

BALANCED SCORECARD-BASED KPI FRAMEWORK FOR AGILE SUPPLY CHAIN PERFORMANCE MEASUREMENT

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ABSTRACT

Performance management is an essential aspect of supply chain management, particularly for companies operating complex supply chain networks. PT X requires an effective performance measurement system to evaluate its ability to respond to changing market demands and deliver products accurately and on time, in line with the Agile Supply Chain concept. This study aims to identify relevant Agile Supply Chain performance indicators from the literature and establish Key Performance Indicators (KPIs) for PT X based on the Balanced Scorecard framework. The research was conducted by collecting Performance Indicators (PIs) from previous studies on Agile Supply Chain performance measurement, followed by validation and selection through interviews, discussions, and assessments involving experts with extensive knowledge of the company's supply chain operations. The selected indicators were then classified into four Balanced Scorecard perspectives: financial, customer, internal business process, and learning and growth. The results identified 18 Agile Supply Chain KPIs, consisting of 4 KPIs in the financial perspective, 5 KPIs in the customer perspective, 5 KPIs in the internal business process perspective, and 4 KPIs in the learning and growth perspective. These KPIs provide a comprehensive framework for measuring Agile Supply Chain performance and can serve as a basis for evaluation and continuous improvement at PT X.

Keywords: *Agile Supply Chain; Key Performance Indicators; Balanced Scorecard; Supply Chain Performance; Performance Measurement.*

INTRODUCTION

Supply Chain Management (SCM) has become an important strategic approach for organizations seeking to improve competitiveness in increasingly dynamic and complex business environments. Effective supply chain management enables organizations to deliver high-quality products, meet customer requirements, reduce operational inefficiencies, and achieve sustainable competitive advantages (Kumar et al., 2023). As market competition intensifies and customer expectations continue to evolve, organizations are required to manage supply chain activities in an integrated and responsive manner. PT X is a company that operates within a complex supply chain network involving procurement, production, distribution, and customer service activities. The increasing complexity of supply chain operations, coupled with rapidly changing customer demands, requires the company to continuously evaluate and improve its supply chain performance. Therefore, a comprehensive performance measurement system is needed to assess whether supply chain activities have been conducted effectively and efficiently in achieving organizational objectives.

Performance measurement is a fundamental component of supply chain management because it provides information for monitoring, controlling, evaluating, and improving organizational performance. An effective performance measurement system enables organizations to identify strengths and weaknesses, monitor strategic objectives, and support continuous improvement initiatives. In supply chain management, performance measurement is commonly conducted through Key Performance Indicators (KPIs), which serve as measurable metrics for evaluating the achievement of strategic and operational goals. Furthermore, KPI-based performance measurement frameworks assist organizations in aligning operational performance with strategic objectives and identifying areas requiring improvement (Verhaelen et al., 2021)

In recent years, the concept of Agile Supply Chain has gained considerable attention due to increasing market uncertainty, shorter product life cycles, and changing customer preferences. Agile Supply Chain refers to the capability of a supply chain to respond rapidly and effectively to changes in customer requirements and market conditions while maintaining operational efficiency. Agility emphasizes responsiveness, flexibility, adaptability, and speed in fulfilling customer demands (BARHMI, 2022). Moreover, flexibility and responsiveness are recognized as critical antecedents of supply chain agility that enable organizations to remain competitive in dynamic business environments (Kazancoglu et al., 2022).

The absence of specific KPIs for measuring Agile Supply Chain performance may hinder organizations from assessing their responsiveness, flexibility, and adaptability to market changes. Consequently, companies may face difficulties in identifying performance gaps and implementing appropriate improvement strategies. Without appropriate indicators, organizations may also encounter challenges in evaluating whether their supply chains are capable of responding effectively to customer requirements and environmental uncertainties. Therefore, establishing relevant Agile Supply Chain KPIs is essential for ensuring that performance measurement systems accurately reflect the characteristics and objectives of agile supply chain operations.

Various studies have proposed different approaches for supply chain performance measurement, including traditional financial measures, the Supply Chain Operations Reference (SCOR) model, and the Balanced Scorecard (BSC). Among these approaches, the

Balanced Scorecard has been widely adopted because it integrates both financial and non-financial performance measures through four perspectives: financial, customer, internal business processes, and learning and growth. This multidimensional approach provides a comprehensive view of organizational performance and aligns operational activities with strategic objectives.

Previous studies have developed KPI frameworks and performance measurement systems for various supply chain contexts. Verhaelen et al. (2021) proposed a performance measurement framework to support organizational performance evaluation, while Piotrowicz (2022) highlighted the importance of developing performance metrics capable of capturing lean and agile supply chain characteristics. Despite these developments, studies focusing specifically on the identification and establishment of Agile Supply Chain KPIs based on the Balanced Scorecard framework remain limited, particularly within manufacturing industries. Furthermore, PT X has not yet established a specific KPI framework for measuring Agile Supply Chain performance. This condition highlights the need for a structured framework capable of capturing the critical dimensions of supply chain agility through a comprehensive set of performance indicators.

To address this gap, this study employs the Balanced Scorecard framework as a basis for identifying, validating, and classifying Agile Supply Chain performance indicators. The Balanced Scorecard is selected because it enables the integration of financial and non-financial measures and facilitates a holistic assessment of supply chain performance. Therefore, the objectives of this study are: (1) to identify Agile Supply Chain performance indicators based on a comprehensive literature review, and (2) to establish Agile Supply Chain Key Performance Indicators (KPIs) for PT X based on the four perspectives of the Balanced Scorecard. The resulting KPI framework is expected to provide a foundation for measuring Agile Supply Chain performance and support continuous improvement initiatives within the company.

RESEARCH METHOD

Preliminary Study

The research began with a preliminary study at PT X to understand its supply chain system and current business conditions. The preliminary findings indicated that the company had not yet established a specific performance measurement system for Agile Supply Chain performance, highlighting the need to identify and establish appropriate Key Performance Indicators (KPIs). In addition, a literature review was conducted to provide the theoretical foundation for the study. Relevant literature was collected from scientific journals, books, conference proceedings, and other credible sources, focusing on Supply Chain Management, Agile Supply Chain, performance measurement, Key Performance Indicators (KPIs), and the Balanced Scorecard (BSC).

Identification of Agile Supply Chain Criteria and Performance Indicators

The identification of Agile Supply Chain criteria and Performance Indicators (PIs) was conducted through a review of relevant literature. Agile Supply Chain criteria were first identified from previous studies, followed by the identification of associated Performance Indicators. The identified indicators were then classified into their respective criteria based on

the alignment between indicator definitions and the characteristics of each criterion. This classification was further supported by findings from previous studies on Agile Supply Chain performance measurement.

Figure 1 presents the overall research methodology, including the preliminary assessment, literature review, identification of Agile Supply Chain criteria and performance indicators, expert validation, classification into Balanced Scorecard perspectives, and the establishment of Key Performance Indicators (KPIs).

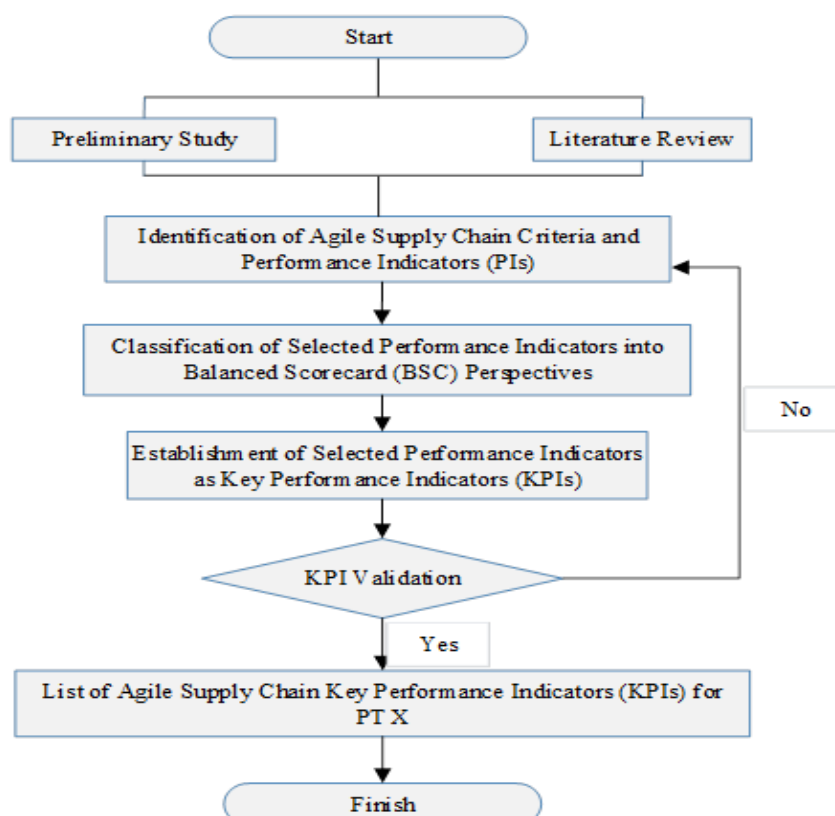


Figure 1. Research Methodology

Identification of Criteria and Performance Indicators Based on Company Conditions

The relevance of the Agile Supply Chain criteria and Performance Indicators (PIs) identified from the literature was evaluated through expert interviews and questionnaire-based assessments. The preliminary list of criteria and indicators was reviewed by the Head of General and Operational Procurement at PT X to determine its suitability for the company's operational context. Based on the expert's evaluation, criteria and indicators deemed relevant to the company's supply chain operations were retained for further analysis, while those considered less relevant were excluded. This process ensured that the selected indicators reflected both theoretical foundations and the practical requirements of PT X.

Classification of Selected Performance Indicators into Balanced Scorecard Perspectives

The selected Performance Indicators (PIs) were classified into the four Balanced Scorecard (BSC) perspectives: Financial, Customer, Internal Business Process, and Learning and

Growth. The classification was based on the alignment between the objectives and measurement scope of each indicator and the characteristics of the corresponding BSC perspective. Previous studies on supply chain performance measurement were also used as references to support the classification process. This step ensured a systematic organization of the selected indicators and facilitated the development of a comprehensive Agile Supply Chain performance measurement framework for PT X.

Establishment of Selected Performance Indicators as Key Performance Indicators

The selected Performance Indicators (PIs) were reviewed by experts from PT X to assess their relevance, applicability, and significance in measuring Agile Supply Chain performance. Experts representing the Finance, Distribution and Transportation, and Procurement departments evaluated the indicators according to their respective areas of expertise. Based on the expert evaluations, the indicators considered most representative of the company's Agile Supply Chain performance were established as Key Performance Indicators (KPIs).

KPI Validation

The established Key Performance Indicators (KPIs) were validated by experts from the Finance, Distribution and Transportation, Procurement, and Human Resources departments of PT X. A face validity approach was employed using a structured questionnaire to assess the relevance, clarity, and applicability of each KPI for measuring Agile Supply Chain performance. The expert feedback was subsequently used to confirm and refine the final set of Agile Supply Chain KPIs.

RESULTS AND DISCUSSION

Identification of Agile Supply Chain Criteria and Performance Indicators

Agile Supply Chain criteria and Performance Indicators (PIs) were identified through a comprehensive literature review. The initial identification resulted in eight criteria and twenty-three Performance Indicators, as presented in Table 1. The identified criteria and indicators were subsequently evaluated by the Head of General and Operational Procurement at PT X through interviews and questionnaire-based assessments to determine their relevance to the company's operational context. This process ensured that the selected criteria and indicators were aligned with the characteristics and requirements of Agile Supply Chain performance measurement at PT X.

Table 1. Agile Supply Chain Criteria and Performance Indicators Identified from the Literature

No	Criteria	No	Performance Indicator	References
1	Flexibility	1	Number of product packaging variations	(Ampuh Hadiguna & Jonrinaldi, 2015; Jafari et al., 2023; Piotrowicz et al., 2023)
		2	Ability to handle urgent orders	
		3	Ability to handle non-standard orders	
2	Market Sensitivity	4	Ability to meet market demand	(Al Humdan et al., 2020; Ampuh Hadiguna & Jonrinaldi, 2015; Gligor et al., n.d.; Mogaka & Njururi, 2024)
		5	Forecast accuracy	
3	Information Technology Utilization	6	Accessibility of information and information technology	Oliveira-Dias et al. (2022); Saleeshya <i>et al</i> (2012); Khalili-Damghani dan Tavana (2013)
		7	Supplier selection evaluation	
4	Process Integration	8	Material and product inventory level	(Khalili-Damghani & Tavana, 2013; Kumar et al., 2023; Oliveira-Dias et al., 2022; Saleeshya et al., 2012)
		9	Number of defective raw material supplies	
		10	Raw material supply lead time	
		11	Capacity utilization	
5	Innovation	12	Percentage of fulfilled new product requests	(Jafari et al., 2023; Mogaka & Njururi, 2024; Saleeshya et al., 2012)
		13	Percentage of new product ideas successfully implemented	
		14	Customer satisfaction level	
6	Service Level	15	Employee training frequency	(Al Humdan et al., 2020; Mogaka & Njururi, 2024; Piotrowicz et al., 2023; Saleeshya et al., 2012)
		16	Employee performance satisfaction level	
		17	Product quality improvement	
7	Cost	18	Inventory cost	(Ampuh Hadiguna & Jonrinaldi, 2015; Gligor et al., n.d.; Khalili-Damghani & Tavana, 2013; Kumar et al., 2023; Piotrowicz et al., 2023)
		19	Transportation cost	
		20	Employee training and development cost	
8	Delivery Speed	21	Total supply chain cost	(Ampuh Hadiguna & Jonrinaldi, 2015; Piotrowicz et al., 2023; Saleeshya et al., 2012)
		22	Product delivery lead time	
		23	On-time delivery quantity	

Identification of Criteria and Performance Indicators Based on Company Conditions

Following the expert evaluation, one criterion and three Performance Indicators (PIs) were excluded due to their limited relevance to the operational context of PT X. The excluded criterion was Innovation, while the removed indicators were the number of defective raw material supplies, the percentage of fulfilled new product requests, and the percentage of new product ideas successfully implemented. No additional criteria or indicators were proposed

by the expert. Consequently, the final framework consisted of seven Agile Supply Chain criteria and twenty Performance Indicators, as presented in Table 2.

Table 2. Selected Agile Supply Chain Criteria and Performance Indicators (PIs)

No	Criteria	No	Performance Indicator
1	Flexibility	1	Number of product packaging variations
		2	Ability to handle urgent orders
		3	Ability to handle non-standard orders
2	Market Sensitivity	4	Ability to meet market demand
3	Information Technology Utilization	5	Forecast accuracy
		6	Accessibility of information and information technology
4	Process Integration	7	Supplier selection evaluation
		8	Material and product inventory level
		9	Raw material supply lead time
		10	Capacity utilization
5	Service Level	11	Customer satisfaction level
		12	Employee training frequency
		13	Employee performance satisfaction level
		14	Product quality improvement
		15	Inventory cost
6	Cost	16	Transportation cost
		17	Employee training and development cost
		18	Total supply chain cost
7	Delivery Speed	19	Product delivery lead time
		20	On-time delivery quantity

Classification of Selected Performance Indicators into Balanced Scorecard Perspectives

The selected Performance Indicators (PIs) were classified into the four Balanced Scorecard (BSC) perspectives: Financial, Customer, Internal Business Process, and Learning and Growth. The classification was performed by aligning the objectives and measurement scope of each indicator with the characteristics of the corresponding BSC perspective. Previous studies on supply chain performance measurement were also used to support the classification process.

The resulting classification framework is presented in Table 3. Four indicators were assigned to the Financial Perspective, reflecting the contribution of supply chain performance to financial outcomes such as profitability and cost efficiency. Five indicators were classified under the Customer Perspective, representing the company's ability to satisfy customer requirements through responsiveness, service quality, and delivery performance. Another five indicators were grouped into the Internal Business Process Perspective, focusing on operational effectiveness, inventory management, capacity utilization, and demand fulfillment. The remaining indicators were assigned to the Learning and Growth Perspective, emphasizing organizational capabilities, employee development, forecasting capability, and information accessibility.

This classification demonstrates that Agile Supply Chain performance cannot be evaluated solely through financial measures. Instead, it requires a balanced assessment of customer-related outcomes, internal operational capabilities, and organizational learning factors. Such findings are consistent with previous studies highlighting the suitability of the Balanced Scorecard framework for integrating financial and non-financial dimensions of supply chain

performance measurement (Neri et al., 2021; Llivisaca et al., 2020) The classification also provides a structured foundation for developing a comprehensive Agile Supply Chain performance measurement framework for PT X.

Table 3. Classification of Selected Performance Indicators into BSC Perspectives

No	BSC Perspective	No	Performance Indicator
1	Financial	1	Inventory cost
		2	Transportation cost
		3	Employee training and development cost
		4	Total supply chain cost
2	Customer	5	Product delivery lead time
		6	Ability to handle urgent orders
		7	Ability to handle non-standard orders
		8	Customer satisfaction level
		9	Product quality improvement
		10	On-time delivery quantity
3	Internal Business Process	11	Ability to meet market demand
		12	Material and product inventory level
		13	Raw material supply lead time
		14	Capacity utilization
		15	Number of product packaging variations
4	Learning and Growth	16	Forecast accuracy
		17	Employee training frequency
		18	Accessibility of information and information technology
		19	Employee performance satisfaction level
		20	Supplier selection evaluation

Establishment of Selected Performance Indicators as Key Performance Indicators

The selected Performance Indicators (PIs) were subsequently reviewed by experts from PT X to assess their relevance and applicability within the company's operational context. The verification process involved experts from the Finance, Distribution and Transportation, and Procurement departments, who evaluated the indicators according to their respective areas of expertise. Several modifications were made following the expert review. Within the Financial Perspective, inventory cost and transportation cost were excluded because both measures were considered components of total supply chain cost. In addition, employee training and development cost was reassigned to the Learning and Growth Perspective due to its association with employee capability development. The experts further proposed the inclusion of EBITDA, company revenue, and net profit as key financial indicators. These measures were considered more representative of the financial outcomes generated by effective and efficient supply chain operations. This finding is consistent with previous studies emphasizing that supply chain performance measurement should capture both operational efficiency and organizational value creation through appropriate financial indicators (Neri et al., 2021).

All identified Key Performance Indicators (KPIs) were subsequently subjected to expert validation using the face validity method. Through a structured validation questionnaire, experts were asked to evaluate whether the proposed KPIs accurately represented the dimensions of Agile Supply Chain performance and were suitable for implementation within PT X. The validation results confirmed the relevance and applicability of the selected KPIs

for the company's operational environment. The validated Agile Supply Chain KPIs and their corresponding symbols are presented in Table 4.

Table 4. KPI Validation Results

No	BSC Perspective	No	Performance Indicator
1	Financial	1	EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization)
		2	company revenue
		3	Net profit
		4	Total supply chain cost
		5	Product Delivery Lead Time
		6	Ability to Handle Urgent Orders
2	Customer	7	Ability to Handle Non-Standard Orders
		8	Customer Satisfaction Level
		9	Product Quality Maintenance
		10	Accuracy in Fulfilling Cement Demand
3	Internal Process	11	Material and Product Inventory Level
	Business	12	Raw Material Supply Lead Time
		13	Capacity Utilization
		14	Number of Product Packaging Variations
		15	Forecast Accuracy
		16	Employee Training Frequency
4	Learning and Growth	17	Accessibility of Information and Information Technology
		18	Employee Performance Satisfaction Level

For the Customer Perspective, the indicator on-time delivery quantity was removed because product delivery lead time was considered sufficient to represent delivery performance. Furthermore, the indicator product quality improvement was revised to maintaining product quality, reflecting the company's strategic focus on sustaining established quality standards. Consequently, five KPIs were retained in this perspective: product delivery lead time, ability to handle urgent orders, ability to handle non-standard orders, customer satisfaction level, and maintaining product quality. These indicators are consistent with the agility dimensions of responsiveness, flexibility, and customer orientation commonly highlighted in Agile Supply Chain literature (Gawade, 2023).

Within the Internal Business Process Perspective, the indicator ability to meet market demand was refined into accuracy in fulfilling cement demand to better reflect the company's operational objectives. The final KPIs in this perspective were accuracy in fulfilling cement demand, material and product inventory level, raw material supply lead time, capacity utilization, and number of product packaging variations. These indicators represent critical operational capabilities that support supply chain agility through responsiveness, resource utilization, and inventory management (Llivosaca et al., 2020).

For the Learning and Growth Perspective, employee training and development cost was excluded because it was viewed as a supporting investment rather than a key performance measure. In addition, supplier selection evaluation was removed due to its limited strategic significance under the company's current supplier management practices. The final KPIs in this perspective were employee training frequency, accessibility of information and

information technology, forecast accuracy, and employee performance satisfaction level. These indicators emphasize the role of human resources, information systems, and organizational learning in enhancing supply chain agility and long-term performance (Oliveira-Dias et al., 2022)

As a result of the verification process, a total of eighteen Agile Supply Chain Key Performance Indicators were established for PT X, comprising four KPIs in the Financial Perspective, five in the Customer Perspective, five in the Internal Business Process Perspective, and four in the Learning and Growth Perspective. The resulting KPI framework provides a balanced set of financial and non-financial measures for evaluating Agile Supply Chain performance, consistent with recommendations from contemporary supply chain performance measurement studies (Llavisaca et al., 2020; Neri et al., 2021)

CONCLUSION

Based on the findings of this study, a total of 18 Agile Supply Chain Key Performance Indicators (KPIs) were identified and established for PT X using the Balanced Scorecard (BSC) framework. The KPIs were categorized into four BSC perspectives to provide a comprehensive performance measurement structure. The Financial Perspective comprises four KPIs: EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization), company revenue, net profit, and total supply chain cost. The Customer Perspective includes five KPIs: product delivery lead time, ability to handle urgent orders, ability to handle non-standard orders, customer satisfaction level, and product quality maintenance. The Internal Business Process Perspective consists of five KPIs: accuracy in fulfilling cement demand, material and product inventory levels, raw material supply lead time, capacity utilization, and the number of product packaging variations. The Learning and Growth Perspective contains four KPIs: forecast accuracy, employee training frequency, accessibility of information and information technology, and employee performance satisfaction. The resulting KPI framework integrates both financial and non-financial dimensions of performance, enabling a holistic assessment of Agile Supply Chain performance. Furthermore, the framework provides a practical foundation for performance evaluation, strategic decision-making, and continuous improvement initiatives aimed at enhancing the responsiveness, flexibility, and competitiveness of PT X's supply chain operations.

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