Empowering Supply Chain Resilience in High-Growth of Small and Medium Enterprises (SMEs) Through the Integration of the SCOR Model Paradigm

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Abstract – **This study targets high-growth of small and medium enterprises (SMEs), investigating factors contributing to supply chain resilience (SC resilience) within the SCOR model paradigm. The study conducted qualitative research, utilizing semi-structured interviews with 16 key informants in Thailand, focusing on supply chain (SC) resilience during the COVID-19 pandemic. Data analysis using Nvivo employs content and thematic analysis, leading to the development of the framework. The findings reveal main themes and subthemes relating to the relationship between SC resilience and the supply chain operations reference (SCOR) model. This comprehensive exploration extends further into novel subthemes associated with innovation creation, inventory management, financial and cash flow dynamics, as well as business partnerships. The study proposes a framework facilitating the integration of SC resilience with the SCOR model paradigm, empowering SMEs to navigate uncertain events or disruption. SMEs embracing innovative business practices can shape pathways for growth and business survival.**

Keywords – **Supply chain resilience, SCOR model, supply chain performance, thematic analysis, Nvivo.**

1.   Introduction

The world economy faces challenges with slow growth, high inflation, and uncertainties, driven by factors like the consequences of COVID-19, the Ukraine war, climate change, and dynamic macroeconomic conditions. Despite some global improvement, aggressive interest rate hikes due to persistent high inflation tighten financial conditions, heightening debt vulnerabilities [1], [2].

Thai SMEs represent a significant economic sector that powers the country's economy by representing the majority of people's small-scale business owners. According to the current definition of a SME, in 2022, SMEs contributed more than 35% of the nation's GDP, which was indicative of their economic importance. SMEs also provided a significant number of jobs for the labor force in the nation. Its employment share of the total employment in the nation is 71% [3]. Typically, SMEs experience challenges including a tendency to lack long-term planning, face challenges with insufficient cash flow and limited equity reserves, and encounter difficulties in accessing essential capital for business recovery and infrastructure development [4]. During this environment, SMEs are facing unforeseen challenges as a result of the prolonged COVID-19 pandemic, which has decreased business transactions, sales revenue, and supply chain disruption. These pressures have a variety of negative effects on the functioning of businesses and individual entrepreneurs, which affects company confidence. SC resilience has gained popularity among scholars, with many researchers suggesting its practical implementation in handling stressors and restoring business trust for recovery.

This has led to the integration of capabilities for event readiness, enabling timely and cost-effective strategic planning, adaptation, resistance, and/or recovery from the impact of disruptions [2]. However, after going through the SC resilience research literature, there are still significant gaps in the study. These include the absence of a framework that can identify and integrate qualitative relationships and quantify the relationships between supply chain performance indicators, strategic goals, and work process enhancement measures, as well as the lack of connections between SC resilience factors [5].

Consequently, this study has two research objectives as follows:
1. To examine the SC resilience capabilities of SMEs in high growth industry in Thailand.
2. To explore the activity of SC resilience in enabling SCOR model and propose conceptual framework.

To fulfill both research objectives, we conduct a literature review to establish the context and summarize existing findings on SC resilience. This aims to identify the most relevant factors, with a specific focus on the activities outlined in the SCOR model; plan, source, make, and deliver. These factors are later applied in the assessment of SC resilience for SMEs. Following this, we present a research methodology designed to address the two proposed research objectives. Subsequently, in-depth interviews 16 SMEs representative were conducted in three industries: agricultural, food science, and biotech; health and medical-related businesses; and electromechanical and robotic engineering. Thematic analysis was then carried out using Nvivo to identify and present the main themes and subthemes.

In conclusion, this study is the first attempt to introduce a comprehensive conceptual framework for integrated SC resilience and SCOR model. The paper also outlines potential future research directions. From a practical standpoint, these discoveries carry significant implications for SMEs aiming to enhance partnership and innovation visibility. This research is a component of a broader project that investigates the factors influencing SC resilience to develop an assessment specifically context for SMEs. To contribute to these initiatives, this research accomplishments to construct a new theoretical framework that enables the integration of SR resilience with the SCOR model.

The study is structured as follows: Section 2 details literature review. Section 3 outlines the research methodology.

Section 4 presents the findings and concludes by synthesizing individual themes into a hierarchical chart.

Section 5 engages in a discussion of the findings in relation to existing research. Finally, Section 6 summarizes the conclusions derived from this study, including the proposed framework, limitations, and future avenues for further exploration.

2. Literature Review

This section is divided into 2 parts. The first part focuses on the existing literature on SC resilience in SMEs, highlighting the relevant factors that were used in this research. The second part covers the foundational aspects of the SCOR model, which serves as the activity frame for this research.

2.1. SC Resilience in SMEs

The theme of SC resilience gained prominence in literature from the early 2000s, capturing the attention of both researchers and practitioners due to the rising occurrence of disruptive events and their potential impact on business competitiveness and continuity [6]. In practice, the concept of SC resilience has been applied in various contexts, spanning the agricultural industry [7], the oil and gas sector [8], the clothing industry [9], the shipping industry [10], and the food industry [11], [12].

Numerous studies have explored the potential of SMEs, including research [13], which developed and tested a framework for enhancing supply chain recovery potential to foster competitiveness in SMEs. The identified factors influencing supply chain recovery potential encompass organizational structure, personnel management, technology utilization, agility, knowledge, information, supply chain integration, flexibility, network-building capabilities, and the ability to assess supply chains. These elements collectively contribute to increased competitiveness. This aligns with the findings of Pal et al. [9], whose research on organizational resilience during economic crises, particularly in SMEs, highlighted factors conducive to recovery. These factors include the establishment of networks in the supply chain, flexible and adaptable strategies and management, the attitude of management, and effective financial management. Sullivan-Taylor and Branicki [14] proposed that SMEs possess characteristics that enhance business resilience, such as quick decision-making, efficient communication, and the ability to swiftly learn and adapt strategies in uncertain circumstances, ultimately contributing to business survival. Literature on SC resilience factors is described in Table 1 below.

Table 1. SC resilience factors for this study (Source: authors)

Factors	Concepts	Author
Visibility	Gain insights into operations, enabling efficient design in supply chain management.	[11], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26]
Collaboration	Capability for collaborative activities, including joint planning, management, trust-building, and cooperative decision-making, internally and with suppliers.	[2], [16], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28]
Agility	Capable of making swift design or supply chain management decisions.	[11], [16], [19], [21], [23], [25], [26], [28], [29], [30]
Risk management	Handle risk and implement strategies for recovering from events.	[2], [11], [16], [19], [23],[28], [30], [31], [32]
Flexibility	Flexibility, such as preparing alternative distribution channels.	[2], [18], [20], [21], [23], [24], [25], [26], [30], [32], [33], [34]
Information sharing	Engages in internal and external information sharing.	[16], [17], [19], [21], [24], [31], [32]
Reserve capacity	Maintain prepared resources to create business alternatives, such as keeping inventory reserves.	[11], [20], [23], [25], [26], [32]

2.2. SCOR Model

The significance of SC resilience resides in its impact on stakeholders within the supply chain, encompassing facets such as production, sourcing, and delivery [35]. To effectively respond to challenges and maintain normal operational functionality, this study draws upon the supply chain operations reference (SCOR) model as a comprehensive framework, ensuring the consideration of every operational process within the supply chain. The SCOR model consists of 6 core processes; plan, source, make, deliver, return, and enable [36].

Upon reviewing relevant literature, it was identified that the SCOR model concept has been employed to assess operational efficiency and cultivate competitiveness across both large and small organizations. This application extends to various industries, including the airline industry [37], the leather and textile industry [38], the automotive industry [39], and the lithium battery production sector [40].

According to the SCOR model, it is used to clearly align business processes and activities. This study employs SCOR model elements as sub-activities in SC resilience factors during semi-structured interviews to thoroughly investigate activities relevant to serving the research objective. The aims to verify the connection between each SC resilience factor and the fundamental processes of the SCOR model (i.e., plan, source, make and deliver) exploring how this relationship can enhance supply chain performance.

3. Research Methodology

To ensure scholarly rigor in the research, this study employs qualitative semi-structured interviews, analyzed using the thematic analysis technique with NVivo software. Additionally, various validation techniques are employed to ensure reliability and trustworthiness. In the following sections, we will provide detailed descriptions of the study design, sample selection, reliability and trustworthiness measures, data collection methods, and the data analysis techniques used in this study.

3.1. Study Design and Development of Research Questions

The study employed a qualitative research design. The research factors were developed based on the literature as are described in detail in Table 1, and primary data were gathered using semi-structured interviews. This approach gives interviewees the opportunity to respond while guaranteeing that important research topics are covered. It also gives room to examine additional relevant issues that come up during the interview without shifting significantly from the main objective of the study [41]. The aim of this study is to explore the multifaceted factors that influence SC resilience, with a focus on key activities outlined within the SCOR framework, such as planning, sourcing, making, and delivering. Therefore, an in-depth interview method was chosen to carry out the research.

3.2. Sample

This study utilizes purposive sampling within non-probabilistic sampling to select key informants from specific industry groups: agricultural, food science, biotech, health and medical-related businesses, as well as electromechanical and robotic engineering. Each key informant represents an establishment and is interviewed concerning supply chain activities; plan, source, make, and deliver, following the SCOR model.

The sample criteria for in-depth interviews include having a minimum of three years' experience as an entrepreneur or senior/middle-level executive in SMEs registered with the Office of Small and Medium Enterprises Promotion (OSMEP). The SMEs must operate in high-growth industries, adhering to the SMEs Promotion Plan No. 4 (2017-2021) criteria of continuous income growth and positive average net profit growth.

3.3. Reliability and Trustworthiness

To ensure the reliability and trustworthiness of this study, 4 validation methods were employed. First, content validity techniques were assured by validating the accuracy and appropriateness of language through consultations with professors and experts. A panel of 5 experts assessed the content for clarity, question alignment with research objectives (index of consistency: IOC), and made necessary revisions based on their recommendations. Secondly, triangulation techniques were utilized for theoretical validation by examining diverse data sources, including key informant interviews from various industries, and comparing information across different sources, times, locations, and individuals. Consistency among multiple key informant groups confirmed significant factors influencing supply chain restoration potential. Thirdly, member-checking techniques were implemented to verify conclusions, involving 5 key informants reviewing and providing feedback on the analysis results. Finally, confirmability check techniques demonstrated the objectivity of findings, ensuring they were not biased by the researcher's perspective, incentives, or conflicts of interest.

3.4. Data Collection

The in-depth interviews were conducted during the outbreak of the COVID-19 in Thailand from January to April 2022. The first author initiated several phone calls and emails, subsequently inviting them to engage in the research process by explaining the purpose of the study. The focus of this study is on SMEs located in Thailand. These enterprises were selected based on specific criteria established by the Office of Small and Medium Enterprise Promotion (OSMEP), which considers factors such as registered capital and operating characteristics to determine the size classification of entrepreneurs. The study incorporates 3 distinct industry groups. These industry groups consist of businesses operating in agricultural, food science, and biotech, health and medical-related businesses, and electromechanical and robotic engineering.

These selected industry groups represent a diverse cross-section of SMEs in Thailand and form the foundation for the key informant data utilized in the research.

3.5. Coding and Data Analysis

Before the analysis, transcribed texts were interpreted without deviating from the main theme of the original text. The study utilized a descriptive and interpretive approach from the perspective of key informants to describe how they managed their businesses during the COVID-19 pandemic and identified resilience factors they considered important. In order to perform the thematic analysis for this study, we followed the 5 phases of thematic analysis, which include familiarization with data, generating initial codes, searching for themes, defining and naming themes, and producing the final report [42]. In additional the main theme and sub-theme were derived through comparisons within and across groups. The results analyzed by the first author underwent multiple reviews by the second and third authors to coordinate opinions and ensure reliability and trustworthiness.

Thematic analysis, a qualitative research methodology, was employed in this study using NVivo software. While NVivo systematically managed textual data, it interpreted and organized the data into distinct themes. Recurring themes related to SC resilience factors and SCOR activities were identified in connection to the research questions. Finally, the program was used to illustrate the coding hierarchy chart, reflecting the hierarchy of the most frequently referenced items.

4. Results

The study's results were derived from in-depth interviews with 16 key informants across three industry groups. The data from these interviews was subsequently analysed for content and essence using the software Nvivo. The following section provides more details.

4.1. Information of Key Informants

The main key informants in these in-depth interviews included representatives from the agricultural, food science, and biotech, comprising 7 individuals, representatives from health and medical-related businesses, comprising 6 individuals, and 3 representatives from electromechanical and robotic engineering, totaling 16 participants. Only one interviewee was present in each interview session.

Among them, 10 were males, and 6 were females, with an average of 8.43 years of business experience ranging from 3 to 21 years. The majority of the representative entrepreneurs held positions as managing directors and founders, and most of them were affiliated with small enterprises. The duration of the interviews ranged from 51 minutes to 100 minutes, with an average interview time of 64.18 minutes. The details were presented in Table 2. The interviews were carried out using Zoom videoconferencing, and each interview was meticulously recorded with the full consent of the key informants.

Table 2. Key informant characteristics.

ID	Position	Experience (year)	Firm Size	Duration (Mins)
Health and medical-related businesses				
S1	Managing Director and Founder	7	S	84
S2	Managing Director and Founder	4	S	56
S3	Managing Director and Founder	15	S	59
S4	2nd generation heir	10	S	55
S5	Managing Director and Founder	13	S	68
S6	Managing Director and Founder	5	S	51
S7	2nd generation heir	11	M	60
Agricultural, Food Science, and Biotech				
S8	Managing Director and Founder	4	S	67
S9	Managing Director and Founder	7	S	51
S10	Managing Director	7	M	56
S11	2nd generation heir	21	M	53
S12	Managing Director and Founder	7	S	56
S13	Managing Director and Founder	3	S	100
Electromechanical and Robotic Engineering				
S14	Managing Director and Founder	15	M	48
S15	CEO and Advisor	3	M	90
S16	Managing Director and Founder	3	M	73

(Source: Analyzed by the authors)

4.2. Keyword Analysis and Overview of Initial Coding Findings

To obtain an overview of the words that emerged prominently during the interviews, we conducted a keyword analysis in the form of data visualization. Words that were mentioned frequently were displayed in larger fonts, while less commonly mentioned words appeared in smaller fonts. This analysis was performed using the Nvivo software, which facilitated the identification of the most frequently used words. Prior to the keyword analysis, the text underwent a thorough cleaning process, including formatting interviews to ensure they were suitable for analysis, spell-checking, and adjusting spacing. This preparatory step aimed to enhance the accuracy of word group summarization. Additionally, we employed a stop words list to eliminate meaningless words that frequently appeared in interviews, such as common language connectors ("yes," "then," "we will," "think," etc.). The data was processed until all such meaningless words were removed to meet the defined criteria.

The results of the analysis conducted on all the interviews, visualized as word clouds, are summarized as follows: The top 5 words with the highest frequency of mentions, ranked in descending order of frequency, are as follows: "Covid" with a frequency of 230 mentions, followed by "Plan" with 209 mentions, "Supplier" with 171 mentions, "Product" with 112 mentions, and "Flexibility" with 97 mentions. These findings are depicted in Figure 1.

Figure 1. Word cloud analysis.
(Source: Authors /Nvivo program)

4.3. Thematic Analysis

Thorough thematic analysis was conducted from the interviews, 5 main themes emerged to categorize SME opinions regarding factors influencing SC resilience within the SCOR model paradigm. These themes include (1) visibility, (2) agility, (3) flexibility, (4) collaboration, and (5) business partnerships. Subsequently, these overarching themes were subdivided into subthemes.

4.3.1. Main Theme: Visibility

Key informants stated that during a crisis, entrepreneurial visibility helps SMEs potentially improve their SC resilience, particularly by having a vision for innovation, marketing, technology, and discovering new business opportunities. This approach aids businesses in surviving and adapting to complex situations. Conducting research with the education sector to enhance products and services, fostering innovation within the organization, and continuously researching products contribute to technological development and the creation of higher-value products. Identifying market opportunities enables businesses to launch products that align with customer needs during crises. Additionally, preparing for changes enhances a business's ability to spot emerging trends, such as online marketing trends and access to international markets in specific product groups like health and sustainability products, as shown in the excerpt below.

"...We explore upcoming innovations. Although there are new innovations on the horizon, we need to acquire the necessary knowledge; let's take AI as an example. We are collaborating with the university, initiating the process here. As soon as their knowledge becomes available, we can proceed. We have already acquired the machine, including the camera that detects light and spectrum, and we have familiarized ourselves with its functionality. In simple terms, there is just one more step. When this technology becomes available next year, we will be ready. We have already acquired the necessary knowledge. This is considered an investment, an initial investment on our part."

Key informant from the electromechanical and robotic Engineering industry No.16

Furthermore, key informants highlighted the importance of having a vision in planning production during a crisis, especially when considering market volatility and estimating potential obstacles. Using statistical data and analyzing customer needs from previous years allows for more accurate planning. This extends to transportation planning, where anticipating and coordinating upcoming events and managing transportation costs, such as cost analysis on shipping lines, are crucial, particularly during events like the COVID pandemic. These measures are vital for maintaining customer service standards. Concerning a vision for purchasing raw materials during a crisis, purchasing small quantities reduces risk and helps businesses maintain financial stability. Utilizing reserve funds to manage inventory, securing raw materials at appropriate prices, allows businesses to effectively cope with change, as shown in the excerpt below.

"...Actually, in the warehouse function, we are keeping an eye on things. As winter season, we might need to ramp up our stock. Orders start pouring in more frequently, and you know, there can be issues, especially with the packaging. It has a shelf life of about 2-3 months. If we do not handle it well, we might run out of packaging, and if that happens, the product goes out of stock. And you know, dealing with modern trade is a big deal. If we cannot deliver the goods, there is a hefty fine waiting for us."

Key informant from the health and medical-related businesses industry No.2

4.3.2. Main Theme: Agility

Key informants provided their insights on the role of business agility during crises, emphasizing its proactive role in supply activities for quick adaptation to change.

This ability enables businesses, particularly in the SMEs, to swiftly adjust to changes and respond promptly to customer needs. This agility is particularly notable in businesses with flexible decision-making processes and adaptability due to a smaller chain of command and lack of hierarchy. Rapid decision-making proves crucial in averting crises and allows for timely adjustments.

The key informants highlighted the diverse role of agility in business operations, extending from upstream activities such as production and services, procurement, transportation, distribution channels, and financial channels to cash flow. This agility in production and service encompasses the ability to alter product or service formats to meet customer needs during crises. Examples include shifting production from slow-selling products to those in high demand, substituting normal orders, modernizing branding or product labels, downsizing packaging for easier sales during crises, and adapting marketing and distribution channels, as shown in the excerpt below.

"...It has had an effect because, after facing COVID-19 crisis, we started anew—reworking everything, relocating, rebranding, and revamping our processes. Our adaptability allows us to stay in sync with the market, meeting customer preferences and finding suitable channels to distribute our products."

Key informant from the health and medical-related businesses industry No.3

In terms of procurement agility in SMEs, the advantage lies in their access to diverse channels and the ability to control prices more effectively than larger organizations. This agility proves beneficial when changing raw materials during production. Additionally, agility in logistics is crucial for adjusting transportation plans and modes to maintain service level and readiness for delivery.

However, key informants highlighted the primary limitations faced by SMEs during crises, specifically in terms of financial agility and cash flow. They agreed that decisions to alter plans depend on having adequate cash flow, and financial agility, supported by financial institutions, is instrumental in enabling businesses to survive. The ability to maintain cash flow and have financial reserves plays a pivotal role in surviving crises, as shown in the excerpt below.

"...Actually, it is all about being agility in financial, you know. The real hurdle for us SMEs is having enough cash flow. It is never smooth sailing. The thing is you need money to make things happen. Sometimes, customers pay late, or unexpected stuff comes up.

So, even if you have got the ideas and plans, you are stuck without the cash. Budget constraints and cash flow issues limit us. I have often wondered, why not just get a bank loan? But hey, getting a loan is no walk in the park, especially if your company has not hit the three-year mark. It is a bit of a struggle."

Key informant from the agricultural, food Science, and biotech industry No.12

4.3.3. Main Theme: Flexibility

Many key informants emphasized the significance of business flexibility during crises, impacting the potential for SC resilience and adapting business operations. By providing this flexibility, businesses can sustain operations in an unstable environment, affecting various activities in the supply chain, including production, procurement, logistics, and inventory management.

Examples of operational flexibility highlighted by key informants involve considering the purchase of products from multiple suppliers to accommodate situations where the regular supplier is unable to deliver, and the ability to switch suppliers when necessary. Having alternative suppliers can reduce costs, particularly when importing raw materials from abroad in emergencies. Planning a procurement strategy to address uncertainties in national lockdowns or other changes, including auditing and evaluating suppliers to ensure they meet standards and can act as a backup option, was also emphasized, as shown in the excerpt below.

"...The supplier will not be a monopoly with just one supplier. We aim to have 2, 3, 4, or even 5 suppliers, which we carefully evaluate through price comparisons to ensure competitiveness. In case one supplier is unavailable, we assess the possibility of using an alternative. This involves thorough research and preparation. For instance, if a particular shampoo ingredient is no longer available in the market, we search for alternatives, comparing them to our original product. This way, we anticipate potential issues and have a contingency plan. While challenges may arise, having 2nd, 3rd, or 4th suppliers help us navigate and overcome difficulties, although the majority of problems we face revolve around shortages of raw materials."

Key informant from the health and medical-related businesses industry No.2

Production flexibility plays a crucial role in adjusting production when there are changes in the market or customer demands. This includes utilizing machines for rapid production, contributing to business continuity.

Regarding inventory flexibility, key informants stressed the importance of setting minimum inventory levels in raw material management to maintain production flexibility. Increasing inventory levels can help businesses navigate uncertain crisis conditions, especially when facing delivery uncertainties, and involves regularly checking, as shown in the excerpt below.

"...We have plans to modify the production plan, including having spare parts. If something breaks, we have a replacement. If the customer wants something specific, we can adapt the workflow to meet their needs. We will utilize what's functional and implement a plan to swiftly adjust production to keep it running. "

Key informant from the health and medical-related businesses industry No.3

4.3.4. Main Theme: Collaboration

The key informants reiterated a consistent viewpoint: building cooperation is a crucial factor significantly influencing the creation of SC resilience. This is achieved by fostering cooperation and engagement among all members of the supply chain, whether in activities like production planning, procurement, product delivery. Key informants emphasized the importance of fostering teamwork within the company to enable everyone to contribute to enhancing business operations, especially crucial for smaller organizations that may lack the resources of larger counterparts. The cooperation and exchange of knowledge and experience between SMEs can strengthen their ability to conduct business during crisis situations.

During crises, the establishment of collaboration plays a pivotal role. A key aspect of this is the increased frequency of communication and information exchange within and outside the organization. This heightened collaboration aids in tracking work progress and adjusting plans swiftly in response to dynamic situations. The importance of collaboration between production planning and procurement was highlighted, particularly in effectively managing procurement when demand surpasses supply. Continuous discussions and evaluations are deemed necessary for ongoing adjustments, as shown in the excerpt below.

"...Collaboration is incredibly beneficial, I think especially SMEs need to collaborate with other organizations as much as possible because, being SMEs, we face a disadvantage due to our limited strength compared to larger companies.

We cannot stock up on a variety of items, so we must rely on suppliers to help recommend where to find raw materials in times of crisis or suppliers to help us with notifications about product prices that are about to increase. This collaborative effort helps us predict paper stock needs and secure fixed prices until the year-end or find alternatives at a reasonable cost."

Key informant from the agricultural, food science, and biotech industry No. 2

Furthermore, collaborative initiatives between the supply chain and various government agencies, such as the Ministry of Commerce, Provincial Industry Federation of Thai Industries, and universities, in the research and development of products and services, as well as assistance with various information, were emphasized. This collaborative approach, particularly during crises, can include providing support in business matching and sharing information about trade fairs, significantly increasing the likelihood of finding customers, as shown in the excerpt below.

"…Do not overlook the government sector. The government sector plays a crucial role in keeping us going. Whether it is providing information, supporting marketing efforts, or various other aspects, they are vital. We admit that we came at a time when we were not fully prepared, but we also have government agencies supporting us with knowledge and various information."

Key informant from the health and medical-related businesses industry No.6

4.3.5.   Main Theme: Business Partnerships

The key informants highlighted the significance of developing business partnerships for mutual benefit, emphasizing their crucial role in enabling SMEs to navigate crisis situations and fostering the SC resilience. Successful business partnerships rely on a common vision, facilitating joint efforts to achieve shared objectives.

Various partnership forms in production and services, like joint ventures, offer shared ownership and strengthen business networks. For instance, collaborating with farmers cultivating sericulture as raw materials establishes a network that provides mutual support during crises and assistance during periods of increased demand by sharing manpower within the farmer group.

Marketing partnership proves invaluable for expanding sales channels and reaching diverse customer groups. This includes ventures like exporting products abroad, utilizing shops in modern trade, and leveraging marketing partners to broaden outreach.

"…We have friends doing exports overseas. So, we asked a friend to collaborate and share ownership in a joint venture company. They assist us in selling our products and expanding the market internationally. It is akin to participating in a joint venture, making them co-owners of our products."

Key informant from the agricultural, food science, and biotech industry No.8

Procurement partnerships, especially during crises with limited raw materials, involve establishing robust trading relationships. Engaging in trade alliances grants privileges for accessing raw materials at reasonable prices, often surpassing what other trading partners may receive. Building a network within the supply chain fosters partnership among businesses, transforming potential competitors into supportive partners. This collaboration extends to sharing inventory within a business network to sustain operations and cultivate positive relationships, as shown in the excerpt below.

"…We are a group of four people, running four shops and handling imports ourselves. For products requiring significant licenses, we share with a friend who specializes in large-scale imports. For items not requiring specific licenses, we manage our own inventory. This way, we support and collaborate with each other, communicating regularly. There is no competition among us; instead, we aim to help one another. If certain parts are running out, we inquire: 'Do you need them? Want to buy and stock up first?' This is what we call partnership."

Key informant from the electromechanical and robotic Engineering industry No.12

Furthermore, having partnerships with government agencies and universities is recommended. This involves creating mutual benefits and sharing knowledge between businesses and academic institutions, fostering innovation and enhancing competitiveness in a dynamic market and industry.

Table 3. Main theme and sub-theme

Sub-Theme	No. of Coding Reference
Main Theme 1: Visibility	
• Innovation creation, trends in technology and marketing, including identifying new business opportunities.	76
• Production and service visibility	17
• Sourcing visibility	10
• Inventory management visibility	9
• Logistics planning and cost management visibility	4
Main Theme 2: Agility	
• Production and service agility	35
• Marketing and distribution channels agility	23
• Financial and cash flow agility	16
• Sourcing agility	13
• Logistics agility	7
Main Theme 3: Flexibility	
• Sourcing flexibility	22
• Inventory management flexibility	17
• Production flexibility	11
• Logistics flexibility	3
Main Theme 4: Collaboration	
• Communication and information exchange	63
• External government agencies and universities collaboration	30
• Internal organization collaboration	17
Main Theme 5: Business Partnerships	
• Business partnerships with government agencies and universities	14
• Business partnerships in production and services	15
• Business partnerships in sourcing	10
• Business partnerships in marketing and distribution channels	3

(Source: Analysed by the authors)

This analysis presents the findings derived from assessing the essence and frequency of factors contributing to the SC resilience in SMEs within the framework of SCOR model activities. The data were analyzed using the hierarchy chart analysis technique. Figure 2 illustrates main theme and sub-themes based on the number of references coded, emphasizing the significance of the themes in SMEs' SC resilience within the SCOR model framework. The size of each theme area corresponds to the number of times key informants referenced it, while the theme hierarchy indicates the order of importance.

The main themes of visibility were mentioned and referenced the most, with 205 references (blue). Collaboration followed with 179 references (yellow), agility with 155 references (orange), flexibility with 145 references (grey), and business partnerships with 114 references (green) as showed in Figure 2.
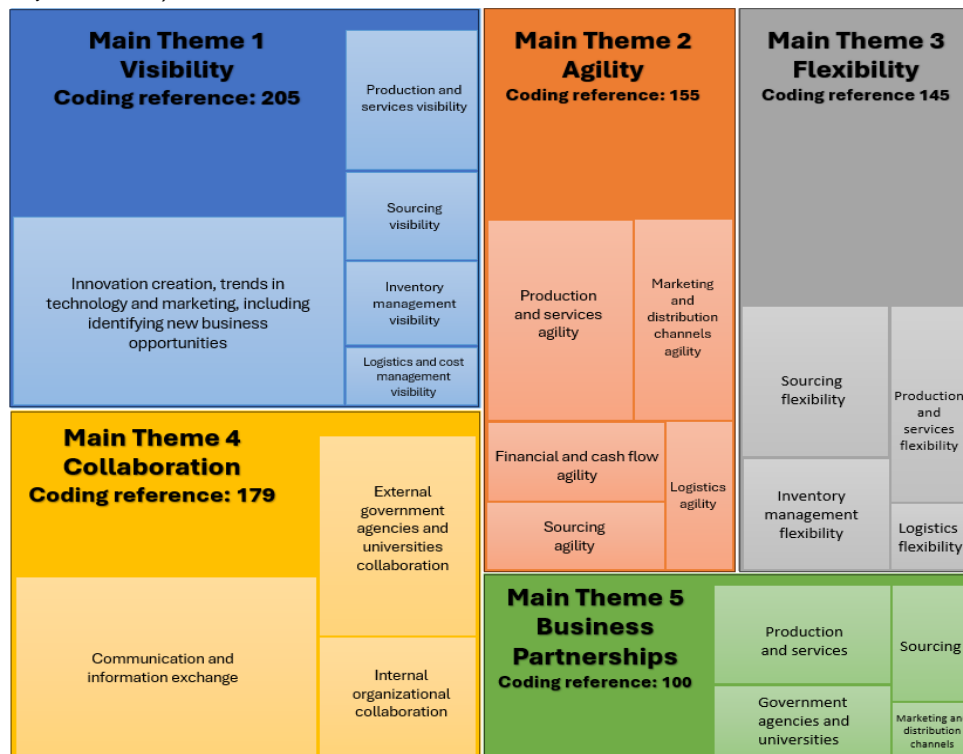

Figure 2. The main themes and sub-themes of the factor of SC resilience to the SCOR model activity framework with hierarchical chart techniques. (Source: Retrieved from NVivo software)

5.   Discussion

Results from the data analysis showed that key informants most mentioned factor influencing the SC resilience potential in the SMEs within high-growth sectors is the "Visibility". Following closely are "Collaboration", "Agility", "Flexibility, and "Business Partnerships". These insights reflect the perspectives of key informants in SMEs within the 3 main high-growth clusters: 1. Agricultural, Food Science, and Biotech, 2. Health and medical-related businesses, and 3. Electromechanical and Robotic Engineering. The emphasis is on visibility in operation (main theme 1) across various functions, aligning with the SCOR model for plan, source, make, and deliver. Additionally, key informants focused on the importance of visionary operations, particularly in fostering innovation, monitoring technological and marketing trends, and ensuring business sustainability while identifying opportunities. This finding aligns with a study by Sabahi and Parast [33], which concluded that companies with a more innovative corporate environment demonstrate increased SC resilience and are better equipped to handle disruptive events, positively impacting their risk management abilities. Similarly, these results are consistent with goal 4 of the United Nations Sustainable Development Goals (SDGs), which focuses on utilization of innovation for post-pandemic recovery and sustainable development [1].

Key informants emphasized the significance of operational flexibility in the SC resilience during crises, whether it relates to flexibility in production, procurement, inventory management, or transportation. In line with Jüttner and Maklan [43], flexibility is a core competency that helps businesses cope with the negative impacts of a recession and respond to difficult-to-predict demand shifts. Flexibility allows businesses to have operational options, enabling them to switch to cost-effective sources of procurement, allocate new production capacity, and increase efficiency in using both internal and external production capacity. This helps control costs and meet increasing demand, as well as adjust procurement at a lower cost, thereby increasing bargaining power in price negotiations with suppliers. Additionally, this research indicates that resilience is the ability of a dynamic supply chain not only to withstand disruptions but also to create a competitive advantage during normal operating hours. Alshahrani and Salam [44] also pointed out that flexibility and agility have a significant positive relationship with the production and marketing performance of SMEs. SMEs with more flexibility in their supply chain operations will be better able to adapt to change and disruption.

Affecting more efficient operations. This study reflects the importance of developing flexibility and agility in supply chains to be able to effectively cope with changes and changing market conditions.

In terms of "Collaboration" (main theme 4), this involves fostering collaboration through communication and information exchange, both within the organization and between supply chains. This aligns with the research of Scholten and Schilder [45], which found a positive relationship between factors supporting cooperation and SC resilience. In other words, organizations that engage in information sharing, collaborative communication, and relationship-building, while also enhancing knowledge within the organization, can achieve greater visibility, business agility, and flexibility. These outcomes contribute to the effective SC resilience. In the study of Carissimi et al. [46] also found that organizations should support collboration during crises in planning joint operations, whether it involves production planning, transportation planning, or inventory planning to meet customer needs during a crisis. They also emphasize the importance of collaborative efforts to ensure the organization's survival in the future. In addition, the findings of Banerjee et al. [47] highlighted the necessity for collaboration among SMEs and highlighting the benefits of pooling knowledge. The collaboration assist entrepreneurs in formulating effective operational plans, facilitating well-informed decision-making in the planning of business supply chain operations.

In addition, having "Business Partnership" (main theme 5) in SMEs, whether forming alliances in production, procurement, marketing, or engaging with government agencies and universities, is a crucial factor that strengthens the ability to conduct business during a crisis. This aligns with the findings of Tarigan et al. [29], indicating a positive relationship between SC resilience and having supply chain partnerships. Building a mutual relationship between suppliers and trading partners involves a strategic approach, emphasizing long-term relationships built on trust, commitment, and mutual cooperation. The objective of supply chain partnerships is to create a win-win situation by sharing risks, costs, and benefits. Effective supply chain partnerships assist businesses in coping with uncertainty, improving supply chain agility and flexibility, and achieving sustainable advantages. Therefore, orgniazation must foster strong relationships and collaborate with supply chain partners to enhance agility, flexibility, and sustainable advantages. Sustainable and effective supply chain partnerships enable companies to share information, resources, and knowledge, leading to better decision-making and improved performance.

Kamalahmadi et al.'s [48] study underscores the importance of relationship commitment in building resilience in the supply chain loop, emphasizing that companies with strong relationships with suppliers and other partners are better equipped to deal with disruptions and recover more quickly. Additionally, these findings align with the SDGs in Goal 17 [1], which focuses on strengthening partnership support and promotes partnership between the public sector, public-private partnership, and the community, built on the experience and resource strategies of the stakeholders for the goals.

6. Conclusion

In conclusion, the proposed framework for integrating SC resilience factors with the SCOR model paradigm from the data analysis included 1) visibility, 2) agility, 3) flexibility, 4) collaboration, and 5) business partnerships. Conversely, outcomes from the data analysis and the identification of sub-themes were developed as components for SC resilience with the SCOR model paradigm using the hierarchy chart technique.

The findings revealed that the theme of the visibility comprised 5 sub-themes: 1) innovation creation, trends in technology and marketing, including identifying new business opportunities; 2) production and service visibility; 3) sourcing visibility; 4) inventory management visibility; and 5) logistics planning and cost management visibility. The theme of the agility comprised 5 sub-themes: 1) production and service agility; 2) marketing and distribution channels agility; 3) financial and cash flow agility; 4) sourcing agility; and 5) logistics agility. The theme of flexibility included 4 sub-themes: 1) sourcing flexibility; 2) inventory management flexibility; 3) production flexibility; and 4) logistics flexibility. The theme of collaboration consisted of 3 sub-themes: 1) communication and information exchange; 2) external government agencies and universities collaboration; and 3) Internal organization collaboration. The theme of business partnerships comprised 4 sub-themes: 1) business partnerships with government agencies and universities; 2) business partnerships in production and services; 3) business partnerships in sourcing; and 4) business partnerships in marketing and distribution channels. This finding is illustrated in Figure 3.
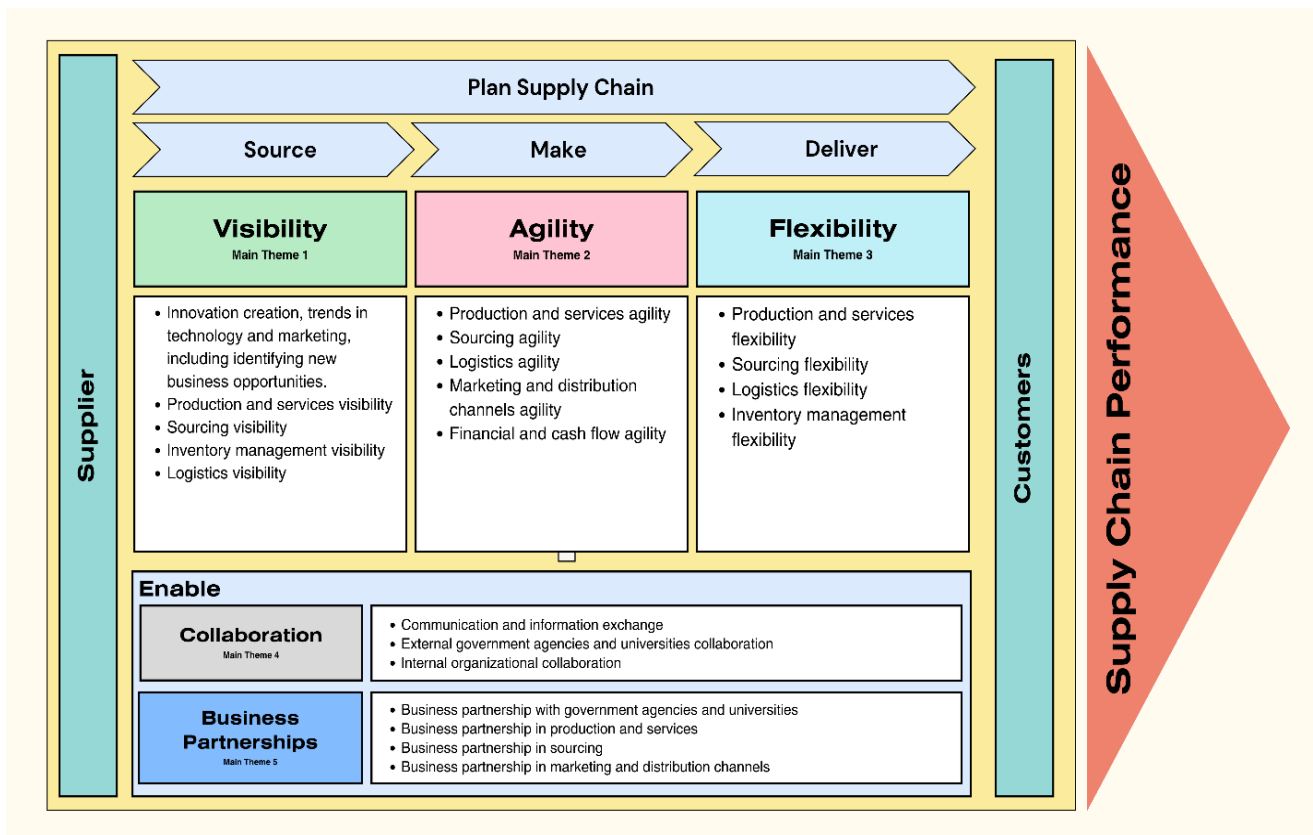

Figure 3. The proposed framework for integrating SC resilience factors with the SCOR Model Paradigm
(Source: Developed by the authors)

6.1. Theoretical Contribution and Practical Implications

The study's theoretical contribution has not been explored in current research trend in SC resilience, highlighting the incorporation of a specific factor within the SCOR model, delving deeply into the components of plan, source, make, deliver, and enabling factors, specifically focusing on collaboration and business partnerships. It is of academic significance in that it considered extending the SCOR model in the context of SC resilience ensures the alignment of supply chain processes with overarching business objectives and contributing to organizational success and competitiveness. To respond to and manage potential disruptions and changes in demand, the proposed framework is invaluable in providing a structured and adaptable approach to supply chain management, encouraging business efficiency, collaboration, and continual improvement. In addition, through a close qualitative analysis of the results of one-on-one interviews, it was possible to draw out the in-depth story of the research subjects, a dimension not well revealed by quantitative research.

The practical contribution of this study lies in enhancing the SC resilience of SMEs. The paper presents specific supply chain activities designed to improve both SC resilience and performance. These strategies can be applied to extend the results of the present study and develop a strategy to increase SC resilience. Such insights would be beneficial for offering suggestions to SMEs in Thailand's high-growth SME clusters, which include agricultural, food science, biotech, health and medical-related businesses, as well as electromechanical and robotic engineering.

6.2. Limitation and Recommendation Future Research

The limitation of this study is that the interviews were conducted among SMEs in a specified cluster in Thailand. To ensure that the key interviews were conducted with individuals experienced in crises and capable of addressing factors related to SR resilience, the researchers conducted interviews during the COVID-19 pandemic to gather information about the impact on their businesses. This study relied on data generated through a literature review and qualitative methods. The framework proposed may not necessarily lead to results that ensure generalizability. It is crucial to incorporate companies from various industries, and the outcomes might differ across diverse countries and regions.

Future studies should conduct quantitative research to confirm the validation of the proposed framework.

The study's outcomes could further contribute to the establishment of weighted assessment criteria for SC resilience factors, either as support for the SCOR model or as part of a system for evaluating SC resilience capabilities through a mobile or web-based application. These tools could then be utilized to implement specific strategies aimed at enhancing supply chain performance within SMEs.

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