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Diagnosing Supply Chain Agility Gaps in Organic Vegetable Production Using the SCOR Racetrack Framework

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Abstract—Organic vegetable supply chains face operational challenges in aligning production capacity with fluctuating market demand, potentially resulting in production surpluses and reduced efficiency. This study aims to diagnose supply chain agility performance gaps and prioritize improvement strategies using the SCOR Racetrack framework at CV Tani Organik Merapi, Indonesia. A quantitative descriptive approach was applied using historical operational data collected from January to August 2025. The analysis employed SCOR version 12.0, performance gap assessment, Snorm de Boer normalization, fishbone analysis, and effort–risk prioritization. The findings identified manufacturing flexibility (AG.2.2) as the primary area requiring improvement, with reported performance deviations of 13.00 for AG.3.32 (Number of Orders Shipped) and 43.27 for AG.3.38 (Manufactured Quantity). Root cause analysis identified demand uncertainty, inadequate production planning, limited technical expertise, insufficient supervision, and communication constraints. Six improvement initiatives were proposed, with operational assessments, production planning expertise, and demand forecasting identified as the highest priorities. The study demonstrates the applicability of SCOR Racetrack for diagnosing operational weaknesses and supporting structured improvement decisions in organic vegetable supply chains. Further empirical validation is required to assess implementation effectiveness.

Keywords: Organic vegetable supply chain, Performance gap analysis, SCOR Racetrack, Supply chain agility, Supply chain improvement.

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1. Introduction

Organic vegetable supply chains play an increasingly important role in supporting sustainable agricultural production, environmental protection, and growing consumer demand for healthier food products. However, the expansion of organic markets has created operational challenges related to production planning, supply chain coordination, and responsiveness to fluctuating market demand. According to The World of Organic Agriculture 2026, global organic food and beverage retail sales reached EUR 145.0 billion in 2024, while organically managed agricultural land accounted for approximately 98.9 million hectares worldwide [1]. In Indonesia, horticultural production remains an important component of the agricultural economy, as documented in the 2025 horticultural statistics published by Statistics Indonesia [2]. Preliminary national statistics estimated vegetable production at approximately 15.03 million tonnes in 2025, representing an increase of 1.94% compared with 2024 [3]. Although these figures reflect the development of the horticultural sector rather than certified

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organic production specifically, they highlight the importance of strengthening agricultural supply chain management. Operational challenges remain particularly significant because of product perishability, production surpluses, and imbalances between supply and market demand. The United Nations Environment Programme reported approximately 1.05 billion tonnes of food waste worldwide at the retail, food-service, and household levels in 2022 [4]. Furthermore, recent research has emphasized the environmental and economic consequences of horticultural postharvest losses, highlighting the importance of preventive and adaptive supply chain management strategies [5].

The operational characteristics of organic vegetable production create substantial challenges for maintaining supply chain agility, particularly when production capacity cannot be adjusted immediately to changing customer requirements. Agricultural production depends on biological growth cycles, cultivation schedules, harvesting periods, and quality standards, whereas market demand may fluctuate over considerably shorter periods. Consequently, discrepancies between production output and actual customer orders can generate excess inventory, declining product quality, and avoidable operational losses. Previous research has demonstrated the importance of forecasting postharvest waste to support evidence-based decisions in fresh produce supply chains [6]. Climate-related disruptions and interorganizational dependencies have also been identified as significant factors influencing agri-food supply chain resilience [7]. A comprehensive review of agri-food supply chain network design further emphasized the importance of managing perishability, uncertainty, and operational coordination [8]. From an organizational perspective, supply chain agility refers to the ability to respond effectively to changing conditions through flexible resource allocation, coordinated operational activities, and timely adjustments. A meta-analysis confirmed the relationship between collaborative capabilities, supply chain agility, and organizational performance [9], while empirical research on fresh agricultural enterprises highlighted the importance of operational capabilities under supply chain uncertainty [10]. Similarly, big data analytics and information integration have been associated with improvements in supply chain agility and performance within the food industry [11].

These operational challenges are relevant to CV Tani Organik Merapi, an organic vegetable producer located in Sleman, Special Region of Yogyakarta, Indonesia. The enterprise manages agricultural production and distribution activities involving various organic vegetables, with particular attention in this study to carrot production. Historical operational records indicate discrepancies between production quantities and customer order requirements, suggesting limitations in aligning cultivation activities with market demand. Such discrepancies may contribute to surplus production, inefficient resource utilization, and additional product-handling requirements. The biological characteristics of agricultural production further complicate operational adjustments because cultivation schedules, harvesting decisions, labor allocation, and distribution arrangements are interconnected. Therefore, identifying the specific operational activities responsible for production–demand mismatches is essential for improving supply chain adaptability. Previous research involving an Indonesian greenhouse cherry tomato enterprise demonstrated that satisfactory overall supply chain performance can coexist with weaknesses in agility and responsiveness [12]. Similarly, research on organic vegetable farmers in Thailand emphasized the importance of operational coordination, production management, and distribution efficiency in improving agricultural supply chain performance [13]. These findings indicate that aggregate performance assessments alone may be insufficient to explain the operational sources of supply chain agility weaknesses.

The Supply Chain Operations Reference (SCOR) model provides a structured framework for evaluating supply chain performance through standardized processes, performance attributes, and hierarchical metrics. Previous research has demonstrated the relevance of SCOR-based performance measurement for identifying operational weaknesses and supporting supply chain improvement [14]. The hierarchical structure of SCOR enables performance assessment at strategic, diagnostic, and operational levels, facilitating the identification of performance deviations. Studies in the floricultural sector have shown that SCOR-based assessments can identify weaknesses in planning, manufacturing, and other supply chain processes [15]. Furthermore, research on agri-food supply chains has emphasized the importance of agility, information integration, and organizational productivity in

supporting sustainable operational performance [16]. Within this context, the SCOR Racetrack framework comprises five sequential stages: Pre-SCOR Program Steps, Set the Scope, Configure the Supply Chain, Optimize Projects, and Ready for Implementation. This study applies SCOR version 12.0, focusing on the Agility attribute and the hierarchical relationships among downside supply chain flexibility, manufacturing flexibility, and Level-3 operational metrics.

Despite these methodological developments, an important research gap remains in systematically connecting the measurement of supply chain agility gaps with root cause identification and the prioritization of operational improvement initiatives in organic vegetable production. Recent studies have emphasized digital technologies, information sharing, traceability, and data-driven decision-making as mechanisms for strengthening agri-food supply chain resilience [17]. Other research has demonstrated the relationships among supply chain coordination, analytical capabilities, agility, and organizational innovation [18]. Integrated approaches incorporating sustainability, operational risk, and resilience have also been proposed to support improvement decisions in fragmented fresh food supply chains [19]. Moreover, a systematic literature review highlighted the importance of supply chain innovations and operational coordination in preventing and reducing food loss [20]. Although these studies provide valuable insights into supply chain performance and adaptability, they do not directly establish an integrated diagnostic procedure for tracing production–demand discrepancies from hierarchical SCOR agility metrics to operational root causes and subsequently translating the findings into improvement priorities within a single organic vegetable case study. Consequently, there is a need for a structured analytical approach that connects performance measurement, operational diagnosis, and improvement decision-making rather than treating these activities as separate assessments.

To address this gap, the present study integrates three complementary analytical components within the SCOR Racetrack framework. First, hierarchical SCOR version 12.0 metrics are used to identify relevant agility attributes and quantify deviations between actual operational performance and internal company targets. This stage establishes a measurable basis for diagnosing manufacturing flexibility constraints. Second, fishbone analysis is employed to systematically identify potential root causes of the observed performance gaps across operational categories, including human resources, methods, materials, equipment, and environmental conditions. This stage provides an explanatory connection between numerical performance deviations and the operational factors that may contribute to them. Third, an effort–risk prioritization matrix is applied to evaluate proposed improvement initiatives according to their estimated implementation requirements and operational risks. This stage translates diagnostic findings into a structured set of managerial priorities. Integrating these components within the sequential SCOR Racetrack stages creates a traceable analytical pathway from performance gap identification to root cause diagnosis and improvement project selection.

The novelty of this study lies in the operational integration of hierarchical SCOR agility measurement, fishbone-based root cause analysis, and effort–risk improvement prioritization within a unified SCOR Racetrack diagnostic procedure for organic vegetable production. Rather than introducing new SCOR metrics or claiming that the individual analytical methods are novel, this study emphasizes their coordinated application to connect quantitative performance deviations with operational explanations and actionable improvement priorities. Specifically, the approach traces manufacturing-related agility constraints through selected SCOR metrics, examines potential causes of production–demand misalignment, and links the resulting diagnosis to the selection of feasible improvement initiatives. This integration provides a practical distinction from studies that focus primarily on aggregate supply chain performance measurement or examine improvement strategies without explicitly connecting them to diagnosed metric-level performance gaps. The resulting framework supports a more transparent and systematic interpretation of production flexibility problems in the context of perishable agricultural products. Accordingly, this study aims to diagnose supply chain agility performance gaps in organic vegetable production using the SCOR Racetrack framework, with CV Tani Organik Merapi serving as a retrospective case study. The analysis focuses on production–demand discrepancies through the hierarchical assessment of selected SCOR version

12.0 agility metrics, particularly AG.1.2 (Downside Supply Chain Flexibility), AG.2.2 (Downside Flexibility—Make), AG.3.32 (Number of Orders Shipped), and AG.3.38 (Amount of Each Item Which Is Manufactured). The study uses historical operational data from January to August 2025 to assess performance deviations, identify potential root causes through fishbone analysis, and prioritize improvement initiatives using an effort–risk matrix. Its principal contribution is a structured operational diagnostic procedure that links supply chain agility measurement to managerial improvement decisions. The findings are expected to provide practical recommendations for strengthening production adaptability, improving coordination between production activities and customer demand, and reducing potential production surpluses in organic vegetable supply chains. Because the proposed initiatives have not undergone post-implementation evaluation, their effectiveness remains subject to further empirical validation.

2. Method

2.1 Research Design and Data Collection

This study employed a quantitative descriptive approach through a retrospective case study at CV Tani Organik Merapi, Sleman, Yogyakarta, Indonesia. The unit of analysis was the company's carrot production and related supply chain activities during January–August 2025. Primary data were obtained through operational observations and interviews with company management and employees. Secondary data comprised production records, customer order and shipment records, purchasing documents, and operational records. Actual performance values were derived from the relevant company records, while internal targets were based on performance benchmarks established by company management. The data were examined to identify discrepancies between operational performance and internal targets. The documentary basis, measurement units, and authorization of these targets require confirmation against the original company records.

2.2 SCOR Racetrack Framework

The SCOR Racetrack framework was applied using SCOR version 12.0 through five stages: (1) Pre-SCOR Program Steps, identifying operational problems; (2) Set the Scope, defining supply chain boundaries; (3) Configure the Supply Chain, selecting metrics and evaluating performance gaps; (4) Optimize Projects, identifying root causes and improvement alternatives; and (5) Ready for Implementation, prioritizing improvement initiatives. The assessment focused on AG.1.2 (Downside Supply Chain Flexibility) and AG.2.2 (Downside Flexibility Make). Four Level-3 operational metrics were examined, as summarized in Table 1.

Table 1. Operational Definitions and Measurement Procedures of SCOR Level-3 Metrics

SCOR Metric	Operational Definition	Unit	Calculation Method	Performance Direction	Data Source
AG.3.2 – Labor Use in Manufacturing in Direct Activity	Total direct labor hours utilized in carrot production activities.	Labor hours	Sum of direct labor hours allocated to production activities.	Context-dependent	Labor and production records
AG.3.32 – Number of Orders Shipped	Total number of customer orders shipped during the assessment period.	Orders	Count of customer orders shipped during the assessment period.	Target-dependent	Customer order and shipment records
AG.3.38 – Amount of Each Item Which Is Manufactured	Total quantity of carrot products manufactured during the assessment period.	Product units	Sum of manufactured quantities for each product item.	Target-dependent	Production records

AG.3.42 – Amount of Each Item Which Is Purchased	Total quantity of production inputs purchased during the assessment period.	Input units	Sum of purchased quantities for each input item.	Target-dependent	Purchasing records

Table 1 summarizes the four operational metrics used to assess supply chain agility. The metrics represent direct labor utilization, shipped orders, manufactured quantities, and purchased inputs. Each metric was assessed against its corresponding internal target, considering its operational unit and performance direction. The resulting deviations were used to identify activities requiring further investigation.

2.3 Supply Chain Performance Gap Analysis

Supply chain performance gaps were assessed by comparing actual operational values with internal company targets. Four SCOR Level-3 metrics were examined: AG.3.2, AG.3.32, AG.3.38, and AG.3.42. Their operational definitions, measurement procedures, and data sources are summarized in Table 1. Performance gaps were calculated separately for each metric using Equation (1).

$$G_i = |A_i - T_i| \quad (1)$$

Where G_i represents the absolute performance gap, A_i denotes actual performance, and T_i is the internal target for metric *i*. The gap retains the unit of the corresponding metric. Relative performance was evaluated using Snorm de Boer normalization for indicators with an established reference range, as expressed in Equation (2):

$$S_{norm,i} = \frac{S_i - S_{min,i}}{S_{max,i} - S_{min,i}} \times 100\% \quad (2)$$

2.4 Cause Analysis and Improvement Prioritization

The identified performance gaps were further examined using fishbone diagrams to determine their underlying operational causes. Improvement alternatives were subsequently formulated and organized into a project portfolio. Each proposed project was assessed using an effort–risk prioritization matrix, with lower-effort and lower-risk alternatives receiving higher implementation priority. Finally, project charters and readiness assessments were prepared to support operational decision-making. The proposed improvements were evaluated at the planning stage without claiming verified post-implementation performance gains.

3. Result and Discussion

3.1 Cause Analysis and Improvement Prioritization

The supply chain of CV Tani Organik Merapi involves three principal actors: suppliers, the organic vegetable producer, and customers. Suppliers provide agricultural inputs, while the company manages production planning, cultivation, harvesting, storage, and distribution activities in collaboration with partner farmers. The products are subsequently delivered to supermarkets and individual customers. Figure 1 presents the supply chain configuration, highlighting the relationships among supply chain actors and the associated material, product, and information flow.

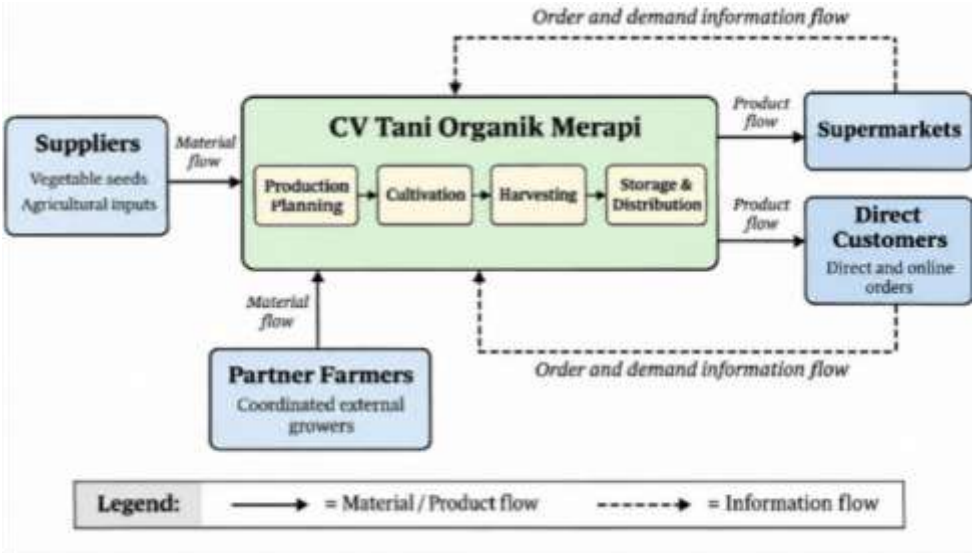


Figure 1. Organic Vegetable Supply Chain Configuration

Figure 1 presents the organic vegetable supply chain configuration at CV Tani Organik Merapi, involving suppliers, partner farmers, production activities, and customers. The supply chain includes agricultural input sourcing, cultivation, harvesting, storage, and distribution, supported by material and information flows. Differences between production output and customer demand indicate potential weaknesses in manufacturing flexibility. Therefore, the SCOR Racetrack framework was applied to assess supply chain agility gaps and identify appropriate improvement strategies.

3.2 SCOR Agility Performance Metrics Identification

The SCOR version 12.0 assessment identified Agility as the key performance attribute for evaluating supply chain challenges at CV Tani Organik Merapi, particularly in responding to declining customer demand. The analysis focused on AG.1.2 (Downside Supply Chain Flexibility), supported by three Level-2 metrics: sourcing flexibility (AG.2.1), manufacturing flexibility (AG.2.2), and delivery flexibility (AG.2.3). Manufacturing flexibility was identified as the primary area requiring improvement, with four Level-3 metrics covering direct labor utilization (AG.3.2), shipped orders (AG.3.32), manufactured quantities (AG.3.38), and purchased inputs (AG.3.42). Particular attention was given to AG.3.32 and AG.3.38 due to their observed performance deviations. Table 2 presents the selected SCOR agility metrics and their measurement purposes.

Table 3. Supply Chain Agility Performance Gap Analysis

SCOR Metric	Actual Value	Internal Target	Performance Gap	Snorm (%)
AG.3.2 – Direct Labor	12.00	12.00	0.00	–
AG.3.32 – Orders Shipped	43.27	30.27	13.00	49.66*
AG.3.38 – Manufactured Quantity	100.00	56.73	43.27	–
AG.3.42 – Purchased Items	1.00	1.00	0.00	–

Table 3 presents the performance gaps identified across four SCOR Level-3 metrics for the organic vegetable supply chain at CV Tani Organik Merapi. AG.3.32 (Number of Orders Shipped) recorded a numerical deviation of 13.00, while AG.3.38 (Manufactured Quantity) showed a larger deviation of 43.27 from its internal target. In contrast, AG.3.2 (Direct Labor) and AG.3.42 (Purchased Items) matched their respective targets, indicating no numerical differences for these indicators. The results suggest that order fulfillment and manufacturing activities require closer examination, particularly regarding the alignment of production output with customer demand. The reported Snorm score of 49.66% for AG.3.32 indicates its relative position within the specified reference range,

although the underlying normalization parameters still require further verification. Overall, these findings provide a basis for investigating potential causes of operational discrepancies and prioritizing appropriate improvement initiatives to strengthen production planning, coordination, and supply chain agility.

3.3 Root Cause Analysis of Agility Performance Gaps

Root cause analysis was conducted using a fishbone diagram to examine potential factors contributing to performance gaps in AG.3.32 and AG.3.38. The assessment covered five operational categories: Man, Method, Material, Machine, and Environment. Figure 2 presents the identified factors, including limited planning capabilities, inadequate coordination, inconsistent input availability, insufficient equipment, and environmental uncertainty. These factors provide a basis for understanding manufacturing flexibility constraints and developing targeted supply chain improvement initiatives.

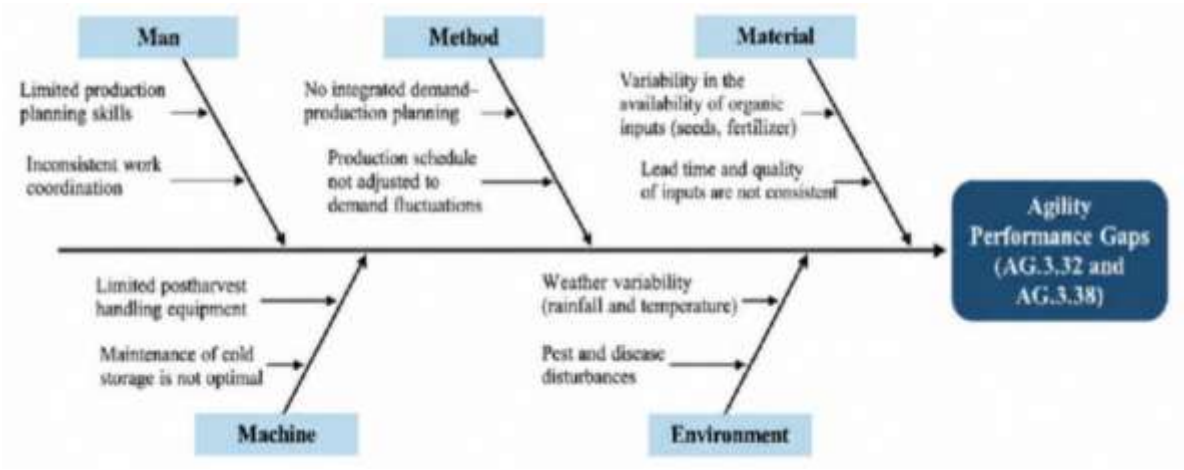


Figure 2. Fishbone Analysis of Supply Chain Agility Performance Gaps

Figure 2 presents five categories of potential causes contributing to supply chain agility gaps at CV Tani Organik Merapi: Man, Method, Material, Machine, and Environment. The identified factors include limited production planning skills, inadequate coordination between operational activities, inconsistent availability and quality of organic inputs, insufficient postharvest equipment, and environmental uncertainties such as weather variability and pest disturbances. These conditions may restrict the company's ability to align carrot production with changing customer demand, resulting in reduced manufacturing flexibility and potential production surpluses. The findings suggest that improving supply chain agility requires stronger demand-based production planning, more effective resource allocation, better communication among supply chain actors, and improved operational supervision. These measures provide a practical basis for developing targeted improvement initiatives.

3.4 Improvement Project Prioritization and Managerial Implications

Based on the identified supply chain agility gaps and root cause analysis, six improvement projects were developed using the SCOR Racetrack framework. These projects focused on improving production planning, demand forecasting, operational supervision, product awareness, and technological coordination among supply chain actors. Each project was evaluated using a five-point effort–risk assessment scale, ranging from 1 (very low) to 5 (very high), where lower scores indicated lower implementation effort and risk. Projects with the lowest combined effort and risk were assigned higher implementation priority. This approach supports systematic decision-making by identifying feasible improvement initiatives to strengthen manufacturing flexibility and operational responsiveness. Table 4 presents the proposed improvement projects, their effort–risk scores, and corresponding implementation priorities.

Table 4. Prioritized Supply Chain Improvement Projects

Project	Proposed Improvement	SCOR Metric	Effort	Risk	Priority
P1	Improve organic product awareness	AG.3.32	2	1	Second
P2	Conduct operational condition assessments	AG.3.38	1	1	First
P3	Strengthen production planning expertise	AG.3.38	1	1	First
P4	Enhance operational supervision	AG.3.38	2	1	Second
P5	Improve demand forecasting accuracy	AG.3.38	1	1	First
P6	Provide technology training for partner farmers	AG.3.38	2	1	Second

Table 3 presents the prioritization of six supply chain improvement projects based on their estimated implementation effort and risk. Projects P2 (Operational Condition Assessment), P3 (Production Planning Expertise), and P5 (Demand Forecasting Improvement) were classified as first-priority initiatives, each receiving the lowest effort and risk scores of 1. These projects directly address the manufacturing flexibility gap associated with AG.3.38 by strengthening operational assessment, production planning, and demand forecasting capabilities. Meanwhile, P1 (Product Awareness), P4 (Operational Supervision), and P6 (Technology Training for Partner Farmers) were assigned second priority, with effort scores of 2 and risk scores of 1. From a managerial perspective, prioritizing demand-driven production planning and systematic operational monitoring could improve alignment between production output and customer requirements, thereby reducing potential production surpluses. Furthermore, strengthening workforce coordination and communication with partner farmers may enhance supply chain adaptability. This effort–risk prioritization provides a structured basis for selecting feasible improvement initiatives; however, their effectiveness requires further evaluation following implementation.

3.5 Discussion of Supply Chain Agility and Improvement Strategies

The findings indicate that manufacturing flexibility is a critical factor affecting supply chain agility at CV Tani Organik Merapi. The SCOR version 12.0 assessment identified AG.2.2 (Downside Flexibility—Make) as the primary area requiring improvement, particularly in aligning production activities with changing customer demand. This finding is consistent with Nguyen [14], who examined the application of SCOR-based performance measurement, and Rodríguez Mañay et al. [15], who demonstrated the relevance of SCOR metrics for identifying performance weaknesses in agricultural supply chains. The present study extends these applications by focusing on manufacturing-related agility gaps in organic vegetable production.

The performance assessment identified numerical deviations of 13.00 for AG.3.32 (Number of Orders Shipped) and 43.27 for AG.3.38 (Amount of Each Item Which Is Manufactured) relative to their internal targets. These differences indicate potential misalignment between order fulfillment and production activities, although their operational significance depends on the verified measurement units and target definitions. Opara et al. [6] emphasized the importance of forecasting in reducing postharvest waste, while Beigi Firoozi et al. [9] identified the relationship between supply chain agility, collaborative capabilities, and organizational performance. These findings support the importance of improving demand forecasting, production planning, and operational coordination.

The fishbone analysis identified potential causes of agility performance gaps across five operational categories: Man, Method, Material, Machine, and Environment. Major concerns included limited production planning capabilities, inadequate coordination, inconsistent agricultural input availability, insufficient supporting equipment, and environmental uncertainty. Sharma et al. [17] emphasized the importance of information sharing and technological integration in strengthening agri-food supply chain resilience. Similarly, Ramos et al. [16] highlighted the role of supply chain agility and information integration in sustainable performance measurement. These studies support the need for coordinated improvements in production planning, resource management, and information exchange among supply chain actors.

The effort–risk assessment identified operational condition assessments (P2), production planning expertise (P3), and demand forecasting improvements (P5) as first-priority initiatives, each receiving effort and risk scores of 1. Meanwhile, product awareness (P1), operational supervision (P4), and technology training for partner farmers (P6) were classified as second-priority initiatives, with effort scores of 2 and risk scores of 1. These priorities emphasize feasible improvements in manufacturing flexibility and operational coordination. The proposed initiatives are consistent with the importance of evidence-based forecasting discussed by Opara et al. [6] and integrated performance improvement approaches examined by Ramos et al. [16]. However, their effectiveness requires verification through subsequent implementation and performance evaluation.

The principal contribution of this study lies in integrating hierarchical SCOR agility metrics, fishbone-based root cause analysis, and effort–risk prioritization within the SCOR Racetrack framework. This integration establishes a structured diagnostic pathway connecting operational performance gaps, potential contributing factors, and improvement priorities. Unlike assessments focusing primarily on performance measurement, the proposed approach links quantitative diagnosis with managerial decision-making in organic vegetable production. Nevertheless, the study is limited to a single enterprise and historical operational data from January to August 2025. Further verification of measurement units, internal targets, and normalization parameters is necessary to strengthen the reliability of performance interpretations. Future research should involve multiple enterprises and post-implementation assessments to validate the effectiveness and applicability of the proposed improvement strategies.

4. Conclusion

This study identified supply chain agility performance gaps in organic vegetable production using the SCOR Racetrack framework, with CV Tani Organik Merapi as a case study. The findings revealed that manufacturing flexibility (AG.2.2) represented the primary area requiring operational improvement. The performance assessment identified numerical deviations of 13.00 in AG.3.32 (Number of Orders Shipped) and 43.27 in AG.3.38 (Amount of Each Which Are Manufactured) relative to internal company targets. Root cause analysis indicated that demand uncertainty, inadequate production planning, limited planning expertise, insufficient operational supervision, and communication constraints contributed to production–demand mismatches. These findings demonstrate the usefulness of hierarchical SCOR metrics for identifying operational weaknesses and supporting structured supply chain performance assessment. The SCOR Racetrack analysis identified six improvement initiatives, with operational assessments, production planning expertise, and demand forecasting accuracy classified as the highest priorities based on implementation effort and risk. The study provides practical recommendations for strengthening production adaptability, improving operational coordination, and reducing potential production surpluses in organic vegetable supply chains. However, the findings are limited to a single enterprise and historical operational data, while inconsistencies in measurement units require further verification. Future research should incorporate updated operational datasets, standardized performance indicators, and post-implementation evaluations to validate the effectiveness of the proposed improvement strategies.

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