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Enhancing Financial Performance through Supply Chain Innovation (SCI) with Mediating Role of Robustness and Resilience Capability in Thailand's Manufacturing Sector

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Abstract- **Purpose: Main objective of this research is to assess the relation between SCI and risk management capabilities of firms and to focus that how innovation and risk affect financial performance. Methodology: In order to analyze the hypotheses developed in this study, survey method in the form of questionnaire was adopted to collect data from the manufacturing firms of Thailand. The data collected in then analyzed by using different statistical tools including SPSS and AMOS. Findings: Outcomes of research clearly shows that SCI has significant positive impact on the level of risk associated with firms including both robust and resilience risk factors in terms of technological advancements. The results show that these variables are inter-related with each other which means that with the increase in innovativeness, the risk associated with it also increases as a result the financial performance of firms also increases. Implications: The research provides data and an addition in literature related to SC management by investigating the impact of innovation on risk and performance levels of firms. It also provides help to mangers to critically analyze and to make sound decisions related to impacts of technological processes on their Supply chain (SC) practices globally. Novelty: This study is unique in its own perspective because it has focused on the relationship of SC innovation, risk management as well as financial performance altogether of the manufacturing firms that are involved in international levels of SC in Thailand.**

Keywords; *SC innovation, Risk management, Robustness, Resilience, Financial performance, global supply chains, Thailand*

Introduction

Today, businesses are becoming more complex and risky because of the adoption of practices such as globalization of supply chains, increase in the level of outsourcing leading to shorter life cycle of products. With the increase in levels of risk, supply chains are becoming time sensitive and complicated therefore some strategically measures are needed to be applied within supply chains by the firms to effectively develop coordination with its suppliers and customers in order to compete and enhance performance [1-5]. Risk management performed significantly in decision making practices of organizations [6-7]. It has also played a significant role in the process of SC management (SCM). This relation has been studied by [8] who proposed that by increasing technological advances, moving towards global competition and looking ways for attaining competitive edge increases the chances of risk management in their approaches. A few authors also wrote on the increasing amount of risks particularly in supply chains and also proposed solutions to mitigate these risks by adopting and implementing appropriate measures during their decisions [9]. A few studies also concluded that with the adoption of these performance measures, there is also an increase in the challenges faced by operations management [10]. Moreover, [11] also elaborate this concept and found that in order to obtain coherent SCM, developments are required to be made in these performance measurements.

Supply Chain Risk management (SCRM) is considered to be have a distinct strategic value in the supply chains globally [8]. It is considered that this trend of increase in risk in SC efficiency has been aroused because of the availability of facts associated with globalization, outsourcing, reduction in inventories, decreased level of operation timings, presence of centralized production and distribution levels [12-15]. No doubt, supply chains have integrated global economies by increasing their chances of getting advantage in international markets by focusing more on complex worldwide logistics and sourcing, but it has also enhanced the amount of risks associated with it including uncertainties regarding cultural , exchange rate as well transportation issues [16]. Therefore, with the increase in these risks, SCrisks are considered to have a natural response [9]. Technological advancements and innovation has always been under consideration regarding their impact on the levels of risks either these innovations increases or reduces the business risks [17]. Innovations in supply chains have also played a fundamental role in communicating data to all levels in SC with the help of product and process innovation in order to meet the needs of customers and to find ways to further increase the processes [18].

SC innovations not only progress the organizational functioning but also act a catalyst to risk management capabilities by rapidly initiating planning, procuring, observing as well as forecasting processes in SC practices

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[59]. This process has become a significant mark and been adopted by a number of leading firms today including Apple, Microsoft and Samsung that have tried to embed innovative services in their supply chains globally [19]. Studies indicate that such firms having elements of innovation in their SC practices at a high level are considered to be more sophisticated in terms of technological and risk reducing reforms [20]. In the past few decades, risk management has been under discussion by various researchers in terms of SC integration, however a few of them only consider antecedents and consequences of risk management related strategies including robust and resilience factors and less attention has been paid to this relationship [19, 21-25]. Despite of the importance of SC risk management and its influence on the financial performance of firms, still the relationships are considered inconsistent. Numerous researches have been carried out analyze the relationship between SC and performance indicators such as operational performance [26-31], logistics performance [32-34] etc. but no study has focused on the combined relationship of SC innovation, risk management and financial performance of firms together in the context of Thailand firms. So, the main purpose of this paper is to analyze the impact of SCI on risk capabilities of manufacturing firms in Thailand and how these innovations and risk capabilities affect their financial performance. Moreover, it also emphasizes the mediating role of robustness and resilience between SCI and performance levels.

The remaining paper is organized as follows: firstly, literature regarding the relationships between SC innovation, risk capabilities and financial performance is reviewed then based on this extensive literature, hypotheses of this study are developed. Secondly, methodology adopted and data collection methods in this study are discussed. Then results are generated and analyzed on the basis of that collected information and finally, the paper is concluded along with some implications and future indications.

2. Literature review
2.1. SCI

Innovation is essential for organizations to cope with modern society and react to quick changes occurring in the everchanging world. Generally, innovation takes place at strategically level, in technologies, product and services as well as in organizational structures. Specifically, SCI involves technological improvements in processes and procedures of the SC as well as changes in product or service that effectively increases satisfaction to the end consumer [60-61]. For example, the organizations are greatly relying on innovation to add value to the transporter [35]. SCI puts emphasis on needs of customers that will add value to customer base. As SC parties are becoming more innovative in terms of adopting new processes, operational practices and investing in new technical methods to supply what was promised, meet standards and solve problems [36]. SCI is distributed in two portions of technology development and process development, the aim to develop technology and processes is becoming difficult for organizations.

Development in technology helps in development of actual tracking methods across global supply chain. Innovation and development in technology helps to increase labor and capital efficiency and offer actual visibility regarding the flow of shipments, information and sales data so that they can enhance inventory management and widen their value proposal for final customers. The use of modern technologies, can effectively support risk management of SC [37]. Innovation and technological advancement play an important role in achieving economies of scale in purchasing, logistics and central distribution centers which can be a key means of difference in logistics services. Although there are various technological innovations but all focus on the one same thing i.e. delivering value to the customer. Innovation in the processes contribute in betterment of systems of SC so that process of supply and management can be developed for the betterment and enhancement of quality [38].

2.2. Robustness and Resilience capabilities

To minimize the effects of some disruption is the main task of SC risk management team because it enables an organization to be sustainable even under severe circumstances ultimately increasing financial performance [23]. Both robustness and resilience are considered as an effective skill to contribute, but they have different meanings. Robustness is the ability to resist and tolerate while resilience is the ability to adjust and maintain. Robustness in SC is the ability to remain effective for all possible future circumstances. Robustness means strength to cope with errors in SC management. SC risk management emphasizes on solution robustness, which means the flexibility decide the possible options under all reasonable future scenarios. Resilience is the quality of an organization to bounce back to original condition after disruption [39]. In the SC situation, it refers to the ability of an organization to become stable again after instability. It can be obtained by swift bouncing back to routine work with the help of effective teamwork and coordination. Opposing to robustness, resilient supply chains are able to deal with unexpected events which can be considered as low probability but having high consequence. Disruptions consists of two extremes one is the insignificant preliminary impact and the other is severe full impact on the organization. To evaluate the magnitude of risk which impacts the organization this approach considers both performance level and duration of impact [40].

Robustness plays an essential part in start of some disturbance because it also prepares a system to avoid disturbance and to get back to normal conditions as fast as a firm can. The deviation in the usual functioning level is also controlled because a robust SC can avoid any disturbance before its occurrence [41]. On the opposite side, elasticity is reactive in nature therefore, it can mitigate unexpected or subsequent risk events [41]. Whenever changes occur at large scale or the entry of an organization in highly unstable environment occurs as an ambiguous event that puts the existence of the firm against a question mark here the need of that time is to firstly try to adjust with the situations that the firm is going through, once a firm adjusts itself according to the disruptive

conditions, after that it can make itself able to devise ways and means to bounce back to the disruption free situation, situations like these demand certain course of actions, these actions include the forecasting of danger and pressure situations, forecasting involves bringing those statistics in the table that will contribute in some kind of disruption in the normal functioning of the firm, then the firm can forecast results and then it can forecast about its course of action against the disruptive or dangerous change, best policy to adopt is to avoid a disruptive condition as much as a firm can and if something like that occurs, the bouncing back to the stable conditions define the risk management abilities of a firm . [39].
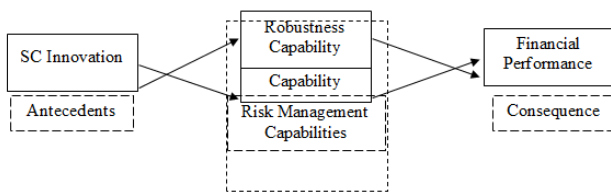

Figure 1. Framework of this study

2.3. Financial performance

In order to make major decisions regarding the changes made in the SC integration in the method of innovation or any other requirement, critical evaluation of various factors is essentially required to undermine the potential outcomes associated with it. Apart from significant outcomes, certain factors are also required to be focused while adoption of these changes and these factors may include costs and risks faced by such key decisions. According to studies, it can be examined that performance and risk are interconnected to each other. Therefore, while making changes, robust implementation tools must be applied by the supplier management in order to control the associated risks and to maximize financial performance due to these technological developments [42]. Financial performance usually explains the degree by which firms attain their goals and objectives in order to obtain edge from their competitors at national as well as international levels [43, 44]. It also explains the efficiency and effectiveness of actions taken by the organizational members [45]. It also act as a source for firms to better understand their business processes and draw management attention to make certain changes if required in order to achieve the objective of a firm efficiently [46]. In terms of performance, SC management has both advantages, in the short run and also in long run. The short term goal is to reduce inventory cycle time and to increase productivity levels where as the long term aims usually include focus on providing profitability to all the participants in SC and increasing market share of that firm in international markets [44, 47]. Few studies divide performance levels by SC management into different approaches including qualitative and quantitative approaches. Qualitative approach focuses on the quality, trust, innovation, visibility and flexibility whereas quantitative approach focuses on consumption of resources and costs faced by the firm [46]. Financial performance metrics are specifically used to assess organizational behaviors and to compare different firms over the time. Any initiative or change adopted by a firm

including change in its SC ultimately lead to enhanced level of firm performance [48]. So based on these studies, it can be clearly said that bringing innovation or change in any process of a firm either SC management results in the enhanced level of risks associated with it. But with these associated risks, there is also an increase in financial performance of firms because where there is greater risk, there is greater return. Despite of the availability of various studies that acknowledge the significance of SC on firm performance [4, 49-52], only few focused on the risk management in SC and its influence on financial performance [4, 49]. Following are the hypotheses:

H1: *There exist a significant positive association between SCI and financial performance of manufacturing firms in Thailand*

H2: *Robust Capability positively mediates the relation between SCI and financial performance of manufacturing firms in Thailand*

H3: *Resilience capability positively mediates between SCI and financial performance of manufacturing firms in Thailand*

3. Methodology
3.1. Method and measures

For collecting data a survey will be conducted. In this survey method, questionnaires are used as a quantitative method to collect required information from the respondents. The questionnaire items adopted are constructed by using various past researches. In order to operationalize the constructs, measuring scales were constructed on the basis of some past studies [53]. As the items were selected on the basis of prior literature therefore, there reliability is not under doubt. Each variable in this study is measured by using various items. And all these items were adapted according to the need and core purpose of this study to get appropriate results. In order to avoid any sort of error, these items were allowed to pass through various monitoring stages and rigorous testing. However, in order to measure construct validity, Q-sort method was applied to these constructs adopted. For this, few practitioners and academics were allowed to go through the hit ratio. The result of this hit ratio clearly indicates that all constructs exceed the required threshold ratio [54] by ensuring the content validity of all these items selected. The medium of language while constructing these measures is English so that it becomes easy for respondents to clearly understand the meanings and concepts.

Seven-point Likert scale is utilized to measure all the variables adopted ranging from 'strongly disagree' to 'strongly agree'. SCI is measured by using six items, robustness and resilience capabilities of risk management variable is measured by four items for each whereas for financial performance, four measures have been adapted by the studies of various researchers [39].

3.2. Data collection

The data used for this study is collected from high performance manufacturing firms of Thailand. The sample adopted are those manufacturing firms that are directly associated with high levels of SC integration and

innovations. While collecting data, as few things were kept under consideration in this study including; type of industry and firm size focusing number of employees working in a firm. All the manufacturing firms including final finished goods or semi-finished goods manufacturers, trading companies, logistics and transport intermediaries, exporter or importer of raw materials, international freight forwarders are considered in it. Whereas for size, larger firms having at least 100 employees are selected. Because larger firms are considered to have close relations with the SC practices and technological innovations [55].

On the basis of availability of financial data, the firms selected are contacted through telephonic communication in order to take permission from them to conduct survey in their respective firms. Then questionnaires along with cover letters are sent through mails to these firms. Continuous follow up was a top priority while collecting data in the form of telephonic contact or direct visits to the selected firms. The questionnaires were distributed to the senior managers or experts who were considered to have a direct link with SC practices globally and have enough knowledge regarding the operations and performance level of their firms with respect to these innovative practices. A definite time was given to these respondents to fill the given questionnaires with careful consideration and return those fully filled questionnaires within that time. The questionnaires collected were then passed through screening stages by removing all the unfilled or blank questionnaires in order to analyze the collected data leaving the sample size of 302 of these manufacturing firms.

4. Data analysis

Data is collected from the manufacturing sector of Thailand, there are 302 respondents were participating in this study, researcher run the different analysis in order to obtain the results from data.

Table 4.1. Demographic Profile

Characteristic	Category	Frequency	Percentage
Gender	Male	160	53.0
	Female	142	47.0
Age	21 to 30 years	90	29.8
	31 to 40 years	129	42.7
	41-50 years	68	22.5
	Above 50 years	15	5
Education	Graduation	47	15.6
	Post-graduation	133	44
	Master	93	30.8
	Other	29	9.6

Above mentioned table shows that, there are 160 male and 142 females were participate in this study. Mostly respondent falling in the range of 31-40 years of age and 133 respondents have post-graduation degree, 93 have master's degree and remaining have other degrees.

4.1. Reliability Test

The researcher used KMO and Kaiser-Meyer-Olkin (KMO) to measure reliability of data for factor analysis and then run Rotated Component Matrix. KMO. KMO returns values between 0 and 1. A **rule of thumb** for

interpreting the statistic. The results of KMO test indicated our data is suitable for factor analysis and factor analysis also good fit. See table 4.2 and 4.3.

Table 4.2. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.919
Bartlett's Test of Sphericity	Approx. Chi-Square	5419.267
	df	171
	Sig.	.000

Table 4.3. Rotated Component Matrix[a]

	Component			
	1	2	3	4
SCI1	.875			
SCI2	.877			
SCI3	.848			
SCI4	.850			
SCI5	.864			
SCI6	.845			
ROB1			.812	
ROB2			.822	
ROB3			.822	
ROB4			.707	
RES1				.833
RES2				.834
RES3				.843
RES4				.620
FP1		.838		
FP2		.834		
FP3		.847		
FP4		.713		
FP5		.736		

4.2. Data Normality and Descriptive Statistics

Skewness is a test of the irregularity of the probability division of an actual valued random construct regarding its mean. Its value can either be positive or negative or indeterminate. Skewness value ranges from "+1 to -1". This table also shows the descriptive statistics of the data;

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Table 4.4. Data Normality and Descriptive Statist ics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
SCI	302	1.00	5.00	3.3267	1.09866	-.193	.140
ROB	302	1.00	5.00	3.4048	1.14982	-.503	.140
RES	302	1.00	5.00	3.4081	1.12804	-.543	.140
FP	302	1.00	5.00	3.4742	1.12975	-.631	.140
Valid N (listwise)	302						

Findings show that the skewness value for all variables is under the range from -1 to +1 that's why data is normal, and descriptive statistics shows that there is no outlier in the data.

4.3. Discriminant and Convergent Validity
Discriminant validity is the degree in which the variable is in fact differing from each other experimentally. On the other hand, Convergent validity is the extant of assurance a researcher has that a characteristic is well evaluated by its measures [56].

Table 4.5. Discriminant and Convergent Validity

	CR	AVE	MSV	MaxR(H)	RES	SCI	ROB	FP
RES	0.9	0.689	0.349	0.914	0.83			
SCI	0.96	0.813	0.3	0.975	0.548	0.9		
ROB	0.89	0.681	0.349	0.98	0.591	0.48	0.825	
FP	0.92	0.733	0.297	0.985	0.512	0.541	0.545	0.9

Results prove the convergent and discriminant validity of the data, because every contract discriminate from each other, and value of AVE for all variables are greater than MSV.

4.4. Confirmatory Factor Analysis
The confirmatory factor analysis (CFA) is "a multivariate arithmetic process which is utilized in order to examine how good the studied constructs signify the figure of variables." Following table shows the findings;

Table 4.5. Nested Confirmatory Factor Analysis

	Model Fit Indices	Threshold Range	Observed Values
Nested Model	χ^2		289.835
	Df		129
	χ^2 / df	Lesser than 3	2.247
	GFI	≤ .80	.910
	IFI	≤ .90	.968
	CFI	≤ .90	.968
	RMSEA	≥ .08	.064

Above table shows the threshold range and observed value. The model above displayed the GFI=0.910; IFI=0.96; CFI=0.96 and RMSEA=.064. Above stated five indicators prove the CFA of the study except GFI, but it is near to range.
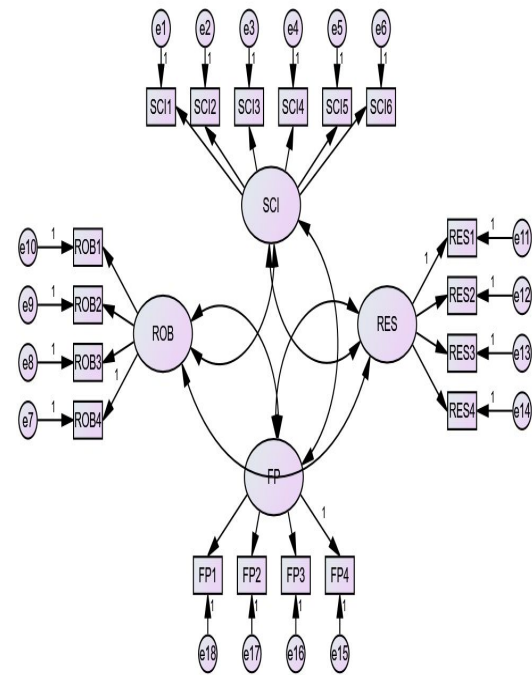

Figure 1. CFA

4.5. Structural Equation Modeling
By using AMOS structural equation modeling test was performed in order to test the hypothesis of this study, this test at the same time provide the direct and indirect results of regression;

Table 4.6. Structural Model Results

Effects	Hypothesized Path	B	S. E	P value	Conclusion
Linear Effects					
Hypothesis 1 (+)	SCI→ FP	0.278	0.058	0	Accepted
Mediation Effect					
Hypothesis 2 (+)	SCI→ ROB→ FP	0.336	0.048	0.01	Accepted
Hypothesis 3 (+)	SCI→ RES→ FP	0.189	0.052	0.01	Accepted

Above mentioned table 4.6 shows the structural modeling results and finding indicated that SCI has 29.5% positive impact on firm performance, which mean that if one unit of SCI increased it will bring 29.5% positive impact on Firm performance. Hypothesis 2 and 3 shows the indirect effect of SCI on firm performance via resilience capability and robustness capability. The finding of the hypothesis 3 indicated that robustness capability has 33.6% mediating effect between SCI and firm performance, whereas resilience capability has 18.9% mediating effect between SCI and form performance.

The following figure below is a screenshot of structural equation modeling while running in SEM in AMOS and

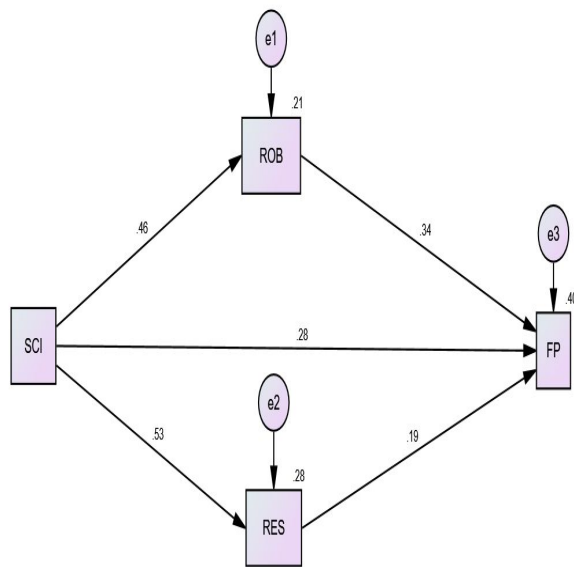shows the standardized regression weights between the variables.

Figure 2. Structural Equation Modeling

5. Conclusion

The research has concluded and provided information regarding the relation between innovation and financial performance of firms with relation to SC management (SCM) at a global perspective. It also provides a clear understanding of strategic risks associated with the adoption of such technological advancements in SCM by focusing on both robustness and resilience capabilities of firms. Because of increasing interest in the section of SC integration, numerous studies have been conducted regarding this relation, but the results are still considered unsatisfactory. So, this research is considered to expand the importance level of SCI at international level by focusing on the manufacturing firms of Thailand. The results of this theory are highly in accordance to the resource-based theory because the capabilities are highly associated in providing competitive edge to the firms that leads to increase their performance. The most influential outcome of this study is that SCM places a very important impact on the management of uncertain conditions and conditions that disturb the normal functioning of the organization. In the beginning, innovation leads to low levels of performance and high levels of risk attributes which my make it a barrier in SC practices but after certain time period it is considered as a driving force in generating high performances. The findings of this study clearly show that SCI has significant positive impact on financial performance of firms. It also provides evidence that innovation leads to an increase in robust and resilience risk capabilities but in return provides support to performance indicators. Moreover, it can be seen that innovation levels significantly enhance performance levels and also risk management capabilities significantly arbitrates the relation between SCI and financial performance among manufacturing firms in Thailand. These results are also found by various other researchers

too which state that technological improvements in SC not only enhance risk uncertainties but also provide chances of enhanced financial performances [57].

This study is considered to be an addition in theoretical literature by providing significant evidence about the extent of dangers related with SC innovation. It also provides an evidence on robustness and resilient capabilities of firms by associating innovation and financial performance together. This study is also in consistent with the previous studies and states that firms having high innovation levels are assumed to have higher risk levels associated with it [58]. Moreover, this relationship was investigated by developed countries including North America and European countries, but nobody focused on the Thailand firms. So, this study is considered to be the first one focusing on the manufacturing firms of Thailand. It can be adopted by various other researchers to conduct study in various other regions of the world to analyze the efficacy of innovation on performance level of firms with the mediating role of robustness and resilience capabilities. This study also provides implications at managerial level that help managers to find out the level of danger related with the implementation of innovativeness among its SC practices. It also allows them to critically review and make sound financial decisions regarding the effect of technological processes on their SC practices particularly working at international levels. It also helps managers to not only focus on the innovations in their functional units but also provide backup in the form of useful and productive resources to increase the performance of the organization.

Despite of the hypothetical and professional implications, this study has also some boundaries. Firstly, this study focuses on manufacturing firms of a single country that is Thailand.in future other multiple countries can also be considered to examine the financial performance because of innovation implementation and risk associated with this innovation at SC level. Moreover, this study does not consider objective data for financial performance of firms, therefore, further need on adoption of various indicators to measure performance is suggested. Finally, this study lacks longitudinal analysis and is based on cross sectional analysis, so for testing the theoretical representation longitudinal analysis is to be applied in future

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