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RESEARCH ARTICLE

The application of SCOR and DEMATEL models for assessing agricultural supply chain risks: a case study in the Mekong Delta

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ABSTRACT

Agricultural products are major contributors to economic growth and food security in Vietnam. In the Mekong Delta region, agricultural products offer developmental benefits, but not without risks and challenges. Thus, this study identified risks, impacts, and the importance of the agricultural supply chain (ASC) in the Mekong Delta. The study combined qualitative and quantitative methods to review relevant domestic and international literature for data retrieval. Subsequently, the SCOR model was used to identify ASC risk factors, whereas the DEMATEL model was adopted to determine the importance of the identified risks. A total of 17 existing ASC risks in the Mekong Delta were identified in this study. Among the risks, “Planning for production, transportation, and delivery”, “Loss of agricultural products due to damage and quality degradation” and “Non-standard goods” were the most significant concerns in this study. In contrast, the respondents were less concerned about risks such as “Shortage of skilled labour and lack of access to experts” and “Purchasing cultivation seeds”. Meanwhile, “Shortage of skilled labour and lack of access to experts” and “Damaged machinery, production, and vehicles” were the highest rated impacts in this study. Finally, “Increased operating costs” was the most significantly affected risk factor for the respondents. In conclusion, these findings serve as a foundation for deeper investigations studies in ACS, particularly in Vietnam.

1. INTRODUCTION

Food security is a complex issue that varies across different regions. Global factors, such as climate change, emerging diseases, and political challenges, significantly impact food production and quality (Khaled et al., 2024). The agricultural sector plays a crucial role in food security, particularly in developing countries (Pawlak & Kołodziejczak, 2020; Mukhlis & Gürçam, Özlem, 2022). As the population in this region depends heavily on agricultural products for food availability, the agricultural supply chain (ASC) has become a pillar for maintaining economic stability and food security. This complex network encompasses various stages from production to distribution, each facing unique challenges and opportunities (Fang & Wang, 2024; Fang & Zhang, 2024).

The ASC refers to organised activities and processes involved in the production of agricultural products, from sourcing raw materials to delivering finished goods to consumers (Krishan, Beriwal, 2022). In a similar vein, the ASC is described by Atiye, Tumenbatur et al. (2022) as a network that links producers, suppliers, and logistics firms engaged in the manufacturing, processing, and distribution of agricultural goods for efficient product delivery. According to Ray (2021), the interconnected processes involved in the production, processing, distribution, and consumption of agricultural products include cultivation, harvesting, storage, transportation, and retailing, while addressing challenges like perishability, seasonality, and bulkiness.

The coordination and integration of several processes in the production, processing, and distribution of agricultural goods is known as ASC management (Guo & Wei, 2021; Alkahtani et al., 2021). This process involves monitoring the flow of agricultural products from production to consumption and integrating financial models to mitigate risks, such as credit, operational, technical, and legal risks within the supply chain (Yang et al., 2022). Optimising procurement, production, and sales using advanced technology, resource support, and the development of a structured system contributes to the efficient flow of goods and services from production to consumption (Liu et al., 2022).

The Mekong Delta is well known for agriculture, which is essential for national food security and offers significant development potential. This region is one of the largest and most fertile plains in Vietnam and Southeast Asia, with an extensive river and canal system that supports agricultural product growth. Despite the advantages and strategic development plans, the Mekong Delta faces significant challenges, particularly in economic revival post-Coronavirus disease 2019 (COVID-19). Logistics costs are the highest in Vietnam, at 30% of product costs (VLA, 2022; Tung, 2022) due to an uncoordinated system, weak intermodal connections, inadequate seaport facilities, and limited inland waterway transport. Professional logistics companies are also limited, with most being agricultural enterprises managing logistics infrastructure. This situation further increases costs and reduces competitiveness. Infrastructure is also weaker in the Mekong Delta than in other regions; the expressway system is at only 6.7% of the national system, while inland waterway investments are poorly coordinated. Additionally, this region lacks satellite systems, empty container yards, port warehouse systems, hub logistics centres, and food safety inspection units.

Numerous studies have investigated ASC risks in Vietnam. Tran et al. (2022) reported that ASC risks negatively impacted collaboration among stakeholders, including direct interactions and indirect factors such as commitment and opportunistic behaviour. Nguyen et al. (2019) stated that ASC risks are mediated by trust and supply chain connections, which can lead to significant losses for businesses. Van Kiem & Huong (2023) emphasised that building a circular supply chain in the agricultural sector faces risks, such as resource consumption, environmental impacts, and market entry barriers for small and medium enterprises in Vietnam. Other factors that affect ASC locally are challenges related to the regulatory and policy environment, quality control and food safety standards, logistics and infrastructure issues, market dynamics, technology adoption and innovation, supply chain collaboration, and environmental concerns (Nguyen & Dang, 2024).

Although the ASC risks have been identified in the Mekong Delta, studies on specific risks and the significant impacts are limited. Therefore, this study combined qualitative and quantitative methods and integrated the Supply Chain Operation Reference (SCOR) model to identify risks and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) model to analyse the importance of these risks to ASC. The findings can provide solutions to enhance the sustainability and stability of the ASC in this region.

2. THEORETICAL FRAMEWORK

2.1. SCOR model

The SCOR model is a standardised tool designed to manage and evaluate supply chain performance processes, interactions, and performance. The framework maximises supply chain visibility and efficiency by organising dynamic connections throughout the entire supply chain (Pourreza et al., 2022; Gonzalez-Pascual et al., 2021; Fu et al., 2024). Developed in 1996 by PRTM and later endorsed by the Supply Chain Council (SCC), the SCOR model is now updated to the 11th version. Figure 1 illustrates the five management processes in this model: Plan, source, make, deliver, and return (Ntabe et al., 2015; Ricardo, López-Lucas et al., 2024). These strategies aid organisations in identifying demand, managing production, distributing products, and handling returns.

The SCOR model consists of four hierarchical levels. Level 1 identifies core processes, level 2 categorises these processes into activities (sub-processes), level 3 details specific activities, and level 4 breaks down activities into tasks (Rodríguez Mañay et al., 2022). Performance, processes, practices, and people are the four components of the SCOR model. Strategic goals are guided by performance criteria, which include responsiveness, cost, agility, and assets. The model serves as a cross-industry standard for supply chain management, continually updated to reflect industry needs, and emphasises balanced decision-making through a scorecard featuring metrics for each performance attribute (Ayyildiz & Taskin Gumus, 2021).

The adoption of Big Data Analytics (BDA) is also convenient using the SCOR model, as the framework facilitates the analysis and improvements in supply chain operations (Chehbi-Gamoura et al., 2020). Businesses can evaluate their performance standards and competitiveness in price, quality, delivery, and flexibility (Divsalar et al., 2020), identify improvement opportunities, and enhance workflow efficiency, particularly when combined with multi-criteria decision-making methods (Rodríguez Mañay et al., 2022). Furthermore, the SCOR model aids in identifying logistical inefficiencies and enables the design of strategies for performance enhancement through relevant and easily comprehensible metrics (Gonzalez-Pascual et al., 2021).

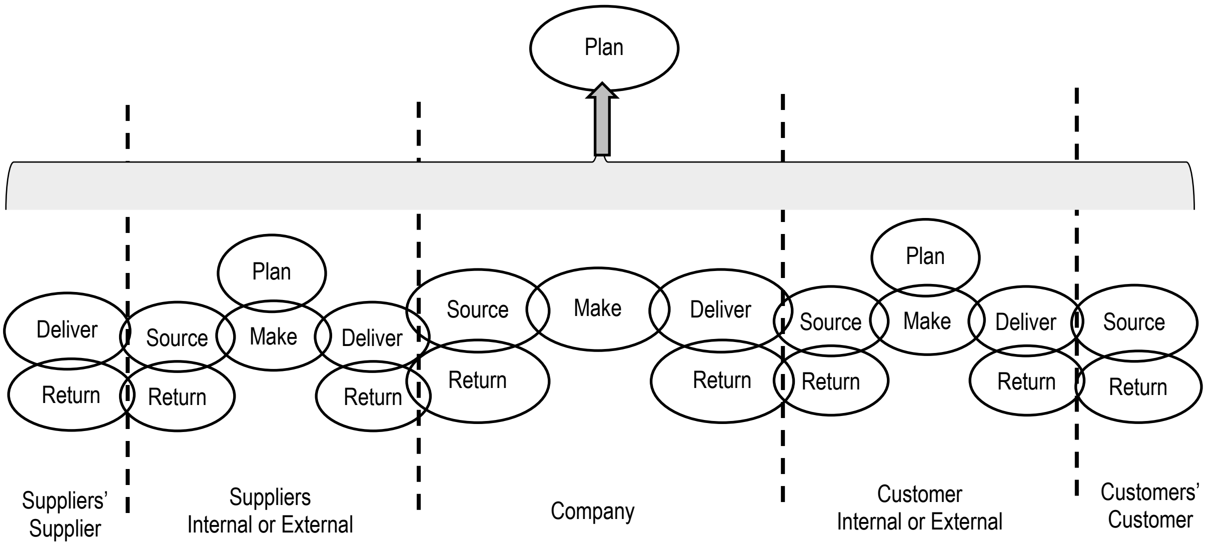

Figure 1: Management processes based on the SCOR model.
Source: Supply Chain Council (2010), SCOR® Version 10.0

2.2. DEMATEL model

The DEMATEL method was developed by the Battelle Memorial Institute through research conducted at the Geneva Research Centre (Gabus & Fontela, 1973; dos Santos Soares et al., 2023). This analytical method is used to examine causal relationships among criteria by employing directed graphs to represent the influence levels of various factors in complex systems (Sundareswaran et al., 2022; dos Santos Soares et al., 2023). The direct and total relation matrices determine the degree of mutual influence between criteria and categorise the factors into different causal groups, thereby transforming complex relationships into a comprehensible structural model (Kashyap et al., 2022; Nilashi et al., 2024; Huang et al., 2024).

DEMATEL stands out in the ability to analyse factors with multidimensional influence by processing bidirectional relationships. In research, this method is used to solve complex decision-making problems with interconnections between key factors, thus clarifying the system structure and optimising operational processes. For instance, this method is used to analyse barriers in aluminium production to optimise processes and improve sustainability (Li et al., 2024). The DEMATEL method can also be combined with other methods, such as sensitivity analysis, to test model certainty and improve analytical outcomes (Kashyap et al., 2022). This model can handle uncertain data, particularly when utilised with other methods such as fuzzy logic and decision trees, which enhance accuracy and efficiency in evaluating supply chain performance (Nilashi et al., 2024).

The DEMATEL has notable limitations that can influence the application and outcomes. Firstly, this method relies on expert evaluations to assess relationships and influences between factors, which introduces subjectivity and potential biases into the analysis. These biases may stem from varying backgrounds, experiences, or preconceptions of the experts, potentially skewing the influence relation structure diagram and the weights assigned to criteria (Zhu et al., 2022; Zou et al., 2022). Therefore, the effectiveness of this method depends heavily on the quality, diversity, and expertise of the selected panels, which can vary widely and affect result consistency (Li et al., 2020). In the present study, a diverse panel of 12 experts from different roles (producers, transporters, distributors) were recruited to mitigate bias, and multiple consultation rounds were conducted to cross-validate responses. Nevertheless, the complete elimination of subjectivity remains challenging.

Another factor that hampers DEMATEL implementation and interpretations is the complexity in handling interdependent factors, particularly in large-scale applications with numerous criteria (Du, 2022; Zou et al., 2022). The accuracy also hinges on the availability of comprehensive and reliable data, which is often limited in dynamic and uncertain contexts such as the Mekong Delta ASC (Zhu et al., 2022; dos Santos Soares et al., 2023). Other limitations include sensitivity to the number of factors analysed, where too many factors may dilute focus, while too few may oversimplify the system. Moreover, the model cannot fully capture the temporal dynamics of risks. Future studies could address these issues by integrating DEMATEL with objective data-driven methods (machine learning) or expanding the expert pool to enhance representativeness and reduce bias.

2.3. ASC risks

The ASC risks are multifaceted and can significantly impact the efficiency and sustainability of agri-food systems. Numerous studies have identified factors influencing ASC risks. Waqas et al. (2023) classified ASC risks into sector-specific risks (supply, demand, and processes) and general environmental risks (political instability, macroeconomic factors, and natural disasters). These risks significantly affect the performance of agribusinesses, particularly in the fresh produce sector, as the products are perishable. Similarly, Imbiri et al. (2021) stated that ASC risks include various challenges arising from global and local factors, which significantly impact logistics and business processes. Furthermore, factors such as weather, demand fluctuations, logistics, infrastructure issues, regulatory and policy-related risks, financial instability, biological threats, and environmental challenges are among the key elements affecting ASC risks (Yazdani et al., 2021).

Global warming, natural disasters (landslides, floods), and human-induced factors are key disruptors of ASC in emerging countries (Clavijo-Buritica et al., 2023). Meanwhile, insufficient information flow, logistical inefficiencies, inadequate infrastructure and storage facilities, and the absence of risk mitigation systems can lead to significant disruptions, exacerbating the severity of food insecurity and sustainability issues (Ray et al., 2021). In a study conducted by Kuizinaitė et al. (2023), 11 major risks in ASCs were identified, including natural disasters, labour strikes, changes in government regulations, supply chain disruptions due to social or political instability, short-term raw material shortages, seasonality, food safety incidents, lack of connectivity among chain participants, and market and pricing strategies affected by economic crises. As ASCs are vulnerable to resource scarcity, climate change, and waste generation, immediate and innovative action from stakeholders is required to enhance resilience, such as the implementation of digital technologies (Joshi et al. 2023).

3. RESEARCH METHOD

This study utilised qualitative and quantitative methods. Relevant domestic and international data sources were synthesised using the qualitative method to identify risk factors for agricultural products in the Mekong Delta. Meanwhile, a quantitative tool (surveys) was distributed to participants for data collection, followed by data analysis to establish and identify the risk factors that significantly influence agricultural products in this region.

Participants in the ASC, including experts in the field, transporters, producers, and distributors in the Mekong Delta region, were interviewed in this study. The information gathered is synthesised to identify the risk factors affecting the ASC.

3.1. SCOR and DEMATEL models

The study uses the SCOR and DEMATEL models to identify risks and assess the importance of risks in the ASC. The analysis process is divided into two stages:

Stage 1: The SCOR model was used to identify ASC risks in the ASC, as proposed by earlier studies with modifications (Tham & Phong, 2024; Huan et al., 2004):

Step 1: Existing risks were identified through five activities in the supply chain (Plan, Source, Make, Deliver, and Return).

Step 2: Once the risks were identified, experts in the field were consulted.

Step 3: The risks were adjusted to determine the most relevant ones.

Stage 2: The DEMATEL model was used to assess the ACS risks in five steps (Kashyap et al., 2022; Nilashi et al., 2024; Hien & Mai, 2022):

Step 1: The direct influence matrix was identified by experts, where M represented the number of experts who evaluated the mutual influence of n risks, and X_{ij} refers to the level of influence of risk i on risk j. Experts rated the risks using a scale of 0 to 4 (0: no influence; 1: slight influence; 2: moderate influence; 3: strong influence; and 4: very strong influence). The experts' evaluations were represented by a matrix in the form of n×n, as follows:

$$X^k = \begin{bmatrix} 0 & \cdots & X^k_{1n} \\ \vdots & \ddots & \vdots \\ X^k_{n1} & \cdots & 0 \end{bmatrix} \qquad (1)$$

Where Xk is the matrix determined by expert k (k = 1, 2,...M).

Step 2: The average matrix (direct relationship matrix) was calculated using the following formula:

$$A= \left[a_{ij}\right]nxn = \begin{bmatrix} 0 & \cdots & \frac{1}{M}\sum_k^M X^k_{1n} \\ \vdots & \ddots & \vdots \\ \frac{1}{M}\sum_k^M X^k_{n1} & \cdots & 0 \end{bmatrix} \qquad (2)$$

Where A is the average matrix.

Step 3: The direct relationship matrix was normalised, and the normalised matrix D was calculated as follows:

$$D = \left[d_{ij}\right]nxn = \frac{A}{S} \qquad (3)$$

Where S is the largest value of the sum of the rows and columns in A.

$$S = (\max(\max_{1\leq i\leq n} \textstyle\sum_j^n a_{ij}, \max_{1\leq i\leq n} \sum_i^n a_{ij})) \qquad (4)$$

Step 4: The total influence matrix, G, was calculated using equation 5.

$$G = Dx(I-D)^{-1} \tag{5}$$

Where I is the identity matrix.

Step 5: The threshold value was determined, and a relationship map was constructed.

Suppose that n and c are n×1 and 1×n vectors representing the sum of the rows and the sum of the columns of the matrix G. The direct and indirect influence caused by factor i is denoted as ri. The direct and indirect influence of factor j is denoted as cj. When i = j, the total (ri + cj) represents the importance level of factor i. Conversely, (ri-cj) represents the causal relationship between the factors. If (ri-cj) > 0, i becomes the causal factor; if (ri-cj) < 0, then i represents the effect factor.

3.2. Data collection

All respondents (N = 12) were selected carefully based on well-defined criteria to ensure the credibility of the DEMATEL analysis. Firstly, each expert has at least five years of hands-on experience in the ASC of the Mekong Delta. Secondly, they represent key roles across the supply chain, including producers (farmers managing cultivation and harvesting), transporters (logistics providers handling product movement), distributors (wholesalers and retailers connecting producers to markets), and agricultural specialists (consultants or researchers with expertise in ASC operations).

Lastly, all experts are actively involved in decision-making processes related to production, logistics, or risk management. Their diverse roles ensured a comprehensive assessment that aligns with the five core processes of the SCOR model. Expert insights were gathered through structured interviews and pairwise comparison surveys, with two rounds of consultations conducted to address discrepancies and refine the findings. This iterative approach, along with a diverse panel, strengthened the reliability and depth of the risk assessment.

4. RESULTS

4.1. Risks identification

Based on the SCOR model and relevant studies (Divsalar et al., 2020; Ricardo, López-Lucas et al., 2024; Fu et al., 2024; Tham & Phong, 2024; Huan et al., 2004), this study identified 17 risks related to the ASC in the Mekong Delta (see Table 1). There were three main activities in the "Plan" and "Source" processes, each associated with three risk factors. In the "Make" process, there are three main activities and four corresponding risks. The "Delivery" process comprised two main activities and four risks. Finally, the "Return" process has one main activity and three risks in the chain. These findings highlighted the multiple risks in the ASC in the Mekong Delta that can affect the outcomes and efficiency of the entire chain.

Table 1: ASC risks in the Mekong Delta.

Process	Activities in the supply chain	Risk factors	Encoding
Plan	Planting and cultivating agricultural products	Risk in purchasing cultivation seeds	R1
	Production, transportation, and storage costs	Inaccurate cost forecasting	R2
	Planning for production, transportation, and delivery	Risk in planning for production, transportation, and delivery	R3
Source	Investment capital	Lack of financial support for production, business, and distribution	R4
	Storage for agricultural products	Loss of agricultural products (damage, quality degradation)	R5
	Linkage with buyers	Shortage of skilled labor and lack of access to experts	R6
Make	Packaging and preserving products	Non-standard goods	R7
	Inappropriate production processes and methods	Increased operating costs	R8
	Production sites, warehouses, and post-production workplaces	Non-standard warehouses	R9
		Damaged machinery, production, and transportation vehicles	R10
Delivery	Determining the timing for harvesting and transportation	Prolonged delivery times or delayed delivery schedules	R11
	Managing collaborative relationships with buyers and distributors	Products damaged during delivery	R12
		Accidents and delays occurring during the delivery process	R13
		Delayed payments from consumers	R14
Return	Return of non-compliant products	Return of defective products that cannot be repaired	R15
		Errors in delivery	R16
		Poor contract/agreement with consumers	R17

4.2. Establishing the matrices

After the experts compared the pairs of criteria, a response matrix was constructed. The size of the matrix reflects the number of observers. As this study recruited 12 respondents, a 12 matrix was established. Each expert's evaluation corresponds to an n×n square matrix (based on formula (1)), where n is the number of observed variables.

Subsequently, formula (2) is applied to calculate the average matrix. The results obtained are presented in Table 2. The initial direct relationship matrix D is determined as follows (based on formulas (3) and (4)) (see Table 3).

Table 2: Average Matrix A

Factor	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17
R1	0.0000	1.1667	2.0000	1.1667	2.7500	0.9167	3.3333	1.8333	1.0833	0.6667	1.5000	1.4167	1.3333	0.9167	1.8333	1.8333	1.1667
R2	2.3333	0.0000	2.9167	3.3333	1.5833	1.6667	1.7500	2.9167	1.8333	1.3333	1.3333	0.9167	1.1667	1.9167	2.0000	1.3333	1.3333
R3	1.9167	2.3333	0.0000	2.0833	2.6667	1.8333	2.9167	3.0000	2.2500	1.8333	3.0000	2.5000	2.4167	1.8333	2.3333	2.5833	1.6667
R4	2.5833	2.3333	2.2500	0.0000	1.5000	1.3333	2.3333	2.1667	1.9167	2.0000	2.6667	1.0833	1.8333	1.5833	1.3333	1.6667	1.5000
R5	1.6667	1.5000	2.3333	1.4167	0.0000	0.9167	3.0833	2.4167	1.5833	1.0000	3.1667	2.5833	2.7500	2.2500	2.8333	2.0833	2.4167
R6	1.7500	2.0000	2.5833	1.5833	2.0833	0.0000	3.0000	2.1667	1.5833	1.6667	2.0833	2.0833	1.5000	1.0833	1.4167	1.7500	1.7500
R7	1.4167	1.5833	2.1667	1.5000	3.0000	1.3333	0.0000	2.2500	1.1667	1.2500	2.8333	2.8333	1.4167	2.0833	2.3333	1.8333	2.6667
R8	1.9167	2.8333	2.5000	2.7500	1.5833	1.4167	1.3333	0.0000	1.4167	1.5833	2.3333	1.5833	1.3333	1.0000	1.0833	1.0000	1.4167
R9	1.0833	0.6667	1.5833	0.8333	3.1667	1.2500	2.9167	2.5000	0.0000	1.6667	2.5833	1.8333	1.4167	1.0833	2.2500	1.6667	1.5833
R10	1.4167	2.0000	2.2500	1.2500	2.4167	1.3333	2.6667	3.1667	1.8333	0.0000	2.8333	2.3333	1.7500	1.0000	1.5833	2.1667	1.7500
R11	1.0000	1.1667	2.5000	1.7500	2.9167	0.7500	3.1667	2.7500	1.8333	1.2500	0.0000	2.5000	2.0833	1.8333	2.1667	2.0833	1.9167
R12	0.7500	1.5833	2.5000	2.0000	3.1667	1.3333	2.6667	3.0833	1.5000	2.1667	2.9167	0.0000	2.5833	1.7500	2.1667	2.0833	2.0000
R13	1.0000	1.5833	2.6667	1.5000	3.2500	1.500	3.1667	3.0833	1.5833	2.0833	3.0833	2.7500	0.0000	2.2500	2.0833	2.1667	2.0833
R14	1.8333	1.5000	2.0833	3.0000	1.3333	1.1667	0.8333	1.8333	1.0000	0.7500	1.6667	0.9167	0.9167	0.0000	0.7500	1.3333	2.8333
R15	1.1667	1.5000	2.2500	1.3333	3.3333	0.7500	3.3333	2.1667	1.5000	1.4167	2.0833	2.2500	1.9167	2.1667	0.0000	1.5833	2.3333
R16	1.5833	1.9167	2.7500	1.3333	3.0833	1.1667	2.6667	2.6667	1.5000	1.0000	2.8333	2.4167	2.5000	2.3333	2.0833	0.0000	2.1667
R17	1.1667	2.2500	1.9167	1.5000	2.4167	1.3333	1.8333	2.5833	0.8333	1.4167	2.5000	1.5833	1.9167	2.9167	2.3333	2.9167	0.0000

Table 3: Initial Direct Relation Matrix D

Factor	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17
R1	0.0000	0.0285	0.0488	0.0285	0.0671	0.0224	0.0813	0.0447	0.0264	0.0163	0.0366	0.0346	0.0325	0.0224	0.0447	0.0447	0.0285
R2	0.0569	0.0000	0.0711	0.0813	0.0386	0.0407	0.0427	0.0711	0.0447	0.0325	0.0325	0.0224	0.0285	0.0467	0.0488	0.0325	0.0325
R3	0.0467	0.0569	0.0000	0.0508	0.0650	0.0447	0.0711	0.0732	0.0549	0.0447	0.0732	0.0610	0.0589	0.0447	0.0569	0.0630	0.0407
R4	0.0630	0.0569	0.0549	0.0000	0.0366	0.0325	0.0569	0.0528	0.0467	0.0488	0.0650	0.0264	0.0447	0.0386	0.0325	0.0407	0.0366
R5	0.0407	0.0366	0.0569	0.0346	0.0000	0.0224	0.0752	0.0589	0.0386	0.0244	0.0772	0.0630	0.0671	0.0549	0.0691	0.0508	0.0589
R6	0.0427	0.0488	0.0630	0.0386	0.0508	0.0000	0.0732	0.0528	0.0386	0.0407	0.0508	0.0508	0.0366	0.0264	0.0346	0.0427	0.0427
R7	0.0346	0.0386	0.0528	0.0366	0.0732	0.0325	0.0000	0.0549	0.0285	0.0305	0.0691	0.0691	0.0346	0.0508	0.0569	0.0447	0.0650
R8	0.0467	0.0691	0.0610	0.0671	0.0386	0.0346	0.0325	0.0000	0.0346	0.0386	0.0569	0.0386	0.0325	0.0244	0.0264	0.0244	0.0346
R9	0.0264	0.0163	0.0386	0.0203	0.0772	0.0305	0.0711	0.0610	0.0000	0.0407	0.0630	0.0447	0.0346	0.0264	0.0549	0.0407	0.0386
R10	0.0346	0.0488	0.0549	0.0305	0.0589	0.0325	0.0650	0.0772	0.0447	0.0000	0.0691	0.0569	0.0427	0.0244	0.0386	0.0528	0.0427
R11	0.0244	0.0285	0.0610	0.0427	0.0711	0.0183	0.0772	0.0671	0.0447	0.0305	0.0000	0.0610	0.0508	0.0447	0.0528	0.0508	0.0467
R12	0.0183	0.0386	0.0610	0.0488	0.0772	0.0325	0.0650	0.0752	0.0366	0.0528	0.0711	0.0000	0.0630	0.0427	0.0528	0.0508	0.0488
R13	0.0244	0.0386	0.0650	0.0366	0.0793	0.0366	0.0772	0.0752	0.0386	0.0508	0.0752	0.0671	0.0000	0.0549	0.0508	0.0528	0.0508
R14	0.0447	0.0366	0.0508	0.0732	0.0325	0.0285	0.0203	0.0447	0.0244	0.0183	0.0407	0.0224	0.0224	0.0000	0.0183	0.0325	0.0691
R15	0.0285	0.0366	0.0549	0.0325	0.0813	0.0183	0.0813	0.0528	0.0366	0.0346	0.0508	0.0549	0.0467	0.0528	0.0000	0.0386	0.0569
R16	0.0386	0.0467	0.0671	0.0325	0.0752	0.0285	0.0650	0.0650	0.0366	0.0244	0.0691	0.0589	0.0610	0.0569	0.0508	0.0000	0.0528
R17	0.0285	0.0549	0.0467	0.0366	0.0589	0.0325	0.0447	0.0630	0.0203	0.0346	0.0610	0.0386	0.0467	0.0711	0.0569	0.0711	0.0000

Table 4: Total Influence Matrix G.

Factor	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17
R1	0.0928	0.1339	0.1855	0.1354	0.2140	0.0980	0.2280	0.1931	0.1184	0.1034	0.1846	0.1560	0.1429	0.1310	0.1609	0.1563	0.1452
R2	0.1637	0.1241	0.2272	0.2024	0.2085	0.1277	0.2151	0.2400	0.1507	0.1329	0.2023	0.1604	0.1547	0.1678	0.1802	0.1618	0.1649
R3	0.1795	0.2082	0.2026	0.2058	0.2794	0.1534	0.2867	0.2880	0.1873	0.1701	0.2845	0.2339	0.2167	0.1995	0.2239	0.2239	0.2085
R4	0.1698	0.1790	0.2159	0.1278	0.2118	0.1215	0.2322	0.2279	0.1543	0.1493	0.2353	0.1682	0.1722	0.1634	0.1691	0.1726	0.1717
R5	0.1624	0.1774	0.2403	0.1788	0.2024	0.1240	0.2730	0.2580	0.1611	0.1415	0.2715	0.2226	0.2120	0.1983	0.2222	0.2008	0.2130
R6	0.1519	0.1737	0.2255	0.1664	0.2274	0.0913	0.2493	0.2304	0.1482	0.1438	0.2257	0.1933	0.1676	0.1545	0.1736	0.1766	0.1796
R7	0.1492	0.1704	0.2244	0.1714	0.2563	0.1265	0.1890	0.2410	0.1438	0.1391	0.2509	0.2166	0.1732	0.1847	0.2008	0.1854	0.2079
R8	0.1457	0.1797	0.2070	0.1805	0.1965	0.1157	0.1939	0.1621	0.1341	0.1316	0.2121	0.1655	0.1498	0.1388	0.1511	0.1457	0.1566
R9	0.1287	0.1352	0.1928	0.1403	0.2415	0.1142	0.2370	0.2265	0.1037	0.1368	0.2269	0.1804	0.1585	0.1473	0.1842	0.1664	0.1687
R10	0.1499	0.1805	0.2273	0.1661	0.2446	0.1274	0.2513	0.2626	0.1598	0.1103	0.2521	0.2070	0.1806	0.1597	0.1848	0.1928	0.1871
R11	0.1404	0.1618	0.2323	0.1770	0.2558	0.1142	0.2619	0.2529	0.1593	0.1401	0.1881	0.2109	0.1884	0.1795	0.1979	0.1912	0.1921
R12	0.1443	0.1821	0.2466	0.1936	0.2755	0.1349	0.2661	0.2756	0.1617	0.1694	0.2694	0.1654	0.2105	0.1881	0.2090	0.2025	0.2052
R13	0.1548	0.1878	0.2579	0.1889	0.2860	0.1429	0.2852	0.2840	0.1684	0.1722	0.2812	0.2354	0.1573	0.2052	0.2139	0.2107	0.2140
R14	0.1316	0.1363	0.1784	0.1714	0.1700	0.0995	0.1609	0.1835	0.1110	0.1004	0.1774	0.1334	0.1256	0.1013	0.1272	0.1383	0.1732
R15	0.1418	0.1662	0.2232	0.1652	0.2610	0.1122	0.2616	0.2361	0.1492	0.1410	0.2323	0.2021	0.1817	0.1847	0.1451	0.1776	0.1989
R16	0.1613	0.1871	0.2499	0.1777	0.2717	0.1300	0.2636	0.2637	0.1597	0.1414	0.2644	0.2187	0.2068	0.1999	0.2058	0.1524	0.2073
R17	0.1431	0.1839	0.2170	0.1707	0.2396	0.1254	0.2279	0.2454	0.1347	0.1407	0.2401	0.1860	0.1812	0.2013	0.1974	0.2064	0.1447

4.3. Determination of threshold value and construction of relationship map

Figure 2 illustrates the causal relationship map of ASC risks in the Mekong Delta, where the x-axis represents the level of importance (r + c) and the y-axis indicates the level of influence (r - c). Risks above the r - c = 0 line (R6, R10, R13, R16, R9, R12) are classified as "cause" factors, exerting influence on other risks. Meanwhile, risks below (R3, R5, R7, R8, R11, R14) are "effect" factors, primarily impacted by other risks.

The R6 and R10 indirectly amplify "Loss of agricultural products" (R5, r - c = -0.5827) by hindering timely harvesting and transportation, increasing the risk of spoilage in the humid climate of the Mekong Delta. These relationships are visually represented in Figure 2, where the impacts of R6 and R10 on R8, R7, and R5 highlight the cascading effects. This analysis underscored the necessity of addressing root causes (R6 and R10) to mitigate impacts on critical risks (R8, R7, and R5), thereby enhancing the overall ASC resilience.

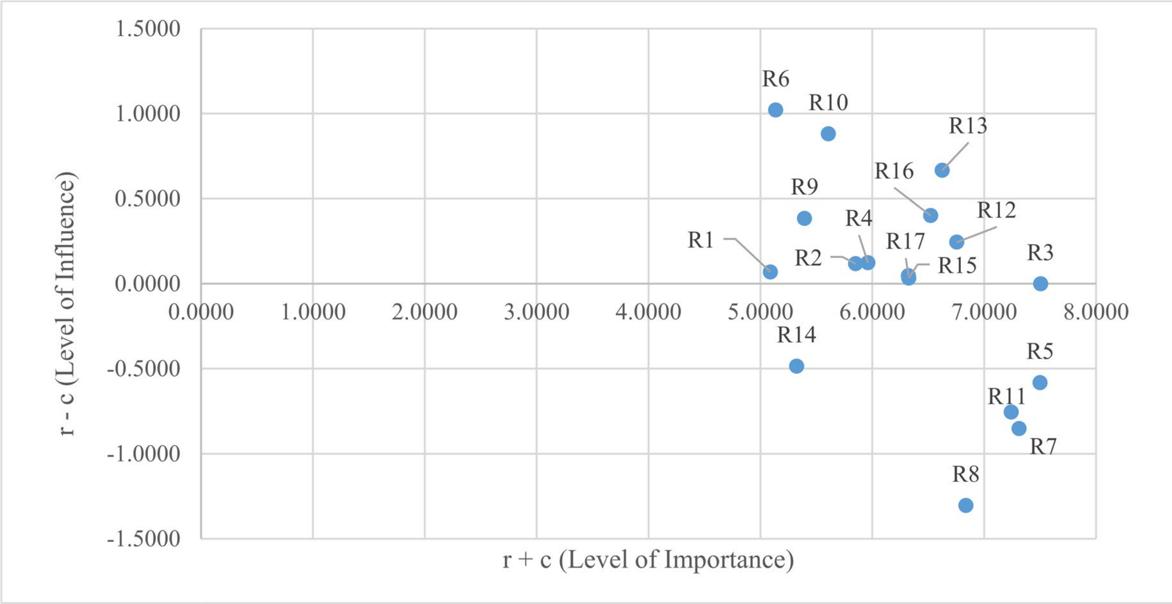

Figure 2: Level of importance and the causal relationship between risks.

Among all risks, "Risk in planning for production, transportation, and delivery" (R3) ranked highest in importance (r + c = 7.5057), followed by "Loss of agricultural products (damage, quality degradation)" (R5, r + c = 7.5013) and "Non-standard goods" (R7, r + c = 7.3133). Nevertheless, "Shortage of skilled labour and lack of access to experts" (R6, r - c = 1.0200) and "Damaged machinery, production, and transportation vehicles" (R10, r - c = 0.8799) emerged as the strongest causal factors despite ranking lower in importance (16th and 13th, respectively).

The causal relationships revealed significant interdependencies among risks. For instance, "Shortage of skilled labour (R6) directly contributed to the increase in "Operating costs" (R8, r - c = -1.3044), the most affected risk. This finding can be explained by the limitations in efficient resource management, and a lack of operational expertise led to higher labour and error-related costs. Similarly, "Damaged machinery" (R10) exacerbated R8 by causing production delays and increasing maintenance expenses while also impacting "Non-standard goods" (R7, r - c = -0.8521) due to inconsistent production quality resulting from equipment failures (see Table 5).

"Risk in planning for production, transportation, and delivery" (R3) emerged as the most significant risk (r + c = 7.5057), aligning with previous ASC studies. The prominence of this risk poses distinct regional challenges in the Mekong Delta. Waqas et al. (2023) reported that inefficient planning is harmful to fresh produce supply chains due to fluctuating demand and product perishability. Likewise, Yazdani et al. (2021) emphasised logistics-related risks in agricultural sectors with underdeveloped infrastructure. In the Mekong Delta, poor R3 is largely driven by a fragmented logistics network, where transportation costs are as high as 30% of product value (VLA, 2022), weak intermodal connections, and heavy reliance on inland waterways, which contribute to unsystematic production coordination and delivery.

Unlike "Loss of agricultural products" (R5) or "Non-standard goods" (R7), which are consequences further down the chain, R3 represents a fundamental bottleneck, exacerbating risks such as "Delivery delays" (R11) and "Rising costs" (R8). This finding is supported by Ray et al. (2021), who revealed that poor planning intensifies logistical inefficiencies in ASCs. The significant R3 ranking

Table 5: Consolidated results of the importance and influence levels of risks.

No	Risk factors	Code	r + c	Level of importance	r - c	Level of influence
1	Risk in purchasing cultivation seeds	R1	5.0903	17	0.0685	9
2	Inaccurate cost forecasting	R2	5.8517	12	0.1171	8
3	Risk in planning for production, transportation, and delivery	R3	7.5057	1	-0.0019	12
4	Lack of financial support for production, business, and distribution	R4	5.9614	11	0.1226	7
5	Loss of agricultural products (damage, quality degradation)	R5	7.5013	2	-0.5827	14
6	Shortage of skilled labour and lack of access to experts	R6	5.1376	16	1.0200	1
7	Non-standard goods	R7	7.3133	3	-0.8521	16
8	Increased operating costs	R8	6.8372	5	-1.3044	17
9	Non-standard warehouses	R9	5.3945	14	0.3837	5
10	Damaged machinery, production, and transportation vehicles	R10	5.6079	13	0.8799	2
11	Prolonged delivery times or delayed delivery schedules	R11	7.2426	4	-0.7550	15
12	Products damaged during delivery	R12	6.7557	6	0.2441	6
13	Accidents and delays occurring during the delivery process	R13	6.6255	7	0.6661	3
14	Delayed payments from consumers	R14	5.3244	15	-0.4856	13
15	Return of defective products that cannot be repaired	R15	6.3270	9	0.0328	11
16	Errors in delivery	R16	6.5228	8	0.4000	4
17	Poor contract/agreement with consumers	R17	6.3241	10	0.0469	10

highlighted the urgent need for better and integrated planning solutions that account for the unique geographical and infrastructural conditions in the Mekong Delta.

5. IMPLICATIONS AND RECOMMENDATIONS

5.1. Implications

This work enhances the theoretical context of supply chain risk management by utilising the SCOR and DEMATEL to evaluate ASC risks. In addition, this study shed light on risk identification, classification, and the interrelations between ASC risks in the Mekong Delta. The study findings added to the body of knowledge on supply chain management by adopting these models to systematically assess the dynamic and interdependent nature of chain risks. This study is valuable for enhancing the resilience and efficiency of ASCs in the Mekong Delta. Using the SCOR and DEMATEL models, it presents a systematic method of identifying performing and prioritizing supply chain risks.

Production planning, product quality, and delivery inefficiencies are revealed as critical ASC risks in this study. Furthermore, combating underlying causes, such as workforce shortages and machinery failures through worker training, preventative maintenance and newer technologies are crucial in mitigating ASC risks. These findings can benefit stakeholders along the ASC, including farmers, suppliers, logistics service providers, and policymakers. Industry leaders can also make informed decisions and design supportive policies, strengthen infrastructure, and promote collaboration based on these findings. These improvements can contribute to the development of sustainable ASC management and improve the competitiveness and resilience in the Mekong Delta.

5.2. Recommendations

Targeting key risks: Stakeholders should remediate major risks by advancing planning tools for production and delivery (R3), improving storage and cold chain systems to prevent spoilage (R5), and tightening quality control measures to standardise goods (R7). Logistics can also be optimised through route planning (R11), improved packaging and handling to minimise damage on delivery (R12), and reduce operating costs by practising lean management (R8).

Targeting high-impact root causes: High-impact root causes can be addressed through training programmes to close gaps in labour supply and better access to experts (R6). Collaborating with academic institutions and industry experts could also improve workforce capabilities. Preventive maintenance programmes, along with modern machinery adoption, can prevent damaged equipment (R10) risks, to minimise disruption in production and transportation.

Prepare a comprehensive system to reduce the overall impact: A risk prioritisation map can help identify areas to invest time and effort by considering the importance and impact of risk-related arguments. Technologies such as blockchain can be utilised in integrated risk management systems to enhance transparency and enable real-time monitoring. Nonetheless, advancing these technologies and infrastructures alongside a skilled workforce requires supportive policies and financial resources, which will contribute to developing resilient and sustainable supply chains in the Mekong Delta.

6. CONCLUSION

This study leverages the SCOR and DEMATEL models to identify and evaluate ASC risks in the Mekong

Delta. A total of 17 distinct risks were identified, where “Risk in planning for production, transportation, and delivery” (R3), “Loss of agricultural products” (R5), and “Non-standard goods” (R7) were the most significant risks. Meanwhile, “Shortage of skilled labour and lack of access to experts” (R6) and “Damaged machinery, production, and transportation vehicles” (R10) were the strongest causal influences despite lower importance rankings. Notably, these root causes drive “Increased operating costs” (R8) as the most affected risk.

This study provides a critical foundation for understanding ASC risks in the Mekong Delta, contributing theoretical insights and practical implications for risk management. Future research could expand the sample size and diversity by incorporating more stakeholders (policymakers, consumers) to enhance the generalisability of the findings. Additionally, exploring the temporal dynamics of risks using longitudinal data or real-time monitoring technologies (Internet of Things (IoT), blockchain) could offer deeper insights into risk evolution. Integrating DEMATEL with advanced methods, such as machine learning or simulation models, could further refine risk prioritisation and prediction accuracy and address the limitations of this model in handling uncertain data. Beyond the Mekong Delta, comparative studies across other agricultural regions could uncover contextual differences and universal strategies, fostering broader applications of circular and sustainable supply chain practices.

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