the importance of each indicator in measuring supply chain performance. Decision-makers must understand the problem, decision needs and objectives, decision criteria, decision sub-criteria, stakeholders and affected groups, and alternative actions that can be taken [11], [12]. The number of respondents in AHP does not have standard provisions, so that weighting can be done even with only one decision maker [13], [14].

Calculation of reliability value

The reliability value is calculated by multiplying the performance score of the level 3 matrix by the weight of each indicator. The matrix values at higher levels (level 2 and level 1) are then calculated by multiplying the matrix weights by the values at the lower levels.

The following is the equation for calculating the level 3 matrix value.

$$M_i = S_i \times W_i \qquad (1)$$

Information:

Mi = the level 3 matrix performance value to be searched for,
Si = Matrix performance score
Wi = Matrix weight

Next is the calculation formula for level 2 and level 1 matrices.

$$M_x = \sum_{i=1}^{n} M_i \qquad (2)$$

Information:

Mx=level 1/2 matrix performance value
Wi = Matrix weight
Mi = value of the matrix below
n = number of matrices at the level below it

BSC evaluation

The Balanced Scorecard (BSC) evaluation was conducted to analyze level 3 matrices with low performance scores based on comparisons to a performance target of 100%. Matrices with low scores were then analyzed from four BSC perspectives: financial, customer, internal processes, and learning and growth. Each evaluated matrix was broken down based on its impact and recommendations for possible management. The matrix breakdown follows the scheme shown in Table 2.

Table 2. BSC evaluation

Matrix	BSC Perspective	Impact	Handling Recommendations
	finance		
	customer		
	internal processes		
	learning and growth (HR)		

The matrix columns will be populated with the selected matrix. The BSC Perspective column indicates the perspective from which the matrix is evaluated. The Impact column lists the potential impacts of a low matrix score from each perspective. The Recommendations column provides recommendations for possible action based on the impacts arising from each BSC perspective.

Result and discussion

Determination of SCOR matrix

This study uses three levels of matrices in the SCOR model to measure supply chain performance. To clarify the indicators used, Tables 3, 4, and 5 present the definitions of each matrix according to the SCOR guidelines established by ASCM. The matrices at each level serve as the basis for supply chain reliability analysis and are structured hierarchically, starting from the general level 1 to the detailed and operational level 3. This systematic indicator structure allows for measurable and standardized assessment of supply chain performance.

Table 3. Level 1 matrix

Matrix	Definition
RL.1.1 Perfect Customer Order Fulfillment	The percentage of customer orders that can be fulfilled perfectly.
RL.1.2 Perfect Supplier Order Fulfillment	Percentage of orders from suppliers that are received in full.
RL.1.3 Perfect Return Order Fulfillment	Percentage of order return processes that were completed perfectly.

Table 4. Level 2 matrix

Matrix	Definition
RL.2.11 Percentage of Orders Delivered in Full to the Customer	The percentage of orders sent to customers in full according to the quantity and items ordered without any shortages.
RL.2.12 Delivery Performance to Original Customer Commit Date	Percentage of customer orders delivered on the agreed date.
RL.2.13 Customer Order Documentation Accuracy	Percentage of completeness and accuracy of all supporting documents for customer orders (invoices, delivery notes, COC, etc.).
RL.2.14 Customer Order Perfect Condition	The percentage of customer orders received in perfect condition without physical damage or defects.
RL.2.21 Percentage of Orders Received In Full from the Supplier	Percentage of orders received from suppliers in full according to quantity and order items.
RL.2.22 Delivery Performance to Original Supplier Commit Date	Percentage of supplier deliveries made on time according to the agreed date.
RL.2.23 Supplier Order Documentation Accuracy	Percentage of completeness and accuracy of supporting documents from suppliers (invoices, packing lists, COC, etc.).
RL.2.24 Supplier Order Perfect Condition	Percentage of orders received from suppliers in perfect condition without damage or defects.
RL.2.31 In Full (Correct Product)	The percentage of orders received or shipped with the correct product as ordered, without any shortages or errors.
RL.2.32 Correct Documentation	Percentage of orders accompanied by complete and correct documents according to order requirements.
RL.2.33 Perfect Condition	The percentage of orders received or shipped in perfect condition without damage, defects, or discrepancies.

Table 5. Level 3 matrix

Matrix	Definition
RL.3.111 Delivery Item Accuracy to the Customer	The percentage of items shipped to customers according to the specifications of the items ordered.
RL.3.112 Delivery Quantity Accuracy to the Customer	Percentage of orders shipped with the amount according to customer orders.
RL.3.121 Customer Commit Date Achievement	The percentage of orders shipped on the date promised to customers.

Matrix	Definition
RL.3.122 Delivery Customer Location Accuracy	Percentage of orders shipped to the correct customer shipping address location.
RL.3.131 Customer Order Compliance Documentation Accuracy	Percentage of complete and accurate customer order compliance documents.
RL.3.132 Customer Order Other Required Documentation Accuracy	Percentage of completeness and accuracy of other supporting documents according to customer orders.
RL.3.133 Customer Order Payment Documentation Accuracy	Percentage of appropriate, complete and correct payment documents for each customer order.
RL.3.134 Customer Order Shipping Documentation Accuracy	Percentage of customer shipping documents that are compliant and accurate.
RL.3.143 Customer Orders Delivered Damage Free Conformance	Percentage of customer orders that arrive without damage/errors in the shipping process.
RL.3.144 Customer Orders Delivered Defect Free Conformance	The percentage of customer orders received without product defects.
RL.3.211 Delivery Item Accuracy from the Supplier	The percentage of items received from suppliers that match the specifications of the items ordered.
RL.3.212 Delivery Quantity Accuracy from the Supplier	The percentage of the number of items from a supplier that match the order.
RL.3.221 Supplier Achievement to Original Organization Commit Date	Percentage of supplier deliveries made on time according to the agreed date.
RL.3.222 Delivery Organization Location Accuracy	Percentage of supplier deliveries that arrive at the correct location as ordered.
RL.3.231 Supplier Order Compliance Documentation Accuracy	Percentage of completeness of compliance documents on supplier orders.
RL.3.232 Supplier Order Other Required Documentation Accuracy	Percentage of completeness of additional supplier documents.
RL.3.232 Supplier Order Payment Documentation Accuracy	Percentage accuracy of supplier payment documents.
RL.3.234 Supplier Order Shipping Documentation Accuracy	Percentage accuracy of supplier shipping documents.
RL.3.243 Supplier Orders Delivered Damage Free Conformance	Percentage of supplier shipments that arrive without damage/errors in the shipping process.
RL.3.244 Supplier Orders Delivered Defect Free Conformance	The percentage of supplier shipments that arrive without product defects.
RL.3.311 Warranty and Returns	Percentage of warranty claims and returns processed according to procedures.
RL.3.312 Percentage of Item Location Accuracy	Percentage of items in the warehouse recorded in the correct location according to the system.
RL.3.321 Percentage of Excess Product Returns Delivered Complete to the Designated Return Center	Percentage of excess product returns that are sent complete to the return center according to the provisions.
RL.3.322 Percentage of Faultless Invoices	Percentage of invoices issued without errors in amount, item, or transaction data.
RL.3.331 Percentage of Identified Maintenance, Repair and Overhaul (MRO) Products Returned to Service	Percentage of MRO items successfully repaired/refurbished and returned to service.

AHP weighting

The weighting of the entire SCOR matrix is determined using the Analytical Hierarchy Process (AHP) method with the help of an Excel template from Klaus D. Goepel from Klaus D. Goepel [15]. All weighting results are declared valid because the consistency ratio (CR) value is below the 10% threshold. Table 6 shows the weight of each matrix from level 1 to level 3. The weights generated by AHP reflect the relative importance of each matrix in shaping supply chain reliability performance.

Table 6. AHP weighting results

Level 1 Matrix	Weight	Level 2 Matrix	Weight	Level 3 Matrix	Weight
RL.1.1	0.537	RL.2.11	0.462	RL.3.111	0.500
				RL.3.112	0.500
		RL.2.12	0.203	RL.3.121	0.875
				RL.3.122	0.125
		RL.2.13	0.072	RL.3.131	0.103
				RL.3.132	0.045
				RL.3.133	0.593
				RL.3.134	0.260
		RL.2.14	0.264	RL.3.141	0.291
				RL.3.142	0.064
				RL.3.143	0.287
				RL.3.144	0.357
RL.1.2	0.364	RL.2.21	0.462	RL.3.211	0.667
				RL.3.212	0.333
		RL.2.22	0.203	RL.3.221	0.800
				RL.3.222	0.200
		RL.2.23	0.072	RL.3.231	0.094
				RL.3.232	0.069
				RL.3.233	0.540
				RL.3.234	0.298
		RL.2.24	0.264	RL.3.243	0.333
				RL.3.244	0.667
RL.1.3	0.099	RL.2.31	0.528	RL.3.311	0.200
				RL.3.312	0.800
		RL.2.32	0.140	RL.3.321	0.667
				RL.3.322	0.333
		RL.2.33	0.333	RL.3.331	1,000

Reliability value calculation

The reliability score is calculated in stages from level 3 to level 1 based on the predetermined AHP weights. The calculation results in Tables 7 and 8 show that PT XYZ supply chain reliability score is 95.48%. This value indicates that there is still room for improvement so that supply chain performance can reach the ideal target of 100%. Therefore, further evaluation of the matrices at level 3 that have not yet achieved a perfect score is carried out to identify the root cause of the problem and determine the appropriate improvement strategy.

Table 7. Results of SCOR matrix value calculations

Level 1 Matrix	Weight	Mark	Level 2 Matrix	Weight	Mark	Level 3 Matrix	Weig ht	Mark
RL.1.1	0.537	100%	RL.2.11	0.462	100%	RL.3.111	0.500	100%
						RL.3.112	0.500	100%
			RL.2.12	0.203	100%	RL.3.121	0.875	100%
						RL.3.122	0.125	100%
			RL.2.13	0.072	100%	RL.3.131	0.103	100%
						RL.3.132	0.045	100%
						RL.3.133	0.593	100%
						RL.3.134	0.260	100%
			RL.2.14	0.264	100%	RL.3.143	0.333	100%
						RL.3.144	0.667	100%
RL.1.2	0.364	87.58%	RL.2.21	0.463	99.16%	RL.3.211	0.667	100%

Level 1 Matrix	Weight	Mark	Level 2 Matrix	Weight	Mark	Level 3 Matrix	Weig ht	Mark
						RL.3.212	0.333	97.48%
			RL.2.22	0.241	74.63%	RL.3.221	0.800	68.28%
						RL.3.222	0.200	100%
			RL.2.23	0.074	100.00 %	RL.3.231	0.094	100%
						RL.3.232	0.069	100%
						RL.3.233	0.540	100%
						RL.3.234	0.298	100%
			RL.2.24	0.222	98.17%	RL.3.243	0.333	97.48%
						RL.3.244	0.667	98.52%
RL.1.3	0.099	100%	RL.2.31	0.528	100%	RL.3.28	0.200	100%
						RL.3.29	0.800	100%
			RL.2.32	0.140	100%	RL.3.30	0.667	100%
						RL.3.25	0.333	100%
			RL.2.33	0.333	100%	RL.3.27	1,000	100%

Table 8. Results of reliability value calculations

Attribute	Mark	Level 1 Matrix	Weight	Mark
		RL.1.1	0.537	100.00%
Reliability	95.48%	RL.1.2	0.364	87.58%
		RL.1.3	0.099	100.00%

BSC evaluation

The BSC evaluation is conducted by benchmarking against both competitors and internal company targets. In this study, the benchmarking process will be based on a 100% target. The benchmarking results from the SCOR matrix and targets are shown in Table 9.

Table 9. Benchmarking results

Matrix	Target	Mark	Gap
RL.3.212 Delivery Quantity Accuracy from the Supplier	100%	97.48%	2.52%
RL.3.221 Supplier Achievement to Original Organization Commit Date	100%	68.28%	31.72%
RL.3.243 Supplier Orders Delivered Damage Free Conformance	100%	97.48%	2.52%
RL.3.244 Supplier Orders Delivered Defect Free Conformance	100%	98.52%	1.48%

The analysis of level 3 SCOR indicators reveals that RL.3.221 (Supplier Achievement to Original Organization Commit Date) represents the most critical performance issue, with a substantial gap of 31.72%. This deviation indicates a systemic weakness in supplier delivery reliability, particularly in meeting committed delivery schedules. Unlike the other identified gaps RL.3.212 (delivery quantity accuracy), RL.3.213 (damage-free condition), and RL.3.214 (defect-free conformity) which show relatively minor deviations (≤2.52%) and are largely operational in nature, RL.3.221 reflects structural inefficiencies in supplier coordination and scheduling processes [16]. Barcode technology enables automatic recording which can reduce human error and speed up the process [17].

A deeper investigation suggests that this gap is primarily driven by the absence of real-time monitoring systems, limited integration between procurement and supplier systems, and weak enforcement of supplier performance agreements. As a result, delays are not only frequent but also unpredictable, creating cascading disruptions in production planning, increasing buffer inventory requirements, and elevating logistics costs. Furthermore, the lack of proactive communication mechanisms exacerbates the issue, as early warning signals of delays are not effectively captured or acted upon.

In contrast, the smaller gaps in RL.3.212, RL.3.213, and RL.3.214 indicate that internal handling, packaging, and quality control processes are relatively well-managed. Therefore, improvement efforts should be strategically prioritized toward enhancing supplier reliability, particularly through the implementation of integrated tracking systems, stricter supplier evaluation frameworks, and collaborative planning mechanisms show in Table 10 and Table 11. Addressing RL.3.221 is expected to yield the most significant impact on overall supply chain performance show in Table 12.

Table 11. Evaluation of BSC matrix RL.3.212

Matrix	BSC Perspective	Impact	Handling Recommendations
RL.3.212 Delivery Quantity Accuracy from the Supplier	Finance	Causes additional costs, such as return handling costs, stock storage, and capital tailwinds due to overstock or low stock.	Implementation of labeling and barcode tracking systems.
	Customer	Decreased customer satisfaction if there is a delay in delivery of goods due to late processing as a result of minimal stock.	
	Internal processes	Overstock resulting in additional work.Lack of stock resulting in delays in work.	
	Learning and growth (HR)	There is additional work for managing excess stock. Minimal work due to lack of stock.	

Table 12. Evaluation of BSC matrix RL.3.213

Matrix	BSC Perspective	Impact	Handling Recommendations
RL.3.243 Supplier Orders Delivered Damage Free Conformance	Finance	Triggers additional return, scrap, rework, and inventory buffer costs	Implementation of Supplier Packaging Standardization System
	Customer	Decreased customer satisfaction if there are components in the product that do not comply with the agreement.	
	Internal processes	Additional processes such as re-inspection, returns, rework, waste management.	
	Learning and growth (HR)	Shows weaknesses in quality control, supplier evaluation systems, and lack of education on quality standards.	

The low value of the RL.3.243 matrix indicates that damage is still found in goods sent by suppliers, resulting in very large damage costs and having a bad impact on the company's reputation. Therefore, to prevent this, more protective packaging is needed low matrix value RL.3.243 [18]. The impact of this condition extends across the four BSC perspectives, including additional costs such as rework, scrap, and inventory buffers, as well as the potential for decreased customer satisfaction due to non-conforming goods. From an internal process perspective, damaged goods increase the workload, such as re-inspection, rework, and waste management. To address this, it is recommended to implement Supplier Packaging Standardization, which establishes packaging standards and packaging methods mutually agreed upon between the company and suppliers, thereby reducing damage during the distribution process [19]. Determining the packaging standards for each product needs to take into account the shipping distance, the mode of transportation used, the quality of the roads along the route, handling by courier partners, the location of the warehouse or even the time of year because during the rainy season, more protection against water or moisture may be required for some products [18].

Matrix RL.3.221 indicates supplier non-compliance in meeting material delivery date commitments. This problem affects the company's operational costs, particularly emergency shipping costs or late penalties. From a customer perspective, the impact can be a delay in final order completion. From an internal process perspective, production schedules are disrupted, while from a learning and growth perspective, this problem indicates a weak supplier monitoring system. The recommended solution is to implement an integrated procurement monitoring system, such as a digital platform that allows suppliers to regularly update progress and allows the company to monitor material status internally in real time.

Table 13. Evaluation of BSC matrix RL.3.221

Matrix	BSC Perspective	Impact	Handling Recommendations
RL.3.221 Supplier Achievement to Original Organization Commit Date	Finance	Causes additional costs for late delivery penalties and emergency shipping costs.	Implementation of an integrated procurement monitoring system.
	Customer	Decreased customer satisfaction if there is a delay in delivery of goods due to late processing as a result of minimal stock.	
	Internal processes	Disruption in production schedule.	
	learning and growth (HR)	Indicates low monitoring and collaboration with suppliers.	

The RL.3.244 value, which has not reached the target, indicates a non-conforming quality of goods delivered by the supplier show in Table 14. The main impact includes increased rework and re-inspection costs. From the customer's perspective, non-conforming goods can reduce customer satisfaction levels. In internal processes, unstable quality hinders smooth production. From a learning and growth perspective, this indicates weak supplier quality control and a lack of understanding of quality standards. To reduce back-end testing and minimize product quality instability, quality control needs to be implemented at the early stages of production [20]. The recommended improvement is the implementation of Supplier Quality Gate, a quality inspection system conducted early in the production process at the supplier's factory before the goods are shipped. This system serves to improve quality consistency and reduce the risk of product defects. The supplier quality gate system has the ability to increase quality visibility at strategic points in the production process [21].

Table 15. Evaluation of BSC matrix RL.3.244

Matrix	BSC Perspective	Impact	Handling Recommendations
RL.3.244 Supplier Orders Delivered Defect Free Conformance	Finance	Triggers rework costs.	Implementation of the Supplier Quality Gate system.
	Customer	Decreased customer satisfaction if there is a discrepancy between the goods sent.	
	Internal processes	Additional processes such as rework and re-inspection.	
	Learning and growth (HR)	Shows weaknesses in quality control, supplier evaluation systems, and lack of education on quality standards.	

Conclusion

This study identified four main matrices causing low performance in the reliability aspect of PT XYZ supply chain, namely: Delivery Quantity Accuracy from the Supplier, Supplier Achievement to Original Organization Commit Date, Supplier Orders Delivered Damage Free Conformance and Supplier Orders Delivered Defect Free Conformance. A reliability value of 95.4% indicates that supply chain performance is good, but still requires improvement to achieve company targets. The Balanced Scorecard evaluation shows that problems occur in the accuracy of material quantities, supplier timeliness, material damage, and product defects. Therefore, the study recommends the implementation of labelling and barcode tracking, packaging standardization, an integrated procurement monitoring system, and supplier quality gates as strategic steps to improve supply chain performance.

Future research should expand the integrated SCOR–AHP–Balanced Scorecard framework by applying it across different industries and incorporating additional SCOR attributes such as responsiveness, agility, cost, and asset management to achieve a more comprehensive performance evaluation. Given that the most critical issue lies in supplier delivery timeliness (RL.3.221), further studies should investigate advanced solutions such as real-time data integration, IoT-based tracking, and predictive analytics to enhance supplier coordination and mitigate delays. In addition, longitudinal research is needed to evaluate the long-term effectiveness of proposed improvements, including barcode systems, packaging standardization, procurement monitoring systems, and supplier quality gates. Future work should also involve more decision-makers in the AHP process and explore alternative or hybrid multi-criteria decision-making methods to improve robustness, as well as conduct comparative studies across sectors and countries to assess the generalizability and adaptability of the proposed model.

References

[1] I. N. Pujawan and Mahendrawati, *Supply Chain Management*, 3rd ed. Yogyakarta: Penerbit ANDI, 2017.
[2] A. P. Kinanthi, D. Herlina, and F. A. Mahardika, "Analisis Pengendalian Persediaan Bahan Baku

Menggunakan Metode Min-Max (Studi Kasus PT.Djitoe Indonesia Tobacco)," *PERFORMA Media Ilm. Tek. Ind.*, vol. 15, no. 2, pp. 87–92, 2016, doi: 10.20961/performa.15.2.9824.
[3] H. Carvalho, B. Naghshineh, K. Govindan, and V. Cruz-Machado, "The resilience of on-time delivery to capacity and material shortages: An empirical investigation in the automotive supply chain," *Comput. Ind. Eng.*, vol. 171, no. June, p. 108375, 2022, doi: 10.1016/j.cie.2022.108375.
[4] ASCM, "SCOR Digital Standard," *Assoc. Supply Chain Manag.*, p. 18, 2022, [Online]. Available: https://www.ascm.org/corporate-solutions/standards-tools/scor-ds/
[5] P. E. Aldianto, "Usulan Rekomendasi Untuk Meningkatkan Kinerja Rantai Pasok Pada Atribut Reliability Menggunakan Metode Supply Chain Operation Reference (SCOR) Racetrack (Studi Kasus: PT Globalindo Intimates)," Universitas Islam Indonesia, 2021.
[6] M. Sururi and A. Rifa'i, "Literature Review : Efektivitas Pengaruh Lima Inti Proses Metode Scor Dalam Pengukuran Kinerja Supply Chain Management (SCM)," *Borobudur Eng. Rev.*, vol. 2, no. 1, pp. 1–11, 2022, doi: 10.31603/benr.6298.
[7] M. N. Sholeh, A. Nurdiana, B. Dharmo, and Suharjono, "Implementation of construction supply chain flow based on SCOR 12.0 performance standards," *J. Phys. Conf. Ser.*, vol. 1833, no. 1, pp. 0–7, 2021, doi: 10.1088/1742-6596/1833/1/012012.
[8] F. I. Maulana, "Konsep AHP (Analytical Hierarchy Process)," Computer Science - Binus University. Accessed: Feb. 27, 2025. [Online]. Available: https://binus.ac.id/malang/2021/06/konsep-ahp-analytical-hierarchy-process/
[9] A. Ishizaka, D. Balkenborg, and T. Kaplan, "Does AHP help us make a choice? An experimental evaluation," *J. Oper. Res. Soc.*, vol. 62, no. 10, pp. 1801–1812, 2011, doi: 10.1057/jors.2010.158.
[10] A. Ishizaka and S. Siraj, "Are multi-criteria decision-making tools useful? An experimental comparative study of three methods," *Eur. J. Oper. Res.*, vol. 264, no. 2, pp. 462–471, 2018, doi: 10.1016/j.ejor.2017.05.041.
[11] T. L. Saaty and L. G. Vargas, "How To Make A Decision: The Analytic Hierarchy Process," 2011. doi: 10.1007/978-1-4419-6281-2_31.
[12] T. L. Saaty, "Decision making with the Analytic Hierarchy Process," *Sci. Iran.*, vol. 9, no. 3, pp. 215–229, 2008, doi: 10.1504/ijssci.2008.017590.
[13] L. L. P. Schiavon, P. A. B. Lima, A. F. Crepaldi, and E. B. Mariano, "Use of the Analytic Hierarchy Process Method in the Variety Selection Process for Sugarcane Planting," *Eng*, vol. 4, no. 1, pp. 602–614, 2023, doi: 10.3390/eng4010036.
[14] K. Schmidt, I. Aumann, I. Hollander, K. Damm, and J. M. G. Von Der Schulenburg, "Applying the Analytic Hierarchy Process in healthcare research: A systematic literature review and evaluation of reporting," *BMC Med. Inform. Decis. Mak.*, vol. 15, no. 1, 2015, doi: 10.1186/s12911-015-0234-7.
[15] K. D. Goepel, "Implementation of an Online Software Tool for the Analytic Hierarchy Process (AHP-OS)," *Int. J. Anal. Hierarchy Process*, vol. 10, no. 3, 2018, doi: https://doi.org/10.13033/ijahp.v10i3.590.
[16] I. P. Arianto, N. Latifah, M. G. N. Sibarani, H. Efendi, and U. Rusilowati, "Barcode System Ever Optimizes Inventory Warehouses," *HUMANIS (Humanities, Manag. Sci. Proceedings)*, vol. 02, no. 1, pp. 288–299, 2021, [Online]. Available: http://www.openjournal.unpam.ac.id/index.php/SNH
[17] S. Achmad, N. Maulana, E. Wijayanti, and A. A. Chamid, "Utilization of Barcode Technology in Modern Inventory Systems to Enhance Accuracy and Operational Efficiency," *MALCOM Indones. J. Mach. Learn. Comput. Sci.*, vol. 5, no. 3, pp. 807–818, 2025, doi: https://doi.org/10.57152/malcom.v5i3.1943.
[18] K. S. Gurumoorthy, S. Sanyal, and V. Chaoji, "Think Out of the Package: Recommending Package Types for E-Commerce Shipments," *ArXiv Comput. Sci. > Mach. Learn.*, vol. 12461 LNAI, pp. 290–305, 2021, doi: https://doi.org/10.48550/arXiv.2006.03239.
[19] S. P. A. Kusumaningrum and M. Tohir, "Analysis of Packaging Standards and Criteria of Goods Conditions Towards The Accuracy of Goods Receipt on The Tokopedia Application," *Siber J. Transp. Logist.*, vol. 2, no. 1, pp. 27–33, 2025, doi: 10.38035/sjtl.v2i1.385.
[20] J. Schnell and G. Reinhart, "Quality Management for Battery Production: A Quality Gate Concept," *Procedia CIRP*, vol. 57, pp. 568–573, 2016, doi: 10.1016/j.procir.2016.11.098.
[21] D. Zondo, "The Impact Of Quality Gates On Product Quality In A Selected Automotive Assembly Organisation In South Africa," *Seybold Rep.*, vol. 18, no. 5, pp. 2534–2549, 2023, doi: 10.17605/OSF.IO/ZY8CB.