THE EFFECTS OF SUPPLY CHAIN INTEGRATION ON TECHNICAL INNOVATION: CASE OF BREAD & BEYOND BAKERS

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DEDICATION

To my husband, **Dr. Sajjad Haider**, without whom this work would have been incomplete. In the hope that this work may in some way contribute to the field of Supply Chain in Pakistan, I would like to dedicate this work to my beloved mother, **Shahnaz Ata**, and father, **Ata-Ur-Rehman Bhatti** for their continuous support regardless of the circumstances I placed in front of them.

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ABSTRACT

This research work is focus on exploring the impact of supply chain integrationon the technical innovation in specific organization Bread & Beyond Bakers. The supply chain risk has been considered as a moderator variable in the relationship of supply chain integration and technical innovation. According to the results, it has been concluded that customer integration and technical innovation have a significant association with technical innovation. It is also shows that internal integration, supply integration had a significant effect on technical innovation. Supply Chain Risk (SCR) as moderator moderate the relationship between supplier integration and technical innovation. SCR hasnot effect as moderator the relationship between Internal Integration and Technical Innovation, it was also found that SCR as moderator did not affect the relationship between customer Integration and Technical innovation.

Keywords: Supply chain integration (SCI), Supplier Integration (SI), Internal Integration (II), Customer Integration (CI), Technical Innovation (TI)

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LIST OF ABBREVIATIONS

SCM	Supply Chain Management
SCR	Supply Chain Risk
SI	Supplier Integration
CI	Customer Integration
II	Internal Integration
TI	Technical Innovation
TIP	Technological Innovation and performance
IOT	Internet of Things

CHAPTER 1

INTRODUCTION

1.1 Background

Supply Chain Integration

Supply chain integration is a process where the completion of a single system involves all parties. A new idea or new development in supply chainsections is called technical innovation. Some benefits and opportunities of technological innovation systems are the launchings of innovative products, information technologies, rural energy, the progress of new development, and capacity-building programs. The growth and expansion of these opportunities have a good impact on the growth and improvement of the supply chain system. The previous study shows that production and distribution and consumption or the supply chain of goods and services are associated with an integrated system. Supply Chain Integration (SCI) is, to a great magnitude, concerned with the development of more integrated approaches that hold out the prospect of eliminating many of the inefficiencies directly attributable to supply chain fragmentation (Solaimani, 2022).

Technology innovation

Technology innovation involves the introduction of new products, services, and processes. Technology innovation is a crucial skill for businesses to have to become sustainably competitive. Min & Lu (2017) suggest that evaluating the performance of

technological innovation is based on measuring the index, specifically: sales of cost, innovative products, the rush of product development, level of sales of new products, leading or participating in standards industry development, and success rates of creative projects (Freije, 2022).

A producer's level of internal and external organizational procedures, as well as the degree to which they collaborate with their supply chain partners, may be used to define SCI. Based on certain research, we take internal integration, customer integration, and supplier integration into consideration in this study. To give a firm's clients the most value possible, a seamless supply chain may lead to efficiency gains and flows of services, money, information, goods, and choices. Internal and external integration of the supply chain is different. Integration with customers and suppliers is a subset of external integration (Jimenez-Jimenez, D., Martínez-Costa, 2019)

Technology Innovation is a very new and useful technology and service. Technical innovation performance evaluation is based on assessing the following indices: sales of cost-effective goods, inventive products, rush of product creation, level of new product sales, participating in standards industry development, and success rates of creative initiatives. Large manufacturing companies with a presence in the high-tech sector are the source of notable examples of open innovation. Small and medium-sized businesses also employ technological innovation. They frequently lack the means to create and market new items on their own, so they stand to gain a lot by opening up their innovation process (Ayoub, 2017)

In terms of pace, certain innovations happen gradually over time, whilst in other cases both the adoption rate and the impact are quick. Some have argued that only radical and industry-disrupting changes should be regarded as innovations, while others have said that any change in the way a firm operates fits under the definition of an invention. It is debatable whether slow or quick changes qualify as innovations (Du, M., Chen, Q., Xiao, 200).

1.2 Research Gap

To characterize supply chain performance and pinpoint areas for improvement, the author determined that the gaps between planning and execution should be a

quantifiable number. They label these as KPIs and discovered that businesses should have a modest list of carefully chosen KPIs that are essential to operations management and customer service for each of the four meta-processes of the SCOR model (Heilmann, 2011).

The transportation and procurement e-hubs were divided into two groups by the author. They discovered a requirement for integration that was measured at three different levels (information, resources, and organization), all of which contribute to knowledge gaps. They also provide a framework for linking the e-hubs with developing IT, such as ERP and CRM, to close gaps and offer functionally superior solutions (Novais, 2019).

To reduce the costs associated with the manufacturing and logistical processes, the author discusses the necessity for innovation to involve all SCM players, starting with the suppliers from which raw materials are purchased to the end retail outlets or distribution networks (Seth, 2006).

Based on supply chain gaps, the author proposes conceptual frameworks for service quality. These gaps, according to the author, are bidirectional and apply to both intra- and inter-organizational interactions. With the use of models like data envelope analysis, quality loss functions, and the categorization of indicators into three groups, the author discusses fresh approaches for assessing these gaps (Service, Service & Performance, Performance) (Chae, 2009).

1.3 Problem Statement

The process of integrating all parties and tasks involved in getting the finished product to the consumer into one system is known as Supply Chain Integration (SCI). In this process, an information system to coordinate supply chain operations, and close coordination of businesses is needed. But there are still gaps. Delivery of the products and communication are not well integrated. There is a need for technological innovation for filling this gap for example, auto detection of the location of the delivery. For this purpose, company can fix the delivery vehicle detectors (like QR code detector) at different cities Motorways. It will help to minimize the communication gap using technological innovation.

The introduction of SCI and the subsequent closing of supply chain gaps through

innovation and integration with new technologies like artificial intelligence for the analysis of plans to obtain competitive advantage caused numerous changes in the supply chain management sector. The goal of this research work is also to find the association of supply chain integration with technology innovation and how the risks / gaps identified in Supply Chain are efficiently mitigated through Technical Innovation to result in an effective Supply Chain Integration in modern business environments.

1.3.1 Research Questions and Objectives

1.3.1.1 Research Questions

Q1: What is the effect of Supply Chain Integration on Technical Innovation (TI)?

Q2: What is the moderating effect of Supply Chain Risk (SCR) on the relationship between Supply Chain Integration (SCI) and Technical Innovation (TI)?

1.3.1.2 Research Objectives

✓ To find the effect of Supply Chain Integration on Technical Innovation (TI).
✓ To find the moderating effect of Supply Chain Risk (SCR) on the relationshipbetween Supply Chain Integration (SCI) and Technical Innovation (TI).

1.4 Significance of the Study

This study can bring many outcomes. It will help senior management to identify gaps in the supply chain integration process. It will help to improve the delivery process of the products. It will help the business to become more productive and efficient. It will contribute to higher customer satisfaction.

Finding will help to implement the information technology solutions. It may provide a competitive edge. Collaboration among the members of the extended manufacturing enterprise is necessary for the improvement of the manufacturing process. The results will help to improve the supply chain integration process. It will help to improve the satisfaction of suppliers and customers. It will increase the revenue of the company.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Review

In 1980, the idea of supply chain integration first emerged. In the 1980s, a Missouri supermarket asked Proctor & Gamble (P&G) to set up an automatic replenishment system for Pampers diapers so that customers wouldn't have to place orders. P&G management carefully planned the development of a cooperative replenishment system and connected the store to this system. The coordinated replenishment mechanism between P&G and Walmart was upgraded in 1987. Since being used at Walmart, the collaborative replenishment system has evolved and been expanded to include more integration processes. The notion of integration has been widely endorsed and respected as a result of the Walmart experience (Gupta, 2020).

The strategic mixing of internal and external organisational operations is known as supply chain integration (SCI), and it measures how successfully supply chain actors work together to produce win-win results. SCI describes the development of networks and technology that include all supply chain participants, including suppliers, consumers, and other relevant stakeholders. In other words, SCI demonstrates the extent to which an organisation collaborates strategically with partners and controls both intra- and inter-organizational activities. Through the integration of their connections, activities, functions, technologies, processes, and locations, SCI links an organisation with its clients, suppliers, and other channel participants. SCI's ultimate goal is to transfer goods, services, information, money, and choices effectively and efficiently through coordinated efforts and information sharing to give the consumer the most value possible at all times (Jimenez-Jimenez, D., Martínez-Costa, 2019).

Business performance is a key factor in innovation. Thinking of one's supplier, customer, and partner is one way to innovate. Further, one method can be to consider as one's customers and suppliers in particular while one's partners in general. Firm's must establish so-called "managerial" innovations in parallel to the traditional know- how of technology and novelties in the product. According to Birkinshaw et al. (2008), such novelties may be a competitive advantage for organizations. In their 2012 paper, As seen in current years by the growth of Supply Chain Management (SCM), there is even greater interest in the inter-organizational aspect of innovation (Du, M., Chen, Q., Xiao, 2020).

According to Pérez-Luo et al. (2011), interpersonal ties are more important to innovation than structural linkages. Our study focuses on trust, which is a component of the social capital's relational dimension. Relationship partners that have mutual trust regard each other as trustworthy and kind. According to Dodgson (1993), a high degree of trust is a crucial component required for promoting communication, which is essential for the creation of learning and invention (Qu, 2022).

According to empirical data from Laursen and Salter (2006), companies that engage in open innovation are more likely to foster greater levels of innovation performance. Similar to this, Cheng and Chen discovered that open innovation activities have a favourable impact on innovation capabilities in a study of Taiwanese businesses. We must thus comprehend the effects of open innovation's rise on businesses' capacity for innovation (Xie, Y., Zhao, 2022).

Previous researchers presented four methods for supply chain integration. The first strategy is to standardise and automate internal business processes throughout the company's several functional divisions. At this level, integration with customers or suppliers is minimal to nonexistent. After putting into practise the first integration strategy, the business can decide whether to carry out the second strategy, which asks for integration with suppliers, or the third strategy, which asks for integration with consumers. With the help of the second strategy, companies may connect and interact strategically with their suppliers. With the third strategy, the company may synchronise data flow from customers to suppliers in the reverse direction. The final and final technique creates an integrated supply and demand. It is an important strategy (Freije, 2022).

Different business players collaborate heavily to create dynamic linkages in

network-like structures in the high-complexity. In reality, as the numbers of end users chains number of values. The more value chains you participate in, the more likely it is that you establish complex network-like structures as a distributor, manufacturer, or supplier farther down the value chain. Building meaningful, positive activity duties among the participants is therefore the industrial business task. Figure 1 depicts how traditional linear thought gradually gives way to more network-like, borderless, and dynamic organizational structures, or the transition from the "old" approach to the "emerging" lean as the structure of the future (Espino-Rodríguez, 2022).

In actuality, SCI is crucial from a strategic and operational standpoint. Various perspectives, such as the resource-based view, transaction cost theory, and dynamic capabilities view, all of which have shown that SCI improves cooperative performance, support this. Partnerships can assist in combining resources and producing effective governance structures from a firm's resource-based and relational perspectives. In these situations, supply chain participants can use coordinated SCI to access skills and technologies that are present within a certain supply chain. To ensure the efficacy of the supply chain, SCI promotes cooperative planning, value creation, and the application of cross-firm problem-solving techniques (Chen, L., Jia, 2022).

Many changes are being confronted by the Swedish military sector in particular, as well as the European and American defence industries. Few players can afford the extremely high costs associated with developing modern, advanced goods. Shorter delivery times, more complex and system-integrated goods, and new and sophisticated technologies all need cooperation inside and within supply chains. This process of transformation is described by Hayward as occurring at a "elephantine pace" among the European defense sector primes. Aerospace and electronics are the industries where this is happening the fastest because of the need to meet regulatory deadlines and the concentration of resources that mergers and acquisitions have already started to bring about (Khan, M. 2022).

Technical innovation has a great impact on the performance of the supply chain. There may be many innovative techniques. Performance is increased as communication and information exchange are improved as a result of increased physical material and product flows. A participant in a supply chain with strong links may be able to lower their net costs. Cost effectiveness is a requirement for price rivalry; therefore, this reduction is quite beneficial. According to the transaction cost hypothesis, businesses strive for

efficiency by lowering their vertical integration and market-wide costs. In fact, SCI enhances the structure of the supply chain to guide behaviour and boost overall efficiency, all while lowering operational costs. SCI may also be a helpful instrument for supporting organisational planning and preserving competitive advantages. The dynamic capacity concept asserts that SCI empowers companies for smooth supply of the products and raw materials (Gupta, H., Yadav 2022).

The goal of the study is to evaluate how well SMEs in Yogyakarta's Special Region are performing in terms of technological innovation. The performance of technological innovation in this study is impacted by supply chain information exchange, green supply chain integration, and environmental management practises. This study is significant since the performance of many SMEs in terms of technological innovation is undeveloped. Performance of technological innovation in organisations demonstrates that innovation has a multi-dimensional ecological performance. Therefore, managing operations, support, and information while putting an emphasis on environmental and social concerns may help SMEs create a sustainable supply chain that will maximise the chain as a whole. The key data used in this investigation. 200 SMEs participated in this survey as responders, and they all used green supply chain management techniques. A questionnaire was utilised as the data gathering tool. (Nayal, K., Kumar, 2022)

The two-step SEM-AMOS methodology is the data analysis procedure tool that was employed. According to the study's findings, SMEs are open to implementing a green supply chain in order to improve their efficiency. The study's performance model for technological innovation is acceptable. According to the research's conclusions, businesses should be encouraged to continue and expand their use of green supply chain integration, greater supply chain knowledge-sharing, and performance-enhancing technology innovations. According to Chang et al. (2015), technological innovation performance (TIP) is a thorough assessment of organizational innovation activities that includes both specific and overall innovation performance. The emphasis of innovation performance in small brains, according to Freeman and Soete (1997), relates to the value produced by innovation and innovation efficiency, including new product creation and the pace of new equipment research and new technology. In a broad sense, innovation performance refers to the entire process (Hahn, 2020).

Both managerial innovation and technology innovation are addressed by TIP. TIP demonstrates the multifaceted nature of innovation's success in organizations. According

to Chen et al. (2006), the performance of green innovation in GSCM I is affected by green process innovation and environmentally friendly product Applying novel design concepts and selling fresh goods that greatly promote environmental sustainability are few instances of technological innovation in green products (Wong, 2012). Green TIP refers to innovative strategies for minimizing harmful effects on the environment brought on by the industrial process. Green TIP entails actions to cut back on hazardous emissions, energy use, and raw material usage (Sharma, 2022).

The business's attention on supply chain performance is driven by the chain's dependence. Given the significance the Malaysian government has placed on the third industrial master plan, the use of SCI is essential to facilitating SCM. Additionally, this study explores the cumulative effects of supply chain technology adoption on operational performance and determines if the link between supply chain capabilities and performance under examination is mediated by supply chain technology adoption. A two-step methodology, using the quantitative research technique and the triangulation research approach, is required to meet the study objectives. Respondents in Malaysian textile and apparel organizations received 201 survey forms. Structural equation modeling with SPSS and Smart PLS was empirically evaluated using 121 usable replies, or a 60% response rate. The results also showed that the adoption of supply chain technology is positively influenced by supply chain skills. In the model under research, the data also showed a sizable mediation impact of supply chain technology adoption. Face-to-face interviews with four professionals from the sector were conducted using a triangulation research technique to learn more about their perspectives on the model under investigation (Nayal, K., Kumar, 2022).

The methodology utilized to check the effectiveness of the hypothesis is the survey method. Here five-point scale system is used to measure three different categories of independent variables. You will require internal integration and supplier integration and customer integration as dependent factors and product quality and product innovation performance) as independent variables in order to develop a questionnaire. Changes were made as needed and after this drafting, a pre-test of the questionnaire was carried out with academics and professionals to confirm validity of its content. The research reveals that in order to monitor and ensure the high grade of their incoming components, the majority of automotive suppliers would anticipate participating in Supplier Relationship Management (SRM) programmes given by automakers. Therefore, it should be expected

that supply integration will have a substantial impact on purchasing and production systems as part of SRM, leading to high product quality performance. Second, companies that prioritise product innovation should emphasise the significance of the customer's participation in the creation of new goods. By being more connected with consumers' requirements, businesses may be able to respond to their changing product preferences more quickly (Gupta, H., Yadav 2022).

Academics and manufacturing managers are becoming increasingly interested in supply chain integration. Case studies like those of Walmart, Dell, Apple, and Nike demonstrate how efficient full integration from suppliers to end users may help businesses improve their operational performance and gain a competitive advantage. Creating an intelligent supply chain manufacturing process and the Internet of Things (IOT) supply chain is more important as Industry 4.0 matures. In order to avoid having to coordinate an excessive amount of difficult work, producers and partners must work closely together. If not, it will be challenging to establish an intelligent IOT supply chain and supply chain manufacturing process. Integration is so important and can influence whether a supply chain is successful or unsuccessful. Additionally, studies have shown that integration, performance, and competitive qualities are related. The majority of the study on enhanced integration, including works by, among others, has concentrated on integrative strategies between partners and has investigated ways to successfully increase SCI (Hahn, 2020).

A coordination programme describes the characteristics of a specific method for coordination and information sharing. During supply chain integration, it enables chain participants to synchronize internal and external operations and strategies. As a result, it is utilized across the supply chain's integrative methods to enable the incorporation of the requirement of physical and information activities of partners. Manufacturers can more effectively enhance integration by putting a coordinating programme in place. According to the study's goal, a supply chain integrative process will be established through coordinating programs (Gupta, H., Yadav 2022).

The first stage of integration process is the initial integration, in accordance with the study questions and findings. Order tracking with partners was the sole integrative tactic used in this step, but some other competing capabilities that includes quality of the product, lead time in manufacturing, speed of its delivery, reliability of delivery, customization ability of product, flexibility in volume, flexibility mix and quality of service were also impacted. The above said eight qualities therefore form the fundamental

competitive capabilities. Partners should enhance order tracking integration in order to achieve these fundamental competitive qualities. This effort may be aided by putting in place unofficial channels of communication for partners' benefit. The outcomes for early integration make sense. Integration of the production process is often the first step in the establishment of a basic supply chain. Integration of the supply chain amongst partners in the production process, such as in a push supply chain.

This implies that manufacturers need to know how suppliers schedule their production of raw material orders before figuring out how they schedule their production of completed goods and semi-manufactured goods orders. Retailers should also modify their finished products inventory and replenishment based on the manufacturer's manufacturing schedule. Partners continue to function independently even if suppliers and manufacturers disagree over the release of information regarding orders. However, fundamental production process integration will be developed if partners choose to share order-related information and each partner is able to track order data for their upstream partners. Supply chain practises will be more effective and have a favourable impact on boosting competitive capacities compared to the conventional practise of independent enterprises as a result of the construction of production process integration. Eight competitive qualities will greatly improve in terms of quality, service, and flexibility, according to the research findings. Actually, the growth of supply chain integration incorporates these eight competitive qualities. All these steps point to the innovation. It shows that there is positive and significant association of SCI with innovation (Solaimani, 2022).

2.2 Hypothesis Development

The hypothesis developed in this study proposed that the integration of supplier has big impact on technical Innovation for instance, it also supports that value of Supply chain integration enhance the Innovation capabilities. Researchers argued that Integration among supply chain play a effective role in the Innovation process. Didnet and Diaz (2012) found that supply chain integration with suppliers and customers improve production and enhances Innovation (Heba Fawzi Ayoub, 2016).

2.2.1 Association of supply chain integration with technological innovation

The transfer of the product from the point of origin, which is the production facility, through a warehouse, and finally to retail establishments or the end user, is what is meant when dealing with the end user. The majority of businesses outsource their logistics operations to logistics service providers since warehousing and distribution are frequently leased to third-party logistics service providers. (Lin, 2008). It is a consensus that with the use of new technologies especially those related to IT, result in enhancing the operational effectiveness as well as provide a much needed competing advantage to the logistics and supply chain sections (Gupta, H., Yadav 2022).

According to Jacobs and Chase (2011), the logistics sector of the supply chain represents a sizable portion of the country's GDP, accounting for 8 to 9% of it. The success of new and current enterprises depends on the placement of effective warehouse and distribution centers, which form the basis of logistics. Establishing and sustaining supply chain competitiveness depends on the management and operation of these centers to provide storage and quick movement of products, services, and associated information from the producing facility to the point of consumption (Ayoub, 2017)

The proposed hypotheses are as following:-

Hypothesis 1: There exists a positive effect of Supplier Integration (SI) on Technical Innovation (TI).

Hypothesis 2: There exists a positive effect of Customer Integration (CI) on Technical Innovation (TI).

Hypothesis 3: There exists a positive effect of Internal Integration (II) on Technical Innovation (TI).

Hypothesis 4: Supply Chain Risk (SCR) moderates the relationship between Supplier Integration (SI) and Technical Innovation (TI).

Hypothesis 5: Supply Chain Risk (SCR) moderates the relationship between Customer Integration (CI) and Technical Innovation (TI).

Hypothesis 6: Supply Chain Risk (SCR) moderates the relationship between Internal Integration (II) and Technical Innovation (TI).

2.3 Hypothesized Research Model

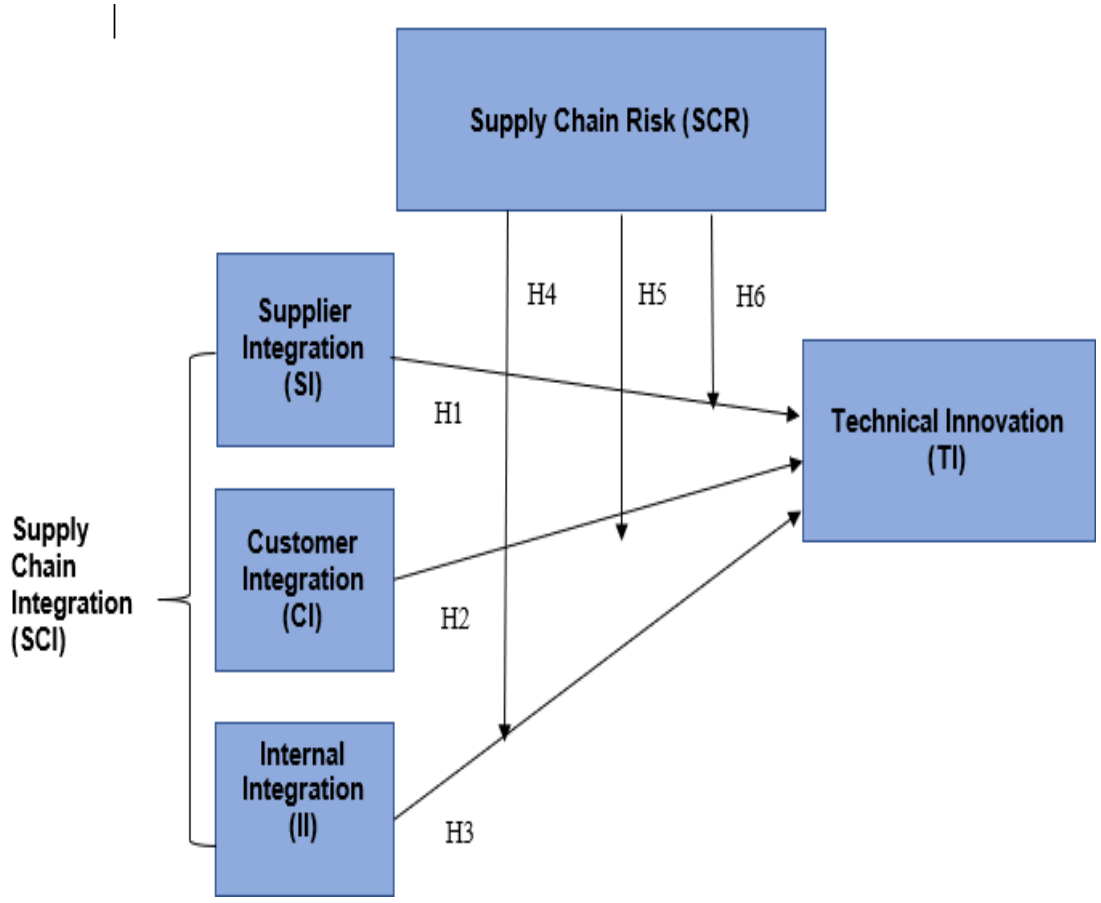

Figure 1: Hypothesized Research Model

CHAPTER 3

RESEARCH METHODOLOGY

Quantitative research was used in this study. The reason is that it uses statistical and mathematical calculations for analysis. Quantitative research involves more data.

3.1 Population, Sample and Sampling Technique

Bread & Beyond Bakery has been set out the targeted population for this study because of huge distribution of bakery items is being carried out on daily basis particularly bread in bakery industry. Bread & Beyond is famous for their extraordinary freshly baked assortments inspired by traditional as well as French baking methods as they ensure stringent quality checks throughout their Supply Chain. Therefore, Supply Chain Integration is kept critically in view by the aforementioned firm.

Normally, the supply chain for a bakery consists of producers, distributors, retailers, and customers. Therefore, Supply chain Integration and its impact on Technical Innovation is surveyed for aforementioned bakery through a questionnaire based on Simple Random Sampling for data collection to examine the research model in this study.

Simple random sampling technique is used for the selected firm in this research study because this category of probability sampling allows the scholar to randomly select a subset of contributors from a huge target population. The advantages of simple random sampling method of probability sampling have less chances of errors, is time and money efficient and free of personal partialities. Individually, every contributor/participant gets an equal chance to be selected. Data is then collected from as large in percentage as possible of this random subset. It is an easy method because it takes population that is close to hand. Companies use this method of sampling to collect information in order to

resolve important business concerns mainly issues related with supply chain integration.

The total number of employees in Bread & Beyond Bakers are 750 so the population size is 750 and sample size decided as 250 in accordance with the Krejcie and Morgan Sampling Method who are directly involved in supply chain management section activities. In this case, respondents are chosen randomly without any bias and all are chosen with the same probability.

3.2 Measurement and Instrumentation

This research was carried out to check the effects of Supply Chain Integration on Technical Innovation and the moderating role of Supply Chain Risk between the relationship of Supplier Integration, Customer Integration and Internal Integration (together as SCI) with Technical Innovation. To accomplish the objectives of this study, a quantitative research method based on the online questionnaire-based survey was chosen as a methodological approach.

The fundamental elements along with their interrelation have been discussed and explained in the literature review chapter. The relations among them are depicted in Fig. 1 and corresponding hypotheses are mentioned there.

The No. of items that have been selected for the measurement are stated below:

1. The adopted scale by Mohammad, A, Lemma, A.E, Ayalew (2018) has been used to measure the Supplier Integration.
2. Internal Integration items have been measured on a scale adopted from Mohammad, A, Lemma, A.E, Ayalew (2018).
3. For the measurement of Customer Integration, the measuring scale by Mohammad, A, Lemma, A.E, Ayalew (2018) is used.
4. For the measurement of Technical Innovation, the scale was adopted from M. Atalay, F. Sarvan (2013) was used.
5. For the measurement of Supply Chain Risk, the scale was adopted from Reinhardt, H (2019) was used.

The items have been measured on 1 to 5 Likert scale i.e., Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5). For the research questionnaire, total 32 questions were developed, in the scale the respondent was asked to rate the views on 1–5 point scale.

Moreover, general information of the respondent like gender, age, education, area of expertise, work experience etc. have also been collected to produce the finding according to their roles in SCI.

The intensity of each statement in questionnaire are measured ranging from 1 to 5 on Likert scale as per given below:

Value in Analysis

Value in Analysis	Value in Likert Scale
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

3.3 Data Collection Procedure

Two types of data collection from sources exist. These are 1) primary sources and 2) secondary sources.

1. **Primary Sources:** Employees of supply chain management section employees of Bread & Beyond Bakers act as a primary sources. Hence, the Primary sources include the direct responses from the employees of a firm. These are immediate interactions of the working class.

2. **Secondary Sources:** These include the previous papers, literature etc.

3.4 Data Analysis Technique

For the investigation of the gathered information, through questionnaire gather data was converted into the numerical form. Descriptive and demographic analysis statistical method regression analysis has been performed through SPSS. SPSS was used as a tool to make the calculations of the given responses using the excel sheets.

Smart PLS4 used as tool for perform main analysis. Cronbach's Alpha was performed by Smart PLS4 to check data reliability, construct validity and reliability test performed by Smart PLS4 to check data consistency. R-Square (r^2) was measured to check the connection between the variables.

CHAPTER 4

DATA ANALYSIS AND RESULTS

4.1 Demographic Analysis

4.1.1 Gender

The participants were given 2 options regarding gender-related question.

Table 4.1: Gender of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	144	57.6	57.6	57.6
	Female	106	42.4	42.4	100.0
	Total	250	100.0	100.0	

The results explain that male are 57.6% and female are 42.4% respondents. It shows that most of the respondents are male.

4.1.2 Age

Table 4.2: Age of Respondents

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 25	56	22.4	22.4	22.4
	25 to 35	102	40.8	40.8	63.2
	36 to 45	49	19.6	19.6	82.8
	46 to 55	39	15.6	15.6	98.4
	Above 55	4	1.6	1.6	100.0
	Total	250	100.0	100.0	

The results explain that 22.4% have age limit below 25 years. 40.8% have age limit between 25 years to 35 years. Respondents of age 36 years to 45 years are 19.6%. Respondents of agelimit 46 years to 55 years are 15.6%. 1.6% have age above 55 years.

4.1.3 Education

Table 4.3: Education of Respondents

Education					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Inter	30	12.0	12.0	12.0
	Graduate	56	22.4	22.4	34.4
	Master	134	53.6	53.6	88.0
	M.phil or Ph.d	30	12.0	12.0	100.0
	Total	250	100.0	100.0	

The results explain that 12% respondents are intermediate passed. 56% of respondents aregraduates. 53.6% respondents are master's degree holder. 12% respondents are at level of M.Phil / Ph.D

4.1.4 Experience

Table 4.4: Experience of Respondents

Experience					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	1-5	12	4.8	4.8	4.8
	6-10	108	43.2	43.2	48.0
	11-15	57	22.8	22.8	70.8
	Above 15	73	29.2	29.2	100.0
	Total	250	100.0	100.0	

The results explain that 4.8% respondents have experience of 1 to 5 years. 43.2% respondents have experience of 6 to 10 years. 22.8% respondents have experience of11 years to 15 years.29.2% respondents have experience of above 15 years.

4.1.5 Status

Table 4.5: Status of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Junior management	112	44.8	44.8	44.8
	Middle management	84	33.6	33.6	78.4
	Senior management	54	21.6	21.6	100.0
	Total	250	100.0	100.0	

The results explain that 44.8% respondents belong to junior management, 33.6% respondents belong to middle management, 21.6% of respondents belong to senior management.

4.2 Descriptive Analysis

The data collection was performed in 5 Likert scales, these five points Likert scales of strongly Disagree, Disagree, Neutral, Agree and Strongly Agree have been used for Supplier Integration, Customer Integration, Internal Integration, Technical Innovation, Supply Chain Integration. The descriptive analysis includes the minimum, maximum, mean, standard deviation, skewness and kurtosis of those variables.

Table 4.6 Descriptive Analysis

Items	Mean	Median	min	max	Standard deviation	kurtosis	Skewness
SI1	3.9	4	3	5	0.581	-0.102	0.012
SI2	4	4	2	5	0.675	-0.563	-0.078
II1	3.84	4	2	5	0.637	0.406	-0.314
II2	3.836	4	2	5	0.699	-0.261	-0.115
II3	3.908	4	2	5	0.74	0.036	-0.388
II4	3.992	4	2	5	0.71	-0.632	-0.123
II5	3.916	4	2	5	0.752	-0.328	-0.258
II6	3.992	4	1	5	0.764	0.84	-0.582
CI1	3.872	4	2	5	0.663	0.011	-0.183
CI2	3.924	4	2	5	0.697	0.114	-0.323
TIN1	3.84	4	1	5	0.714	0.631	-0.416
TIN2	3.856	4	1	5	0.787	0.983	-0.73
TIN3	3.832	4	2	5	0.756	-0.013	-0.379
TIN4	3.904	4	2	5	0.737	-0.073	-0.329
TIN5	3.916	4	2	5	0.735	-0.308	-0.23
TIN6	3.92	4	2	5	0.671	0.648	-0.466
TIN7	3.844	4	1	5	0.772	0.327	-0.458
TIN8	3.844	4	1	5	0.745	1.104	-0.612
TIN9	3.852	4	1	5	0.794	0.18	-0.453
TIN10	3.828	4	1	5	0.789	1.084	-0.667
SCR1	3.84	4	2	5	0.637	0.406	-0.314
SCR2	3.836	4	2	5	0.699	-0.261	-0.115
SCR3	3.908	4	2	5	0.74	0.036	-0.388
SCR4	3.992	4	2	5	0.71	-0.632	-0.123
SCR5	3.916	4	2	5	0.752	-0.328	-0.258
SCR6	3.992	4	1	5	0.764	0.84	-0.582
SCR7	3.872	4	2	5	0.663	0.011	-0.183
SCR8	3.924	4	2	5	0.697	0.114	-0.323
SCR9	3.84	4	1	5	0.714	0.631	-0.416
SCR10	3.856	4	1	5	0.787	0.983	-0.73
SCR11	3.904	4	1	5	0.814	0.682	-0.672
SCR12	3.924	4	1	5	0.809	1.357	-0.864

4.3 Structural Equation Modeling

To analysis the data and testing of quantitative hypotheses we used Structural Equation Modeling (SEM) technique to analyze the structural relationships. This technique provides factor analysis as well as multiple regression analysis, and it provides the structural relationship among latent constructs and measured variables. In order to use SEM technique, Smart PLS version 4 used to utilize this technique.

4.4 Measurement Model

4.4.1 Reliability

Supplier integration, Internal Integration, and customer integration have been taken as independent variables, and Technical Innovation as the dependent variables. Relationship of supplier integration and Technical Innovation moderated by supply chain risk and customer integration and Technical Innovation moderated by supply chain risk, sequentially customer integration and Technical Innovation moderated by supply chain risk. Results of Cronbach's alpha is as follows:

Table 4.7 Reliability Statistics SCI

Reliability Statistics Supply chain integration	
Cronbach's Alpha	N of Items
0.716	02

Table 4.8 Reliability Statistics II

Reliability Statistics Internal integration	
Cronbach's Alpha	N of Items
0.752	06

Table 4.9 Reliability Statistics CI

Reliability Statistics Customer integration	
Cronbach's Alpha	N of Items
0.724	02

Table 4.10 Reliability Statistics TI

Reliability Statistics Technical Innovation	
Cronbach's Alpha	N of Items
0.761	10

Table 4.11 Reliability Statistics SCR

Reliability Statistics Supply chain Risk	
Cronbach's Alpha	N of Items
0.731	12

Cronbach's alpha values are acceptable. Above 0.7 shows that it is high value. It means that there is reliability in the research instrument.

4.4.2 Validity Test

It is also most important to evaluate the results in Smart PLS to access and evaluate the measurement model. During this evaluation, outer loading should be more than 0.70. according to the results, most of the values of items are above 0.70 except for some item's values.

In this part of the analysis, we measured the validity of each construct, for measuring data validity we used Average Variance Extracted (AVE). The accepted value of AVE should be greater than 0.50 for validity.

Table 4.12 Validity Test

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average Variance Extracted (AVE)
CI	0.649	0.850	0.850	0.739
II	0.891	0.892	0.890	0.576
SCR	0.931	0.931	0.931	0.529
SI	0.728	0.731	0.729	0.574
TIN	0.924	0.925	0.924	0.551

2 Cronbach's Alpha

3 Average Variance Extracted (AVE)

According to the above results AVE was used for the measurement of the validity of data. The accepted value AVE should be greater than 0.50 which is calculated by measuring the means of the squared outer loading. The result shows that internal integration is 0.576 whichis an acceptable value, on the hand supply chain risk is 0.529 and supplier integration is 0.574which is also acceptable because those values are greater than 0.50.

4.4.3 Discriminant Validity

Heterotrait -monotrait(HTMT) and Fornell laracker are used for measurement of discriminantvalidity, acceptance value of HTMT less than 0.90.

Table 4.13 Heterotrait- Monotrait

Heterotrait- Monotrait results Tables is following.

	CI	II	SCR	SI	TI
CI					
II	0.888				
SCR	0.689	0.745			
SI	0.827	0.914	0.690		
TI	0.721	0.779	0.878	0.691	

Table 4.14 Fornell laracker

Fornell laracker results Table

	CI	II	SCR	SI	TI
CI	0.699				
II	0.881	0.759			
SCR	0.686	0.743	0.727		
SI	0.818	0.910	0.687	0.757	
TI	0.718	0.779	0.880	0.690	0.742

4.4.4 Collinearity Analysis

In Smart Pls collinearity analysis are measured by variance inflation factor (VIF). According to VIF, if its value 1 means variables are correlated, if its value between 1 and 5 shows that variables are moderately correlated, and if its value is greater than variables are highly correlated which is not acknowledged.

Table 4.15 Collinearity Analysis

	VIF
CI1	1.3
CI2	1.3
II1	1.883
II2	.1774
II3	2.033
II4	2.306
II5	2.468
II6	2.071
SCR1	2.136
SCR10	1.970
SCR11	1.868

SCR12	2.154
SCR2	2.028
SCR3	2.163
SCR4	2.225
SCR5	2.081
SCR6	2.503
SCR7	2.259
SCR8	2.310
SCR9	2.504
SI1	1.486
SI2	1.486
TIN1	1.983
TIN10	2.325
TIN2	2.196
TIN3	2.297
TIN4	2.044
TIN5	2.484
TIN6	2.014
TIN7	2.221
TIN8	2.038
TIN9	2.361
SCR x II	1.000
SCR x CI	1.000
SCR x SI	1.000

4.5 Structural Model

In structural model we check the R square value, it should be lies between 0 and 1, if itsvalue 0.75 than prediction is substantial if its value 0.50 than prediction is moderator and if its 0.25 than prediction is week.

Table 4.16

Coefficient of Determination

	R square	**R square adjusted**
TIN	0.632	0.621

4.5.1 Moderation Analysis

This research work has analyzed the impact that the integration of supply chain has on technical innovation. It is pertinent to mention here that integration of Supply chain is a practice in which all the stakeholders who are involved in a product realization are unified into a single system. A new idea or new development in supply chain sections is called technical innovation. In this case, supply chain risk (SCR) has the role of moderator.

Following table shows the results of bootstrapping values, T-values and P-value for moderator relationship.

Table 4.17 P Values for moderator relationship

	Original Sample (O)	**Sample Mean (M)**	**Standard deviation**	**T values**	**P values**	**Hypothesis**
SI->TIN	0.153	0.151	0.071	2.151	0.032	Accepted
CI->TIN	0.174	0.179	0.066	2.640	0.008	Accepted
II->TIN	0.409	0.418	0.082	4.994	0.000	Accepted
SCR * SI->TIN	0.079	0.077	0.037	0.077	0.033	Accepted
SCR * CI->TIN	0.011	0.005	0.049	0.005	0.830	Rejected
SCR* II->TIN	0.085	0.087	0.049	0.087	0.083	Rejected

Results show that customer integration and technical innovation have a significant association as the value of p is less than 0.05. It also shows that internal integration and technical innovation have a significant association as the value of p is less than 0.05. Results also show that SCR significantly moderates the relationship of SCR, SI with TIN. Results also show that SCR is not significantly moderate and the relationship of II with TIN is not significant. Results also show that SCR is also not significantly moderate the relationship between SCR and CI.

CHAPTER 5

SUMMARY AND DISCUSSION

5.1 Summary

A number of results are drawn from the pragmatic observation:

a) There is a positive association between supply chain risk of the firm and supplier – customer integration
b) In a composite system for supplier- internal – customer integration, a positive effect has been observed on agility performance of the firm. However, here the internal integration remains weak.
c) The interconnection between Supply Chain risk and the agility performance of the firm is regulated through supplier-customer integration
d) The interconnection between internal integration and the agility performance of the firm is regulated through supplier-customer integration

Hence, supply chain integration is defined as a tactical association between the prime supply chain stakeholders and an efficient system of internal and external organization of firm's activities which include manufacturing, services, IT, Accounts and broad level informed decision making.

5.2 Discussion

The finding explains that customer integration and technical innovation has significant association as value of p is less than 0.05. It also shows that internal integration and technical innovation has significant association as value of p is less than 0.05. It also

shows that supply chain risk and technical innovation have significant association as value of p is less than 0.05.H1 is accepted. H2 is accepted. H3 is accepted. H4 is accepted. H5 is rejected as SCR has no significant value for the relationship between Customer Integration (CI) and Technical Innovation (TI). H6 is also rejected as SCR has no significant relationship between Internal Integration (II) and Technical Innovation (TI).

To attain shared teamwork and harmonization to satisfy purchaser necessities, Internal integration specifies to a company how they have organized the quality measures, procedures, and performance indicators for their practical units. There are two crucial elements of internal integration which are data distribution and collaboration through a shared action-oriented framework among their practical subdivisions (Kalyar, 2020)

Recognizing the demands of the customers then bringing into line structural roles to generate worth for them and their contributions that contain happenings reaching from knowledge generation to administration of manufacture and distribution of goods comes under the concept of Customer Integration that mainly takes into account valuable and noteworthy customers. Production in addition to procedure advancement involves their clients for corporation progress as well as the implementation of numerous methods to comprehend in the longer run to achieve Customer Integration. (Tiwari, 2021).

In an unpredictable market, means of marketplace information is also a practical formation to adventure lucrative prospects which works as a prototype, whereas; an alert industrial system is defined as a scheme of performances, likewise comprising logical, worth, besides diversified fundamentals (Narasimhan et al., 2006; Ben Naylor et al., 1999). On the road to swift in addition to operative comeback to shifting client requirements, alert policy indications play a vital role to the structural direction besides the promise to make a deliberate close (Munir, 2020).

The results obtained here related to supplier and end user integration have been found to be in line with the findings of previous research in the same field thus proving that the integration of processes result in improving the overall performance parameters. However, it has also been observed that certain weaker areas remain there like integration affects the performance indirectly through supplier and customer. Nevertheless, internal integration provides a foundation which can improve agility performance. (Zhao, 2021).

Through a pragmatic check, an important finding is made that how organizations which are having supply chain risk are able to get improved agility performance through incorporation of supplier - customer integration. However, pragmatic check did not

conclude any intervention impacts of integration. While implementing this, the research marks a first attempt to deliberate and utilize large-scale data to determine the adoptability in components of supply chain integration in stimulus to its risk for enhancing its agility performance (Tukamuhabwa, 2021).

5.3 Implication of Study

This research study has practical and theoretical implications, which are the following:-

5.3.1 Theoretical Implication

The theoretical implications of this study shed light on the intricate interplay among Supply Integration, Customer Integration, Internal Integration, Technical Innovation, and Supply Chain Risk. The research findings make significant contributions to various theoretical areas, such as innovation, risk management, contingency theory, and dynamic capabilities. This study provides a solid foundation for future research endeavors and offers valuable insights to shape more resilient innovation strategies within supply chain management theory.

This research study adds information to the existing study about the relationship between supply chainintegration and technical innovation moderated by Supply Chain Risk. This research also adds constructive information in the form of moderators (supply chain risk) that have an influence on supply chain integration and technical innovation. This study will further extend research on supply chain risk and their influence on supply chain integration and technical innovation.

5.3.2 Practical Implication

The practical implementation of this research is significant which helps to analyze the relationship between independent variable supply integration, customer integration, Internal integration, and dependent variable technical innovation regarding mediating variable supply chain risk. The finding of this study will improve the research work. The practical implications arising from the relationship between the independent variables

(Supply Integration, Customer Integration, and Internal Integration) and the dependent variable (Technical Innovation), with the moderator variable (Supply Chain Risk), are as follows:

- Identification of Key Drivers of Technical Innovation.
- Understanding the Role of Supply Chain Risk as a Conditional Factor: It can either strengthen or weaken the relationship between the independent variable(s) and the dependent variable.
- Risk Management Strategies for Enhancing Innovation.
- Adopting a Balanced Approach to Innovation.
- Developing Long-Term Innovation Strategies.

5.4 Recommendations

This study is necessary to improve supply chain integration. This research should also be applied on technical innovation. To enhance the supply chain process of the organization it is necessary to use the latest technologies for the delivery of the products. IT sector of the organization should be linked with the supply chain management section. Customer relationships should be improved. It is also recommended to improve the relationship of SCR with Customer Integration (CI) and Technical Innovation (TI). It is recommended that SCR the relationship between Internal Integration (II) and Technical Innovation (TI) should be improved.

This research is essential for advancing supply chain integration. To enhance the organization's supply chain processes, adopting cutting-edge technologies like IoT, AI, etc., for product delivery is crucial. Integrating the IT sector with supply chain management can yield significant benefits. Improving customer relationships is also of paramount importance. Furthermore, it is recommended to strengthen the relationship between Supply Chain Risk (SCR) and Customer Integration (CI), as well as between Internal Integration (II) and Technical Innovation (TI).

5.5 Limitations

This study has been conducted to the limited timescale due to the imitation of the time and resources research work could not comprehensively study. This research has been conducted in limited budget constraints which can influence project performance. There was limited scope of the study, more than one organization cloud improves the scope of the study. Samplesize of this study was very limited therefore the result this study could not generalized for other organization. The study examining the relationship between supply chain integration and technical innovation may encounter certain limitations that could impact the interpretation and generalizability of its results.

Some common limitations in this context include:

- The omission of relevant control variables, such as industry-specific factors, firm size, or technological capabilities, which could potentially confound the relationship between supply chain integration and technical innovation.
- The context-specific nature of the findings, which may not be readily applicable to diverse industries, supply chain configurations, or stages of technical innovation.
- The exclusive focus on technical innovation, possibly overlooking other types of innovation like process innovation or business model innovation, which could also be pertinent in the supply chain context.
- The need to consider the possibility of reverse causality, wherein technical innovation might influence supply chain integration bidirectionally.

5.6 Conclusion

In conclusion, this study demonstrates a notable and favorable correlation between supply chain integration and technical innovation. Organizations that prioritize robust collaborative relationships with suppliers, customers, and internal departments witness elevated levels of innovation, resulting in enhanced performance and competitiveness. The findings underscore the significance of strategic supply chain integration management in promoting sustainable and transformative technical innovation. Nonetheless, additional research is necessary to comprehend the contextual factors

influencing this relationship. For decision-makers, this study provides valuable insights into utilizing supply chain integration as a catalyst for innovation in dynamic market environments.

This study has discussed the effect of supply chain integration on technical innovation. It discussed the different factors like supply chain risk (SCR), Supplier integration (SI), and technical innovation, internal integration (II) and customer integration.

The finding explains that customer integration and technical innovation have a significant association as the value of p is less than 0.05. It also shows that internal integration and technical innovation have a significant association as the value of p is less than 0.05. It also shows that supply chain risk and technical innovation have a significant association as the value of p is less than 0.05. H1 is accepted as there exists a positive and significant effect of Supplier Integration (SI) on Technical Innovation (TI). H2 is accepted as there exists a positive and significant effect of Customer Integration (CI) on Technical Innovation (TI). H3 is accepted as there exists a positive and significant effect of Internal Integration (II) on Technical Innovation (TI). H4 is accepted as supply chain risk (SCR) moderates the relationship between Supplier Integration (SI) and Technical Innovation (TI). H5 is rejected as SCR has no significant value for the relationship between Customer Integration (CI) and Technical Innovation (TI). H6 is also rejected as SCR has no significant relationship between Internal Integration (II) and Technical Innovation (TI).

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Appendix

Below is the questionnaire related to my study. The items have been measured on 1 to 5 Likert scale i.e., Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

Sr. No.	Question
1.	**Supply Chain Integration**
(a)	**Supplier Integration**
1	Supply Chain Integration has provided the organization the ability to quickly and easily relate with Suppliers.
2	Supply Chain Integration is led to a better supplier relationship management.
(b)	**Internal Integration**
3	Sourcing and tendering decisions are easily made due to SC Integration and information sharing.
4	There are external SCintegration that fastens flowssuch as, physical and funds.
5	There are integration ofobjectives, planning, and resources with external organizations.
6	There are internal integration of functions and activities.
7	With integrated SC technologies and systemsestablished, inter and intra organizations' communicationsare optimized.
8	Due to information andtechnology integration, there are access of tracking performances of SC partners.
(c)	**Customer Integration**
9	Distribution and delivery are made at the right time and place due to SC integration, information sharing and coordination.
10	Orders are easily processed as a result of supplier integration.
2.	**Technical Innovation**
1	Our company launches customized products according to market demands.
2	Our company adopts advanced real-time process control technology.
3	Our company imports advanced programmable equipment.
4	Our company adopts innovative reward systems.
5	Our company adopts innovative work designs.
6	Our company engages in organizational reconstruction for pursuing operational efficiency.
7	Our company engages in business process re-engineering.
8	Our company continually enlarges potential demand markets.
9	Our company leads innovative distributing methods to markets.
10	Our company leads innovative promoting methods to markets.

3.	**Supply Chain Risk**
1	My organization has a department or individuals entirely dedicated to supply chain risk management.
2	Supply chain risk management practices allow me to undertake complex supply chain decisions more quickly and efficiently.
3	I am very positive and supportive applying supply chain risk management practices in my company.
4	I regard the establishment of ongoing supplier assessment andthe development of supply chainrisk mitigation strategies asimportant.
5	My organization provides risk management training to oursupply chain team.
6	I know how to relate supplychain risk management tools and techniques to my companyprocesses and decision making
7	The top management (Managing Director or equivalent)acknowledges the contributions and encourage individuals or teams, which establish or enhance supply chain risk management practices in our organization.
8	Management team meetings arefrequently organized to reflect on actions on supply chain risks.
9	I record details of supply chain disruptions and the actions that have been put in place to mitigate or avoid future incidents.
10	I view the resilience and adaptability of our supply chain as very high, therefore there willbe minimal to no effect of man-made or natural catastrophic events to it.
11	I am using instruments or tools (such as: FMEA, 6 Sigma, worstcase modelling, mapping of internal and external processes) for supply chain risk management.
12	Using supply chain riskmanagement tools and techniques improves the quality of work I do.

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