

Developing a Resilient Supply Chain Risk Management Program: A Case Study of an Automotive Parts Manufacturer in Thailand

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Abstract

This research aims to investigate potential risks within the supply chain of Flexigen Korat, a newly established manufacturing facility under the Flexigen Group. The plant operates under a Just-in-Time (JIT) system, making it particularly vulnerable to disruptions in the supply chain. The objectives of this study are to identify potential risks that may disrupt operations, assess their impacts, and propose risk mitigation strategies to enhance supply chain resilience. The study employs qualitative interviews and risk assessment techniques, drawing upon historical disruption records from other manufacturing facilities within the same region. The findings reveal a total of 24 potential risk factors, which were evaluated using ABC analysis and categorized into three priority levels: high-risk (A-RISK), medium-risk (B-RISK), and low-risk (C-RISK). This analysis provides a comprehensive overview of the risk structure that may affect Flexigen Korat and serves as a foundation for developing risk mitigation strategies aligned with the likelihood and severity of each risk. These strategies are intended to strengthen the resilience of the supply chain and improve its ability to withstand and recover from disruptions. measures highlight that systematic risk identification and assessment, combined with the implementation of appropriate mitigation measures, can significantly enhance the overall effectiveness of risk management. Furthermore, it recommends future research on the outcomes of implementing risk management strategies in practice, as well as the continuous monitoring, review, and updating of risk assessments to ensure the long-term continuity of organizational operations.

Keywords: Supply Chain Risk Management, Supply Chain Resilience, Automotive Industry, Just-in-Time Manufacturing, Risk Mitigation

การพัฒนาโปรแกรมการบริหารความเสี่ยงในโซ่อุปทานให้มีความสามารถในการฟื้นตัว: กรณีศึกษาจากผู้ผลิตชิ้นส่วนยานยนต์ในประเทศไทย

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บทคัดย่อ

งานวิจัยนี้มุ่งศึกษาความเสี่ยงที่อาจเกิดขึ้นในโซ่อุปทานของโรงงานเพ็กซีกัน สาขาโคราช ซึ่งเป็นโรงงานผลิตแห่งใหม่ในเครือเพ็กซีกันกรุ๊ป ดำเนินงานภายใต้ระบบทันเวลาพอดี (Just-in-Time) โดยมีวัตถุประสงค์เพื่อระบุความเสี่ยงที่อาจก่อให้เกิดการหยุดชะงักต่อการดำเนินงาน ประเมินผลกระทบ และเสนอแนวทางบรรเทาความเสี่ยงและสร้างความสามารถในการฟื้นตัวให้กับโซ่อุปทาน การศึกษานี้ใช้วิธีการสัมภาษณ์เชิงคุณภาพและการประเมินความเสี่ยง โดยอ้างอิงจากประวัติการหยุดชะงักที่เคยเกิดขึ้นในโรงงานผลิตอื่น ๆ ในภูมิภาคเดียวกัน ผลการศึกษาพบความเสี่ยงที่อาจเกิดขึ้นจำนวน 24 รายการ ซึ่งประเมินด้วยการวิเคราะห์แบบ ABC และจัดลำดับความสำคัญออกเป็น 3 กลุ่ม ได้แก่ ความเสี่ยงระดับสูง (A-RISK) ความเสี่ยงระดับกลาง (B-RISK) และความเสี่ยงระดับต่ำ (C-RISK) การวิเคราะห์ดังกล่าวช่วยให้เห็นภาพรวมของโครงสร้างความเสี่ยงที่อาจเกิดขึ้นกับเพ็กซีกัน โคราช อย่างชัดเจน และนำไปสู่การออกแบบกลยุทธ์การบรรเทาความเสี่ยงที่สอดคล้องกับความเป็นไปและความรุนแรงของความเสี่ยง เพื่อสร้างความสามารถในการฟื้นตัวของโซ่อุปทาน การศึกษานี้ชี้ให้เห็นว่าการระบุและประเมินความเสี่ยงอย่างเป็นระบบ ควบคู่กับการนำมาตราการบรรเทาความเสี่ยงที่เหมาะสมมาใช้ สามารถช่วยยกระดับประสิทธิภาพของการจัดการความเสี่ยงโดยรวมได้อย่างมีนัยสำคัญ ทั้งนี้ ยังแนะนำให้มีการศึกษาต่อเนื่องเกี่ยวกับผลลัพธ์จากการนำกลยุทธ์การบริหารความเสี่ยงไปใช้จริง รวมถึงการติดตาม ตรวจสอบ และปรับปรุงการประเมินความเสี่ยงอย่างสม่ำเสมอ เพื่อคงไว้ซึ่งความต่อเนื่องในการดำเนินงานขององค์กร

คำสำคัญ: การบริหารความเสี่ยงในโซ่อุปทาน ความสามารถในการฟื้นตัวของโซ่อุปทาน อุตสาหกรรมรถยนต์ การผลิตแบบทันเวลา การบรรเทาความเสี่ยง

Introduction

The automotive industry is a highly integrated sector contributing about 3% of global GDP, and Thailand has evolved into a major manufacturing and export hub over the past decade. Thailand's automotive production relies on complex domestic and international supply networks, increasing exposure to supply chain risks. Therefore, Supply Chain Risk Management (SCRM) is essential to reduce disruption impacts, with this study focusing on identifying and evaluating risks faced by auto-part suppliers and developing strategies to enhance supply chain resilience. This research is a case study of Flexigen Korat, a family-owned company that provides on-demand hot-cutting services for monofilament yarn tubes used in wire harness protection systems, supplying a specific OEM located in the same province. The plant operates three hot cutting machines with 12 staffs working two shifts from Monday to Friday. With these resources, Flexigen Korat can produce up to 400,000 pieces per month, operating at 75% of its total production capacity. As a newly established manufacturing plant, Flexigen Korat faces key challenges such as an inexperienced workforce, newly introduced cutting machines, and dependence on overseas raw materials, all of which increase operational vulnerability and require close supervision. To ensure operational consistency and improve profitability, the company must identify potential supply chain risks and determine appropriate response techniques, guided by the research questions: "What are the potential supply chain risks in Flexigen Korat?" and "How can Flexigen Korat develop strategies to enhance supply chain resilience?"

To create supply chain resilience of Flexigen Korat, the objectives of this study are as follows:

1. To identify potential supply chain risks that Flexigen Korat may encounter across its operations.
2. To assess the likelihood and impact of the identified supply chain risks affecting Flexigen Korat's performance.
3. To propose appropriate resilience strategies to mitigate such risks.

Literature Review

Supply chain risks can significantly affect organizational performance because disruptions within interconnected supply chain networks may generate widespread operational and financial consequences. Cases involving Ericsson, Toyota, Boeing, Cisco, and Pfizer demonstrate the substantial impact of ineffective risk management. Consequently, supply chain risk management (SCRM) has become increasingly important as a proactive approach for identifying, assessing, mitigating, and monitoring supply chain risks to enhance organizational resilience and long-term competitiveness (Ghadir et al., 2026).

This study applies the Supply Chain Risk Management (SCRM) process to identify risks in Flexigen Korat's just-in-time operations, aiming to improve efficiency and ensure uninterrupted production and delivery.

Risk management involves using strategies and continuous risk assessment to reduce vulnerabilities and improve supply chain resilience. Since supply chains involve many interconnected members, disruptions at one point can affect the entire chain. Longer and more complex supply chains often face higher risks, although building resilient supply chains can be costly. Therefore, many studies emphasize the importance of strong supply chain risk management to reduce negative impacts on performance (Gurtu & Johny, 2021).

Supply Chain Risk Management (SCRM) is a systematic approach used to identify, assess, mitigate, monitor, and control risks across supply chains in order to minimize disruptions and improve organizational performance. Scholars emphasize that SCRM helps organizations address supply chain vulnerabilities and uncertainties proactively, ensuring operational continuity and reducing negative impacts on business

operations (Nonye & Aruwa, 2026). An effective SCRM system enhances organizational resilience, protects overall performance, and ensures business continuity. Accordingly, strengthening supply chain risk management procedures is essential for managing operational uncertainties, improving disruption response capability, and enhancing organizational resilience in increasingly volatile business environments (Belhadi et al., 2021; Queiroz et al., 2022).

According to Sharifi and Naimzad (2026), **The SCRM process** enhances supply chain resilience by identifying and reducing vulnerabilities. Key stages of SCRM commonly include risk identification, assessment, mitigation, control, monitoring, and continuous improvement. These interconnected processes help organizations proactively manage disruptions, improve risk management practices through experience, and strengthen long-term operational resilience.

Figure 1 presents the conceptual framework of the five-step supply chain risk management process adopted in this study.

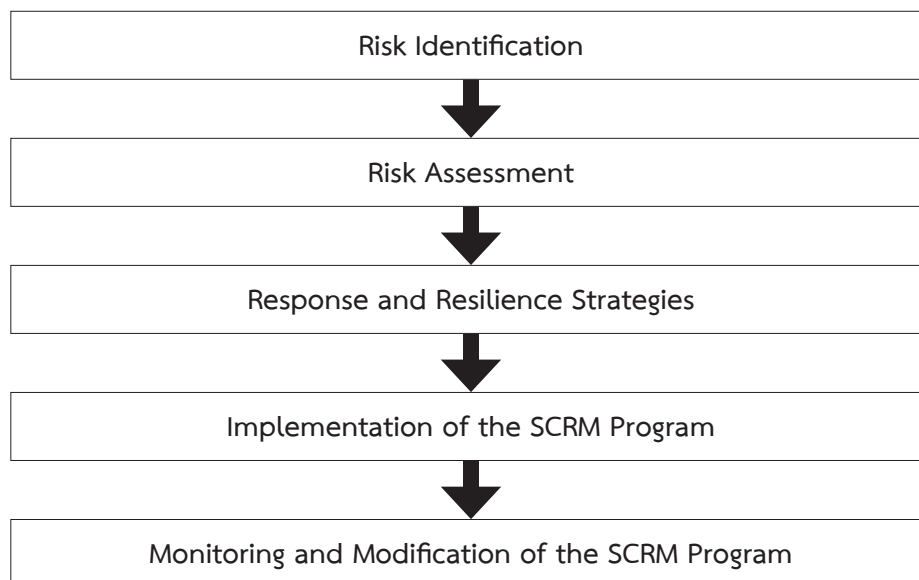


Figure 1: Conceptual Framework of the Study

Step 1: Risk Identification. According to Shahsavari et al. (2024), risk identification involves detecting potential disruptive events before their impact on operations occurs. Effective risk identification enables organizations to develop appropriate mitigation strategies and manage vulnerabilities proactively. Although existing studies use quantitative and qualitative methods to identify potential risk events, they often overlook the contributing factors leading to those risks, limiting the ability to predict and prevent disruptions effectively.

Step 2: Risk Assessment. According to Gurtu and Johny (2021), Risk assessment is part of supply chain risk management used to evaluate vulnerabilities and potential impacts affecting supply chain operations. While Shahsavari et al. (2024) stated that “Risk assessment evaluates the probability of occurrence and the severity of consequences associated with identified risks”. Risk assessment plays a crucial role in supporting informed decision-making in risk management.

Risk Categorized Method

To initiate an effective supply chain risk management and resilience program, the proper risk categorization and prioritization are the primary keys. In this study, ABC analysis is employed to classify risks according to their level of significance, allowing organizations to prioritize and apply appropriate management strategies (Waters, 2011). Risks are categorized into three groups: A risks, which are highly critical and require immediate action; B risks, which are of moderate severity and warrant regular attention; and C risks, which have low impact and may be considered negligible. Risk scoring in this study is based on the calculation.

Additionally, **risk maps** serve as visual tools for categorizing risks by illustrating their relative severity and likelihood (Jia et al., 2022). By plotting risks within a matrix framework, organizations can more effectively identify and prioritize critical risks that require immediate attention. According to Lengyel et al. (2023), risk maps are widely applied in risk matrix methodologies to classify and prioritize risks based on likelihood and impact levels. In process security assessment, these visual tools support risk screening and decision-making processes while enhancing organizational responsiveness and improving decision-making effectiveness under uncertain operational conditions.

Step 3: Response and Resilience Strategies. Common supply chain risk response techniques include avoidance, retention, transfer, and loss control, along with practices such as reducing high-risk sourcing, adopting multi-sourcing, implementing contract-based risk transfer, or accepting low-impact risks (Monczka et al., 2026). According to Sahab and Oulfarsi (2026), supply chain resilience refers to the ability of supply chains to withstand, recover from, and adapt to disruptions, while supply chain robustness focuses on maintaining performance during disruptions. Events such as the COVID-19 pandemic highlighted the importance of implementing effective supply chain risk management (strategies to reduce disruption impacts and strengthen supply chain performance).

Step 4: Implementation of the Supply Chain Risk Management Program should be implemented after appropriate risk response and resilience strategies are selected. Effective implementation of supply chain risk management should follow the selection of appropriate risk response and resilience strategies. Successful implementation requires continuous monitoring, clear protocols for risk detection and response, stakeholder involvement, and well-defined roles and responsibilities to ensure timely and effective responses to supply chain disruptions. Additionally, responsive mitigation strategies and integration into daily operations are essential for strengthening supply chain resilience ((Monczka et al., 2026; Gurtu & Johny, 2021).

Step 5: Monitoring and Modification of the Supply Chain Risk Management Program are essential processes in supply chain risk management programs, enabling organizations to continuously evaluate vulnerabilities, reassess operational risks, and improve mitigation effectiveness. Continuous monitoring supports early disruption detection and operational responsiveness, while modification processes allow organizations to adapt mitigation strategies according to changing supply chain conditions and emerging uncertainties (Gurtu & Johny, 2021; Fritz & Cordova, 2023).

Although Sahab and Oulfarsi (2026) stated that, “Previous research supports this perspective, identifying SCRM practices as vital for preparing for risks, responding to, and recovering from unforeseen disruptions. Moreover, scholars have examined how supply chain partners utilize dynamic capabilities to adapt to market changes and disruptions, often mobilizing cross-organizational processes to do so”, the limited research addresses their application in newly established, small-scale manufacturing plants operating under Just-in-Time systems, particularly in emerging economies such as Thailand.

In addition, there is a lack of empirical studies that integrate risk identification, assessment, and tailored mitigation strategies within a single operational context. This gap is particularly critical in Just-in-Time environments, where reduced buffer capacity and higher supplier dependency increase vulnerability.

As emphasized by Yu et al. (2024), organizations in emerging economies are increasingly balancing JIT practices with resilience-oriented strategies, including inventory buffering and enhanced supply chain coordination. To address these gaps, this study adopted an in-depth case study approach of automotive parts manufacturer in Thailand. It provides a systematic and context-specific analysis of supply chain risks, highlighting how plant-level characteristics such as resource constraints, workforce maturity and reliance on overseas suppliers’ shape risk exposure and resilience strategies.

Research Methodology

Research Design

This study used qualitative technique through open-ended interviews to understand the internal and external risks affecting Flexigen’s international manufacturing sites. The researcher gathered in-depth insights from supply chain managers who directly handle the manufacturing operations under different environmental and operational conditions. Real situations and practical experiences were explored. This design allowed the researcher to obtain a broader perspective on managing supply chain risks.

Sampling and Informants

A qualitative research design was employed using purposive sampling to select three experienced supply chain mangers who represent 60% of the total supply chain managers overseeing Flexigen’s manufacturing operation in Asia region. Given the case study approach, the objective is to provide in-depth context-specific insights rather than statistical generalization. Each informant responsible for operations in distinct manufacturing environments related to Flexigen Korat operational contexts. Each informant is responsible for a separate manufacturing site, located in the Philippines and India. The selection ensured the participants provide a comprehensive and context-rich representation of the organization’s supply chain risk exposure. Data collected reflected diverse experiences from different operational environments. The names of the interviewees are included to acknowledge their professional contributions to the research show in Table 1.

Table 1 Interviewees’ Profile and Interview Details

No.	Respondents And Seniority	Position	Type of Interview	Date
1.	Mira (20 years)	Supply Chain Manager, Flexigen Cebu, Philippines	Online Interview	April 3 – 9, 2025
2.	Kervin (10 years)	Supply Chain Manager, Flexigen Cavite, Philippines	Online Interview	April 8, 2025
3.	Darvin (6 years)	Supply Chain Manager, Flexigen Chennai, India	Online interview	April 8 – 9, 2025

Data Collection Procedure

As shown in Table 1, the interviews were carried out from April 3 to April 9, 2025. Each session was conducted online to accommodate the distance between the interviewer and the interviewees. Open-ended questions were used to allow participants to freely share their experiences and opinions about supply chain risks and operations. To ensure that important details were captured for analysis, the researcher recorded each session with the participants' consent.

Example of open-ended questions

- 1) What is the supply chain risks you have been encountered so far and what are the source of risks?
- 2) Have you ever had supply chain risks that arise from quality issues? Can you share with me the source of risk and how you respond to this issue?
- 3) In case of Just-in-Time delivery, what are supply chain risks you've ever encountered and how did you respond to it?
- 4) How could the risk impact your function or what would be the damage to your organization?

Data Analysis Techniques

The collected data were analyzed using reflexive thematic analysis following Braun and Clarke (2021). Interview transcripts were repeatedly reviewed to identify recurring patterns, operational issues, and resilience-related themes. These themes were then systematically categorized to capture key aspects of supply chain risks, mitigation strategies, and organizational responses. This approach enabled the researcher to develop meaningful insights from participants' experiences and operational practices.

Trustworthiness

To ensure the quality and trustworthiness of the research findings, member checking and audit trail techniques were employed throughout the study (Nowell et al., 2017). Member checking was conducted after the interviews to validate the data and reduce potential researcher bias by confirming that participants' perspectives were accurately interpreted. In addition, an audit trail consisting of interview transcripts, coding notes, and theme development records was maintained to enhance transparency, dependability, and consistency in the thematic analysis process. These procedures strengthened the credibility and rigor of the qualitative findings.

Identification of Supply Chain Risks

Based on qualitative interview findings and operational constraint analyses conducted at manufacturing facilities in Cebu, Cavite, and Chennai, a total of 24 potential supply chain risks were identified. These risks represent the key vulnerabilities and operational challenges that may impact Flexigen Korat branch.

Evaluation of Supply Chain Risks

Risk evaluation involves assessing both the likelihood of a risk occurring (probability) and the severity of its potential impact (consequence) for each identified supply chain risk, adopting a structured qualitative approach by integrating expert judgement, interview insights, and operational evidence derived from Flexigen Korat including frequency of supply disruptions, transportation variability, production interruptions, delivery performance. Adopting structured scales for probability and consequence enables categorize uncertainties into clear levels, making risk assessment, prioritization, and decision-making more systematic and effective.

Probability and consequence scores were derived using structured expert judgment. Three supply chain managers evaluated each risk's likelihood and impact based on their operational experience across supply, production, and delivery, considering factors such as occurrence frequency, past disruptions, and operational variability. The researcher incorporated empirical observations from Flexigen Korat's operations, including supply disruptions, lead time variability, production interruptions, and delivery performance, to assess supply chain risks based on predefined probability and operational impact criteria adapted from recent supply chain risk management frameworks (Fan & Stevenson, 2018; Gurtu & Johny, 2021).

To enhance reliability of the assessment, triangulation was applied by comparing inputs from 1) interview inputs from three informants, 2) operational insights from the researcher's direct involvement and observations of Flexigen Korat's supply chain activities, and 3) predefined probability and consequence scales as evaluation criteria. Discrepancies were resolved through a consensus-based approach. The researcher reviewed differing assessments, considered the majority opinion then aligning final ratings with the most representative operational scenario supported by empirical evidence.

Adapted from Christopher and Peck (2004), a 5x5 risk matrix was used to evaluate the risks, with scores ranging from 1 to 25. Both probability and consequence were rated on a five-point scale (1-5). The overall Risk Score was calculated using the following formula:

$$\text{Risk Score} = \text{Probability} \times \text{Consequence}$$

A probability score of 1 (Very Low) indicates that a risk event is very unlikely to occur under normal operating conditions. A score of 2 (Low) suggests that the event is unlikely to occur but remains possible. A score of 3 (Medium) represents a moderate likelihood, indicating that the event has approximately an even chance of occurring. A score of 4 (High) indicates that the event is likely to occur and should therefore receive greater attention from risk managers. Finally, a score of 5 (Very High) signifies that the risk event is highly likely to occur and may require immediate monitoring and mitigation measures.

A consequence score of 1 (Negligible) represents an insignificant impact with little or no effect on the functioning of the supply chain. A score of 2 (Minor) indicates limited disruptions, delays, or additional costs affecting certain parts of the supply chain, while most operational functions continue normally. A score of 3 (Medium) reflects moderate disruptions that affect some supply chain activities; however, the main functions remain capable of meeting operational requirements. A score of 4 (Serious) represents major disruptions to essential supply chain operations, resulting in significant delays and high recovery costs. The highest score, 5 (Catastrophic), indicates complete and potentially irrecoverable failure of the supply chain or organization, which may lead to operational shutdowns and substantial reputational damage.

This approach ensures that the resulting risk scores reflect a systematic and context-specific evaluation, combining expert insights with real operational conditions, rather than relying on a single subjective judgment. The calculated scores were classified using ABC analysis to prioritize risk management actions.

The resulting risk scores were then categorized using ABC Analysis (Table 5) to determine priority levels as follows:

A-RISK: Score 15-25 (high risk, immediate action required)

B-RISK: Score 8-14 (medium risk, regular monitoring required)

C-RISK: Score <8 (low risk, minimal concern)

Table 2 Probability-Consequence Matrix

Probability	Consequence				
	Negligible	Minor	Medium	Serious	Catastrophic
Very High (5)	5	10	15	20	25
High (4)	4	8	12	16	20
Medium (3)	3	6	9	12	15
Low (2)	2	4	6	8	10
Very Low (1)	1	2	3	4	5

Source: Adapted from Waters (2011)

Table 6 presents the evaluated risks based on a qualitative assessment using probability and consequence scores derived from interview inputs and operational observations at Flexigen Korat. This approach integrates expert judgment with empirical operational evidence, ensuring that the risk evaluation reflects both practical experience and real-world conditions to strengthen prioritization. Scores were reviewed and adjusted as needed, and final risk scores calculated as the product of probability and consequence were categorized using ABC analysis to indicate priority levels.

Table 3 Evaluation of Identified Risks

No.	Type of Risk	Probability	Consequence	Risk Score	Degree of risk
1	Supply Risk	High	Catastrophic	25	A
2	Demand Risk	High	Serious	20	A
3	Capacity Risk	High	Catastrophic	20	A
4	Machine Risk	High	Catastrophic	20	A
5	Production Risk	High	Catastrophic	20	A
6	Customs Risk	High	Serious	16	A
7	Operational Risk	High	Medium	12	B
8	Human Resource Risk	Medium	Medium	6	B
9	Inventory Risk	High	Medium	12	B
10	Transport Risk	Medium	Medium	9	B
11	Security Risk	Low	Serious	4	B
12	Natural Risk	High	Medium	8	B
13	Management Risk	Medium	Medium	6	B
14	Internal Policy Risk	Medium	Medium	9	B
15	Policy Risk	Medium	Medium	12	B
16	Facility Risk	Low	Serious	4	B
17	Strategic Risk	Medium	Medium	12	B

Table 3 Evaluation of Identified Risks (Cont.)

No.	Type of Risk	Probability	Consequence	Risk Score	Degree of risk
18	Competitive Risk	Medium	Medium	9	B
19	Financial Risk	Medium	Minor	4	B
20	Tools Risk	Low	Minor	2	C
21	Packaging Risk	Medium	Minor	6	C
22	Product Risk	Medium	Minor	2	C
23	Safety Risk	Low	Minor	2	C
24	Environmental Risk	Low	Minor	1	C

Risk Map

Figure 2 illustrates the risk map that classifies risks into A-RISK, B-RISK, and C-RISK based on the risk score. A-RISK includes critical production, capacity, supply, demand, customs and machine-related risks requiring immediate action due to their significant impact on Just-in-Time operations. B-RISK covers operational, human resource, inventory, transport, security, natural, management, internal policy, policy, facility, strategic and competitive and financial risk that require monitoring and contingency planning, as they may escalate if unmanaged. C-RISK includes tools, packaging, product, safety, environmental risk which have low impact.

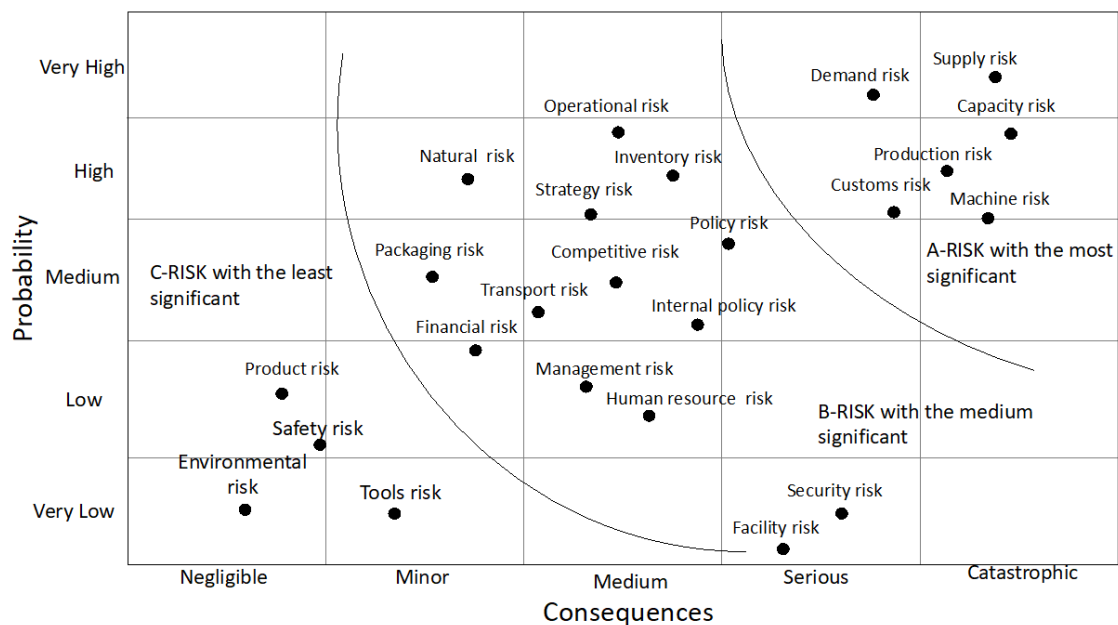


Figure 2 Flexigen Manufacturing Plants' Risk Map

The response and resilience technique presented in Table 7 were developed through a step-by-step risk response mapping process. First, initial ideas were gathered from interview data. These ideas were then improved using operational experience and adjusted to aligned with established supply chain risk management framework. Each response technique was selected based on the specific characteristics of each identified risk, including their probability, impact and operational context ensuring the solutions are both practical and theoretical grounding.

Table 4 Response and Resilience Strategies for Flexigen Korat

No.	Type of Risk	Probability	Consequence	Risk Score	Degree of risk	Response Techniques
1	Supply Risk	High	Catastrophic	25	A	Non-Insurance Transfer: secure purchase contracts with suppliers to ensure raw material quantity and quality. Active Retention: allocate an emergency budget for urgent transport, such as air shipments. Duplication: reduce reliance on single suppliers by adopting multi-sourcing across different regions to mitigate supply shortages.
2	Demand Risk	High	Serious	20	A	Non-Insurance Transfer: establish demand fluctuation agreements with customers to cover additional costs beyond agreed limits and implement demand confirmation policies for sudden demand drops. Collaboration: work closely with customers to identify causes of demand fluctuations and develop appropriate action plans.
3	Capacity Risk	High	Catastrophic	20	A	Active Retention: maintain Kanban or pre-made inventory for high-volume items. Duplication: shift production to intragroup plants with similar capabilities. Collaboration: coordinate closely with customers to anticipate demand increases from new projects. Keep Spare Capacity: expand capacity when new demand is confirmed as firm orders. Standardized Facility: standardize operations to enable flexible production transfers across plants.
4	Machine Risk	High	Catastrophic	20	A	Avoidance: prevent machine overuse to reduce breakdown risk. Active Retention: implement structured preventive maintenance plans and prepare critical spare parts in advance. Collaboration: work with machine suppliers to develop maintenance programs and maintain in-house technical support if needed. Standardized Facility: install standardized spare machines to enable quick replacement and operational continuity.

Table 4 Response and Resilience Strategies for Flexigen Korat (Cont.)

No.	Type of Risk	Probability	Consequence	Risk Score	Degree of risk	Response Techniques
5	Production Risk	High	Catastrophic	20	A	Accept the Risk: absorb additional costs and extend production time through overtime to meet demand and prevent customer line stoppages. Collaboration: communicate the situation clearly and adjust production plans across all stakeholders.
6	Customs Risk	High	Serious	16	A	Accept the Risk: comply fully with Thai Customs tariff codes. Active Retention: allocate additional time for customs clearance procedures. Avoidance: avoid disputes with customs authorities that could disrupt operations. Duplication: prepare tariff code leniency documentation in advance to reduce clearance delays. Collaboration: coordinate with freight forwarders to secure extended demurrage and detention allowances.
7	Operational Risk	High	Medium	12	B	Active Retention: provide Thai-language training and pilot testing to ensure correct use of digital control cards. Contingency Plan: establish shared data access tools to maintain operations during system downtime. Corporate Culture: promote awareness of digital systems to improve efficiency and reduce paper usage. Collaboration: work closely with the IT team to resolve system issues and ensure system stability.
8	Human Resource Risk	Medium	Medium	6	B	Non-Insurance Transfer: outsource workforce support to cover employee absences based on agreed manpower arrangements. Active Retention: provide Thai-language training materials, conduct regular skills training, use KPIs to measure competency, and support team-building activities. Corporate Culture: emphasize employee importance and foster a supportive, open, and problem-solving work environment.

Table 4 Response and Resilience Strategies for Flexigen Korat (Cont.)

No.	Type of Risk	Probability	Consequence	Risk Score	Degree of risk	Response Techniques
9	Inventory Risk	High	Medium	12	B	Adapt to It: adjust Kanban size and inventory levels regularly and ensure pre-made stock can be converted to other products if demand declines. Non-Insurance Transfer: establish agreements assigning customer responsibility for Kanban stock or raw materials in the event of sudden end-of-production decisions. Collaboration: work closely with customers to identify causes of demand reduction and prevent excess or obsolete inventory.
10	Transport Risk	Medium	Medium	9	B	Active Retention: identify alternative transport routes and allocate budgets for urgent modes such as air freight or hand carry. Adapt to It: plan for predictable seasonal risks by increasing buffer stock or transport lead time. Collaboration: maintain regular communication with freight forwarders to monitor transport conditions and routing options.
11	Security Risk	Low	Serious	4	B	Avoidance: avoid opening non-work-related emails and report suspicious messages to the IT team. Collaboration: work with the IT department to filter emails and block access to suspicious websites. Corporate Culture: raise cybersecurity awareness through visible reminders and regular training on the financial impacts of cyberattacks.
12	Natural Risk	High	Medium	8	B	Active Retention: increase buffer stock and extend purchase lead times during the monsoon season. Duplication: source from alternative regions if supplier production is disrupted by natural risks. Insurance: obtain insurance coverage to protect facilities from natural hazard damage. Collaboration: regularly coordinate with suppliers to monitor potential supply disruptions. Agile Supply Chain: temporarily shift demand to manufacturing plants in other regions when supplier flows are impacted.

Table 4 Response and Resilience Strategies for Flexigen Korat (Cont.)

No.	Type of Risk	Probability	Consequence	Risk Score	Degree of risk	Response Techniques
13	Management Risk	Medium	Medium	6	B	Loss Reduction: conduct daily or weekly reviews and promptly adjust manufacturing plans to current conditions. Collaboration: bring stakeholders together to share information and jointly redesign recovery manufacturing plans.
14	Internal Policy Risk	Medium	Medium	9	B	Oppose the Change: respect country-specific tariff code decisions and comply with customs requirements. Passive Retention: accept additional charges when necessary to secure inbound supply. Collaboration: work closely with customs brokers to prepare advance clearance and adapt to regulatory changes.
15	Policy Risk	Medium	Medium	12	B	Active Retention: promptly assess policy impacts on products and components based on the bill of materials and confirm feasibility with customers. Collaboration: coordinate with customs brokers to stay updated on reciprocal tariff policies and source alternative suppliers from non-affected countries. Communication: inform customers of the company's import privileges to minimize perceived tariff impacts.
16	Facility Risk	Low	Serious	4	B	Non-Insurance Transfer: arrange building maintenance with the landlord and ensure building insurance coverage is in place. Active Retention: install and maintain fire alarms, extinguishers, emergency lighting, and evacuation plans. Duplication: strictly follow scheduled maintenance to ensure facility readiness.
17	Strategic Risk	Medium	Medium	12	B	Active Retention: deliver high service quality to meet customer needs and strengthen customer loyalty. Collaboration: work with the sales team to identify new customers and expand cutting services to a broader product range.

Table 4 Response and Resilience Strategies for Flexigen Korat (Cont.)

No.	Type of Risk	Probability	Consequence	Risk Score	Degree of risk	Response Techniques
18	Competitive Risk	Medium	Medium	9	B	Non-Insurance Transfer: establish business contracts specifying minimum purchase quantities and contract duration. Agile Supply Chain: develop flexible supply chains to respond quickly to customer requirements. Collaboration: maintain close communication with customers to monitor their responses to competitor actions.
19	Financial Risk	Medium	Minor	4	B	Contingency Plan: arrange contingency loans from headquarters to address financial shortfalls. Collaboration: revise customer credit terms when late payments affect cash flow. Interchange Parts and Products: optimize excess raw material by reallocating inventory to other plants using the same materials.
20	Tools Risk	Low	Minor	2	C	Active Retention: implement maintenance plans for each tool. Duplication: prepare spare tool sets and engage responsive local tool suppliers for repair or replacement. Avoidance: apply Poka-Yoke principles to clearly identify tool storage areas and ensure proper storage conditions.
21	Packaging Risk	Medium	Minor	6	C	Active Retention: maintain buffer stock of spare packaging to meet demand. Duplication: identify responsive suppliers capable of providing repair services for damaged packaging. Collaboration: work with suppliers to develop upcycling plans for worn-out packaging.
22	Product Risk	Medium	Minor	2	C	Loss Control: improve lighting to reduce defects. Passive Retention: replace defective products promptly to meet customer requirements. Collaboration: conduct root cause analysis and implement preventive actions, particularly during night shifts.

Table 4 Response and Resilience Strategies for Flexigen Korat (Cont.)

No.	Type of Risk	Probability	Consequence	Risk Score	Degree of risk	Response Techniques
23	Safety Risk	Low	Minor	2	C	Loss Control: review and improve operations to address safety issues. Active Retention: ensure first-aid kits are readily available for minor injuries. Insurance: obtain insurance coverage for major injury recovery costs. Collaboration: conduct safety training and install warning signs in critical areas. Policy Enforcement: define and apply penalties for safety rule violations.
24	Environmental Risk	Low	Minor	1	C	Loss Reduction: upcycle defective or obsolete parts before disposal. Active Retention: improve purchasing strategies to minimize the use of air transport. Collaboration: work with product R&D and machine suppliers to use recycled materials and develop low-carbon production methods.

Implementation of the Supply Chain Risk Management Program

To enhance the effectiveness of the Flexigen Korat Risk Management Program, a dedicated risk management team or assigned personnel should coordinate closely with all functions to implement risk and resilience strategies and encourage timely issue reporting. Operational effectiveness can be strengthened through integrated supply processes with customers and suppliers, including aligned forecasting, safety stock agreements, and regular monitoring of demand fluctuations. Transportation efficiency requires systematic recording and analysis of transport risks to refine response strategies. Production efficiency should be improved by controlling capacity utilization, monitoring defect rates, ensuring tool availability, and strengthening operator skills through structured training and KPIs. A safe and clean workplace, supported by safety policies, audits, and pest control, is essential for productivity. Finally, strict adherence to preventive maintenance plans for machines and tools, supported by proper documentation and local repair services, ensures operational readiness and continuity.

Monitoring and Modification of the Supply Chain Risk Management program

After three months of implementation, Flexigen Korat should evaluate the effectiveness of the supply chain risk management program. If the response and resilience techniques are found to be ineffective or inefficient, risks may reoccur, requiring the company to revise existing measures or adopt alternative risk management approaches.

Discussion and Conclusion

Establishing a new manufacturing plant presents significant challenges, particularly when operating under a Just-in-Time system, which inherently increases supply chain vulnerability compared to traditional inventory systems due to lower safety stock levels, higher supplier dependency, demand variability and strict on-time delivery requirements. As a result, even small disruptions at Flexigen Korat can significantly impact the customer operation continuities. The findings indicate that a single response technique is often insufficient due to the interconnection of risks that can amplify their overall impact such as machine risk that has high probability and catastrophic impact, and triggers production risk leading to significant disruptions in operational continuity. Therefore, multiple techniques such avoiding machine overuse, implementing preventive maintenance programs, or ensuring spare part availability to reduce machine-related risks must often be combined.

The study identifies structural vulnerability in Just-in-Time practices, particularly in supply risk as reliance on overseas raw material suppliers introduces transportation uncertainty and lead time variability, with limited Kanban level a small Bullwhip effect caused from demand fluctuation, or port congestion could disrupt the operation continuity. A single customer proximity model creates strategic risk as the asset specified for one customer, increase capital burden, less scalability in the same geography, and may decrease its bargaining power. The finding emphasizes risk management and resilience program is essential for Flexigen Korat as it was designed. Moreover, risks observed during the early operational phase reflects maturity issues. These factors include process instability, workforce learning curve effects, and management planning. Such risks are transitional in nature of a new set up site, and will gradually decrease once system stabilized and organizational learning increase.

In comparison of global Just-in-Time practices vulnerability, as stated by Choi et al. (2023) that supply chain turbulence such as natural disasters, upstream geographic, or long and variable transportation cycles does impact Just-in-Time synchronization. The literature also indicated the misconceptions and misapplications

of the philosophy could lead to management risk. Still, the authors emphasize the need to adapt Just-in-Time through a segmented supply chain design by proposing response techniques include strategic placement of buffers in form of inventory, capacity and capability.

For theoretical implications, the findings of this study are consistent with prior research that highlights the inherent vulnerability of Just-in-Time systems where lean practices and low buffer increase the risk of supply chain disruptions, especially when firms depend on a small number of suppliers. This study supports these ideas by demonstrating how supplier issues, transportation delays, and demand changes can directly affect operations in this particular environment.

In addition, the results confirm that the interconnection of risks observed in this study supports Christopher and Peck (2004) framework that risks are rarely isolated but often transmit across multiple functions such machine related issue triggering production disruptions, which impact directly to delivery performance, reflect a cascading risk structure consistent with existing theoretical frameworks. Unlike many previous researches that focus on mature supply chains, this study extends prior research by providing empirical, plant-level evidence from a newly established manufacturing operation in an emerging economy. The early-stage operation conditions such as workforce inexperience, system instability, and supplier dependency that intensifies supply chain highlighted in this study contribute to the literature by offering a more context specific understanding of how risk manifest and interact in newly developed Just-in-Time environments.

Overall, this study demonstrates that supply chain resilience in newly established manufacturing environments such Flexigen Korat can be significantly strengthened through a systematic integration of risk identification, assessment and context-specific response strategies. These measures support both immediate operational responses and long-term resilience, enabling the company to maintain continuity and adapt effectively to global supply chain challenges. This highlights the importance of developing context-specific SCRM frameworks for emerging manufacturing environments, where operational constraints and supply chain dependencies significantly influence risk exposure.

From the managerial perspective, this study provides several actionable implications for supply chain practitioners, particularly those operating in Just-in-Time environments.

First, managers should adopt a hybrid approach to Just-in-time systems by strategically introducing buffers in form of safety stock, spare capacity, or extended lead times for high risk materials. This is especially critical when sourcing from overseas suppliers, where transportation variability and port congestion can significantly disrupt supply continuity.

Second, organizations should reduce single suppliers' dependency by implementing multi-sourcing strategies across different regions enhancing supply flexibility and mitigate the risk of supply disruption caused by geopolitical, environmental, or operational factors.

Third, managers should establish proactive risk monitoring systems by tracking key operational indicators such as supplier lead time variability, production downtime frequency and demand fluctuation patterns as early warning signal indicators for potential disruptions.

Fourth, companies operating with customer-specific product models should diversify their customer base where possible to reduce strategic risk and improve bargaining power.

Finally, organizations should invest in workforce development and structured training programs to reduce operational risks associated with inexperienced personnel, particularly during the early stages of plant establishment.

These recommendations emphasize that supply chain risk management should not be treated as a reactive function but rather as a proactive and strategic capability embedded within daily operations supporting sustainable operations, competitive advantage, long-term organizational stability, and profitability protection.

Recommendations

As this study proposes risk response and resilience techniques based on insights from supply chain managers of other manufacturing plants and a structured risk identification approach for Flexigen Korat, the empirical validation of proposed strategies hasn't been measured at this state and some lower-severity risks may not have been fully explored. In addition, the applicability of the suggested techniques may vary due to differences in geography, operational conditions, and business practices. Therefore, future research should focus on long-term implementation to evaluate actual effectiveness and provide a more comprehensive understanding of resilience development at Flexigen Korat. Further studies could also compare mitigation strategies across individual entities under similar disruption scenarios and examine emerging digital and cybersecurity risks, which may evolve rapidly and affect the long-term relevance of the findings.

References

- Belhadi, A., Kamble, S., Jabbour, C. J. C., Gunasekaran, A., Ndubisi, N. O., & Venkatesh, M. (2021). Manufacturing and service supply chain resilience to the COVID-19 outbreak: Lessons learned from the automobile and airline industries. *Technological Forecasting and Social Change*, 163, 120447. <https://doi.org/10.1016/j.techfore.2020.120447>
- Braun, V., & Clarke, V. (2021). *Thematic Analysis: A Practical Guide*. SAGE.
- Choi, T. Y., Netland, T. H., Sanders, N., Sodhi, M. S., & Wagner, S. M. (2023). Just-in-time for supply chains in turbulent times. *Production and Operations Management*, 32(7), 2331–2340. <https://doi.org/10.1111/poms.13979>
- Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *The International Journal of Logistics Management*, 15(2), 1–14. <https://doi.org/10.1108/09574090410700275>
- Fan, Y., & Stevenson, M. (2018). A review of supply chain risk management: definition, theory, and research agenda. *International Journal of Physical Distribution & Logistics Management*, 48(3), 205–230. <https://doi.org/10.1108/IJPDLM-01-2017-0043>
- Fritz, M. M., & Cordova, M. (2023). Developing managers' mindset to lead more sustainable supply chains. *Cleaner Logistics and Supply Chain*, 7, 100108. <https://doi.org/10.1016/j.clscn.2023.100108>
- Ghadir, A. H., Vandchali, H. R., Fallah, M., & Tirkolaee, E. B. (2026). Evaluating the impacts of COVID-19 outbreak on supply chain risks by modified failure mode and effects analysis: a case study in an automotive company. *Annals of Operations Research*, 360(1), 483–513.
- Gurtu, A., & Johny, J. (2021). Supply chain risk management: Literature review. *Risks*, 9(1), 16. <https://doi.org/10.3390/risks9010016>
- Jia, J. A., Nwaogazie, I. L., & Anyanwu, B. O. (2022). Risk Matrix as a tool for risk analysis in underwater operations in the oil and gas industry. *Journal of Environmental Protection*, 13(11), 856–869. <https://doi.org/10.4236/jep.2022.1311054>
- Lengyel, D. M., Mazzuchi, T. A., & Vesely, W. E. (2023). Establishing risk matrix standard criteria for use in the continuous risk management process. *Journal of Space Safety Engineering*, 10(3), 276–283. <https://doi.org/10.1016/j.jsse.2023.05.001>

- Monczka, R. M., Handfield, R. B., & Giunipero, L. C. (2026). *Purchasing and supply chain management* (7th ed.). Cengage Learning.
- Nonye, D. V., Alexander, E. O., & Aruwa, S. S. A. (2026). Assessing the effect of supply chain risk management strategies on the operational performance of Nigerian National Petroleum Company Limited (NNPC Ltd). *International Journal of Research and Scientific Innovation*, 13(1), 675–690.
<https://doi.org/10.51244/ijrsi.2026.13010058>
- Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International journal of qualitative methods*, 16(1), 1609406917733847.
<https://doi.org/10.1177/1609406917733847>
- Queiroz, M. M., Ivanov, D., Dolgui, A., & Fosso Wamba, S. (2022). Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review. *Annals of operations research*, 319(1), 1159-1196.
- Sahab, S., & Oulfarsi, S. (2026). The Role of Supply Chain Risk Management in Shaping Supply Chain Resilience and Robustness: Empirical Evidence from Moroccan Manufacturing Firms. *Logistics*, 10(2), 39.
<https://doi.org/10.3390/logistics10020039>
- Shahsavari, M., Hussain, O. K., Saberi, M., & Sharma, P. (2024). Event identification for supply chain risk management through news analysis by using large language models. *The Review of Socionetwork Strategies*, 18(2), 255-278.
- Sharifi, M. S., & Naimzad, A. (2026). A Systematic Literature Review on Supply Chain Risk Management. *Journal of Social Sciences and Humanities*, 3(1), 235-259.
- Waters, D. (2011). *Supply chain risk management: Vulnerability and resilience in logistics*. Kogan Page.
- Yu, W., Wong, C. Y., Jacobs, M. A., & Chavez, R. (2024). What are the right configurations of just-in-time and just-in-case when supply chain shocks increase? *International Journal of Production Economics*, 276, 109352. <https://doi.org/10.1016/j.ijpe.2024.109352>