

# The Effect of Resilient Supply Chain Capabilities on Supply Chain Risk Management

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**Abstract:** *This study examines the influence of supply-chain alertness (SCAI), supply-chain robustness (SCR), and supply-chain preparedness (SCP) on supply-chain risk management (SCRM). This study also accesses the mediation effect of supply-chain agility (SCAg) and supply-chain flexibility (SCF) between SCAI, SCR, SCP and SCRM. An electronic survey (Google form) was conducted to gather the data for this research. We targeted manufacturing companies to gather the quantitative data through purposive sampling. For the analysis Smart PLS version 3.0 and SPSS-17 was used. The empirical findings of this research showed an insignificant effect of SCAI on SCRM, SCR on SCRM. Whereas, SCP had a significant effect on SCRM. Moreover, the mediating role of SCAg and SCF was found insignificant in this research.*

**Keywords:** *Supply-chain, resilience, risk management, alertness, preparedness, robustness, agility, flexibility*

## Introduction

Supply-chain risk management (SCRM) has emerged in the business literature as a key factor and many companies are working to enhance their risk-management in order to minimize supply-chain disruptions (Baryannis et al., 2019). The world is changing rapidly and the competition is growing day by day therefore, companies are putting efforts to be ahead of each other through developing their operations more efficient and effective (Christopher & Holweg, 2011). The changes are happening in the overall field of supply-chain, new markets are emerging, complex strategies of supply-chain are required to cover volatile environment, new risks and the disruption caused by the natural disasters (Wieland & Marcus Wallenburg, 2012).

Over the decade, the supply-chain all around the world has been exposed to many risks coming from the external environment (Baryannis et al., 2019; Wagner & Bode, 2008) such as the tsunami in China caused disruption, or the cargo ship struck in Suez Canal in the beginning of 2021, or the cargo 'Heng tong 77' stuck at the sea view Karachi in the middle of 2021. Similarly, the global pandemic of COVID-19 caused stoppage in the supply-chain activities all around the world. The occurrence of unforeseen events and natural calamities are threats to the companies and they are exposed to risks arising from the supply, process, demand, and environment (Chen et al., 2013; Sharma & Bhat, 2014).

The changing dynamic for the supply-chain are difficult to be dealt with therefore, many companies are working to on their SCRM by developing strategies that could help them in reducing the risks (Ritchie & Brindley, 2007). Yet if we talk about Pakistan, many companies are far behind in assessing, managing, and taking proactive measures to maintain the smooth functioning of the supply chain activities. The absence of SCRM in organizations exposing them to demand, supply, process, and environmental risks which are causing disruptions in the supply chain operations and the companies are bearing losses.

To reduce the risk management in the companies, strategies are needed to develop supply-chain resilience. This study contributes in understanding the importance of supply-chain resilience by examining the effect of resilient supply-chain capabilities such as supply-chain alertness (SCAI) (Li et al., 2017), supply-chain robustness (Afraz et al., 2021a), and supply-chain preparedness (SCP) (Li et al., 2017) with the SCRM. Moreover, we will be testing the mediating effect of supply-chain flexibility (SCF) (Can Saglam et al., 2020) and supply-chain agility (SCAg) (Li et al., 2017) between supply-chain alertness (SCAI) & SCRM, supply-chain robustness (SCR) & SCRM and supply-chain preparedness (SCP) & SCRM.

We selected the field of supply-chain because of its extreme importance and this is the field which is exposed to uncertainties and volatilities. Through our research, we will contribute in the literature by helping the companies to understand about developing resilient supply-chain capabilities. And how these factors can effectively cope up the supply-chain processes and operations in times of uncertainties and volatile disruptions. The expansion of SC resilience is important as it plays an important role in mitigating or reducing the impact of risks associated with supply, demand, process, and environment.

The findings of our research will help the companies to understand and implement the strategies to make their supply-chain more resistant. The organizational capabilities of SCAI, SCR and SCP are the important capabilities that companies seeks to develop proactive measures through which risks are minimized. Moreover, after the occurrence of disruption the capabilities such as SCF and SCAg helps companies to respond back effectively to restart the smooth SC process.

### **Problem Statement**

Although SCRM has emerged globally, the organizations in Pakistan are far behind in assessing, managing, and taking proactive measures to maintain the smooth functioning of the supply chain activities and because of the absence of SCRM, organizations are prone to demand, supply, process, and environmental risks which are causing the organizations to incur disruptions in the supply chain operations and bearing losses. In order to improve risk management in the organization, they need to develop dynamic resilient supply chain capabilities. Through our study, we will be examining the impact of dynamic resilient supply chain capabilities on the supply chain risk management (SCRM) of the organizations.

### **Research Objectives**

- a) To examine the effect of alertness (SCAI), robustness (SCR) and preparedness (SCP) on risk management (SCRM)
- b) To examine the mediating effects of agility (SCAg) and flexibility (SCF) between SCAI, SCR, SCP on SCRM.

### **Research Questions**

The following are the research questions that were developed to highlight the significance of this study and that cover the scope of our study.

- a) Do alertness (SCAI), robustness (SCR) and preparedness (SCP) influences risk management (SCRM)?
- b) Do agility (SCAg) and flexibility (SCF) mediate the effect between SCAI, SCR, SCP on SCRM.

## Literature Review

### Dynamic Capability View

Dynamic capability view is used in this study as dynamic capabilities are the organizations strength to build resilience from the threats coming from external or internal environment with the uncertainties in the fast-changing world (Teece et al., 1997). The changes are happening more frequently in SC resulting in disruptions and arising new threats which are needed to be minimized therefore, dynamic capabilities are the higher order capabilities that combines with the organizational resources effectively to reduce the disruption and produce the desired outputs (Amit & Schoemaker, 1993).

### Theoretical Underpinning

#### *Supply Chain Resilience*

Supply chain resilience is defined as the resistance and the capability of redeeming themselves that an organization shows to overcome threats and disruptions coming from the volatile environment (Christopher & Peck, 2004). Resilient supply-chain capabilities (RSCC) help companies to transform their operational activities to preserve or attain the stable position of the company after the occurrence of disruption (Augier & Teece, 2009; Chakravarthy, 1982). The RSCC that we focused on are flexibility (SCF), alertness (SCAl), agility (SCAg), preparedness (SCP) and robustness (SCR).

#### *SC Alertness (SCAl)*

SC alertness (SCAl) is defined in the literature as the capability through which companies can become aware of the changes from both internal supply network and external market uncertainties proactively (li et al., 2009). SCAl allows companies to keep an eye on threats and opportunities that arises from the market and competitors (Christopher & Holweg, 2011). Whereas, the internal processes and operations allows company to increase SC visibility and be alerted from the changes of one end of SC to the other (Christopher & Peck, 2004b).

#### *SC Robustness (SCR)*

SC robustness (SCR) is the proactive strategy to make the company's operations resistant for carrying out supply-chain functions and operations regardless of disruptions and damages occurred due to any external volatile environment (Meepetchdee & Shah, 2007; Shukla et al., 2011). Companies with robust supply-chain network can perform effectively with the occurrence of regular variations and events that hinders the smooth functioning of supply-chain (Klibi et al., 2010; Tang, 2006b).

#### *SC Preparedness (SCP)*

SC preparedness (SCP) is another proactive strategy that companies uses to withstand disruptions. It is the capability of a company through which the influence of potential changes arises from the internal and external environment is anticipated and contingency plans are prepared (Christopher & Peck, 2004b; Tang, 2006a). SCP allows the companies to maintain stability in processes without changing them in times of disruptions (Wallace & Choi, 2011).

#### *SC Flexibility (SCF)*

SC flexibility (SCF) has a broader concept that defines in literature as dynamic and structural flexibility. In the dynamic flexibility, the companies preserve as their current SC framework and respond back by changes in technology and demand & supply (Eckstein et al., 2015). Whereas, structural flexibility is the transformation of the overall supply-chain operations in regards to disruptions (li et al., 2009; Overby et al., 2006). SCF is the strategic response and transformation to change, increase in competition and uncertainties (Hallavo, 2015; Sezen, 2008).

#### *SC AGILITY (SCAg)*

SC agility (SCAg) is reactive capability of the companies, where companies rapidly respond by adjusting its operations and strategies after the occurrence of SC disruptions (Eckstein et al., 2015; Gligor et al., 2015). SCAg is fundamental for companies to retaliate to the changes in market dynamics by enhancing the processes and operational effectiveness of the internal SC operations (Braunscheidel & Suresh, 2009; Tavani et al., 2014).

#### *SUPPLY-CHAIN RISK MANAGEMENT (SCRM)*

SCRM is the identification of the possible causes of risk and execution of the risk mitigation or management strategies for the purpose of avoiding or overcoming the barriers in the smooth functioning of the supply chain in the company (Jüttner et al., 2003). In this study, SCRM is the higher order construct which constitute of four pillars of SCRM that are: supply risk (SR), demand risk (DR), process risk (PR) and environmental risk (ER) (Schlegel & Trent, 2015). These four pillars of risks represent the four directions from which the organization are exposed to risk and needed to develop strategies to mitigate and manage risk incurring from these four directions.

#### *SUPPLY RISKS (SR)*

Supply risks (SR) are the risks that are linked with the upstream operations such as risks from sourcing of raw material, supplies and the relation between suppliers & companies (Kraljic, 1983). Supply risks are essential to manage as they arise disruptions due to quality problems & technological changes by suppliers, delays in sourcing and the production capacity constraints (Robertson & Gatignon, 1998; Tomlin, 2006; Zsidisin, 2003).

#### *PROCESS RISKS (PR)*

In literature, process risks (PR) are defined as the risks that comes from inefficiencies and interruptions in the processes in the SC operations (Kleindorfer & Saad, 2005). The process risks includes the operational and tactical issues resulting in the failure of equipment's, machineries, breakdowns etc. (Craighead et al., 2007; Svensson, 2000).

#### *DEMAND RISKS (DR)*

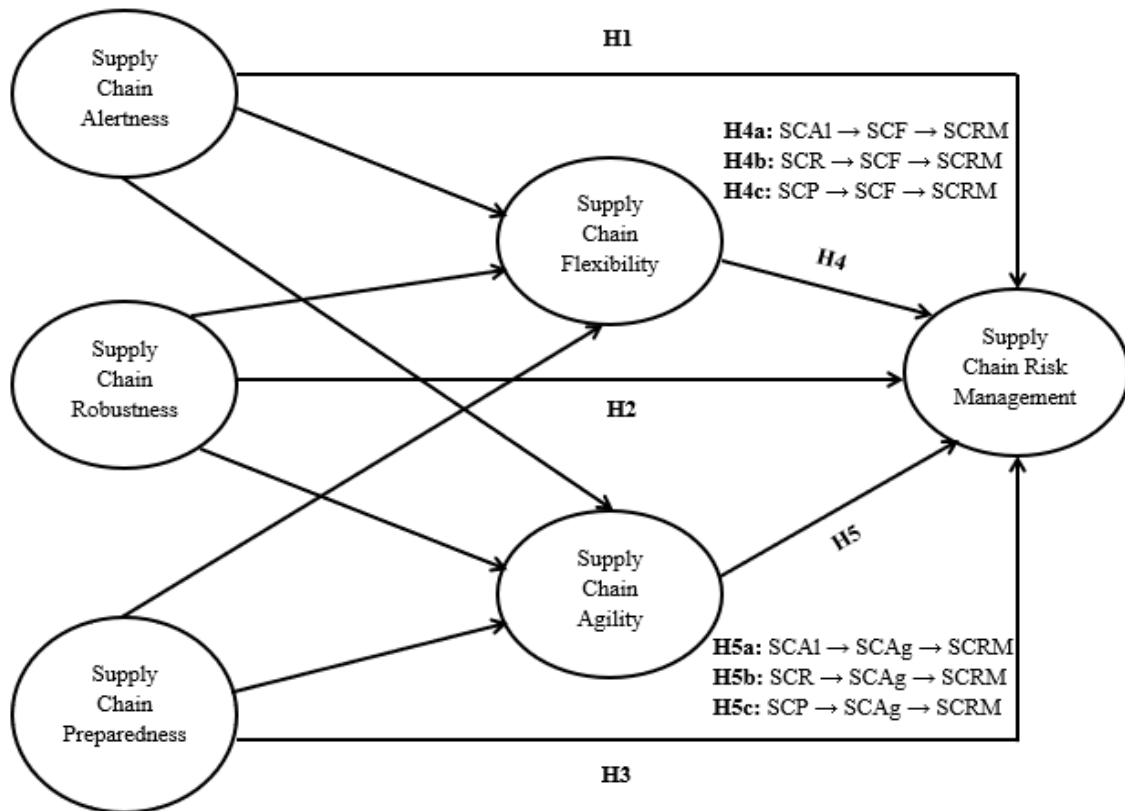
Demand risks (DR) are defined in the literature as the disruptions that arises from the downstream activities (Nagurney et al., 2005). Demand risks are the important issues that any company needs to minimize to have an accurate forecasting of the sales (Lee et al., 1997). Demand risk also arises the financial instability due credit uncertainties by the customers (Kleindorfer & Saad, 2005).

#### *ENVIRONMENTAL RISKS (ER)*

Environmental risks (ER) are the political instabilities, legal regulations, macro-economic changes and the changes affects the company's operations coming from the change in governments policies (*Mattel Takes a Hit on Toy Recall - Bloomberg*, n.d.; Miller, 1992; Shubik, 2010).

### **Conceptual Framework**

The literature above considers supply-chain alertness (SCAl), supply-chain robustness (SCR) and preparedness (SCP) as the independent variables. Flexibility (SCF) and agility as the mediating variables and risk management (SCRM) as the dependent variable. The SCRM is the higher order construct which consists of four pillars to risks including supply risk (SR), process risk (PR), demand risk (DR) and environmental risk (ER) (Schlegel & Trent, 2015) as shown in Figure 1.



*Figure 1: Conceptual Framework*

***EFFECT OF SC ALERTNESS (SCA) ON SCRM***

SC alertness (SCA) has a direct effect on risk management (SCRM) as SC alertness is the firm’s ability to be aware of changes related to technology, macro-economic factors and changes in supply and demand. SC alertness (SCA) increases the SC visibility by allowing the companies to take proactive measures in times of disruption (Craighead et al., 2007). Hence, we proposed our first hypothesis to be:

H1: Supply-chain Alertness (SCA) positively influences SCRM

***EFFECT OF SC ROBUSTNESS (SCR) ON SCRM***

SC robustness (SCR) is the strength of company to make their operations resistant for carrying out SC functions regardless of disruptions (Meepetchdee & Shah, 2007; Shukla et al., 2011). Robust SC processes provides enough time to the companies to take proactive measures for reducing the damages of the recurring threats. Robust SC networks reduce SC risk and increases efficiency in SC performance. Therefore, in the next hypothesis we examined the effect of SC robustness and SCRM.

H2: Supply-chain Robustness (SCR) positively influences SCRM

***EFFECT OF SC PREPAREDNESS (SCP) ON SCRM***

SC preparedness (SCP) is the capability to endure potential changes and develop contingency plans to ensure the performance and smooth functioning of SC functions with wide

variety of disrupting scenarios (Christopher & Peck, 2004b; Tang, 2006a). The company's ability to work with reliable SC partners and create strategic partnerships through equal access to forecast, sales data and plans increases the SCRM of the company. Hence, our third hypothesis was:

H3: Supply-chain Preparedness (SCP) positively influences SCRM

#### ***MEDIATING EFFECT OF SC FLEXIBILITY (SCF)***

SC flexibility (SCF) is the company's ability to respond back with the technological changes and changes in demand & supply (Eckstein et al., 2015). SC alertness (SCAI) makes companies flexible by making them aware of potential disruptions and then the companies can respond effectively of these disruptions. Similarly, SC robustness is the strength of the company to withstand changes. SCR can increase SCF which ultimately increase the risk management of the company. Moreover, SC preparedness (SCP) is the proactive strategy where companies make contingency plans to overcome disruptions. SCP increases the SC flexibility (SCF) as the company's contingency plans allow them to respond back with the changes to reduce the impact of disruptions hence SCRM increases.

Therefore, we examined the mediating effect of SC flexibility (SCF) the following:

H4: There is mediating effect of SC Flexibility (SCF) between:

- a: Alertness (SCAI) and risk management (SCRM)
- b: robustness (SCR) and risk management (SCRM)
- c: preparedness (SCP) and risk management (SCRM)

#### ***MEDIATING EFFECT OF SC AGILITY (SCAg)***

SC Alertness (SCAI) increases the SCAg as the company's ability to identify potential changes give time for company to adjust their production capacity, delivery schedules and SC processes to mitigate disruptions. Similarly, SCR is the strength to preserve current process and the stable configuration which increases the agility to adjust changes without changing the structure of the company. Additionally, SC preparedness increases agility (SCAg) as SCP is the company's capability to make contingency plans through which organizations can adjust back with the change in demand, supply, and processes and adjust production and delivery schedules to mitigate disruption.

Therefore, we examined the mediating effect of SC agility (SCAg) between the following:

H5: There is mediating effect of Agility (SCAg) between:

- a: alertness (SCAI) and risk management (SCRM)
- b: robustness (SCR) and risk management (SCRM)
- c: preparedness (SCP) and risk management (SCRM)

### **Research Methodology**

This chapter of methodology consists of research design, population & sample size, sampling technique and the instrument used in our study.

#### **Data Collection and Measurement**

In our study, we focused on the manufacturing sector as this is the sector which contributes 12.79% to the overall Gross domestic product of Pakistan (Pakistan Economic Survey Team, 2021). Moreover, the supply chain operations of the manufacturing industries and very complex and extensive in nature that they often face disturbances and disruptions due to uncertainties and volatile changes in the market. For the purpose of this research, we collected

the primary data using the google survey from the respondents working in the supply chain departments of the manufacturing companies.

### **Sampling Technique and Sample Size**

The sampling technique that we used is the 'purposive sampling' because of the unavailability of the sampling frame (Bryman, 2016). Based on our judgement, we collected data from the respondents with the insights and knowledge about the manufacturing processes, suppliers, customers, and the environmental factors that impact the overall SC in their companies. The targeted sample size in our study was 250 samples, we collected 265 total numbers of responses. Out of which we filtered out the responses and removed the responses which had a missing data of more than 10%. The study was conducted on 258 responses that were relevant and had meaningful insights for our analysis.

### **Scale and Measure**

In our study, we adopted the constructs from the prior literature and the questionnaire was developed. The constructs included were SC Robustness (4 items) was adopted from (Afraz et al., 2021a), SC Alertness (5 items), SC Preparedness (4 items) and SC Agility (5 items) were adopted from (Li et al., 2017), SC Flexibility (4 items) was adopted from (Can Saglam et al., 2020). We adopted risk management (SCRM) as the higher order construct that consist of four pillars of risks that are supply risk (6 items), process risk (6 items), demand risk (6 items) were adopted from (Chen et al., 2013) and the environmental risk (4 items) from (Sharma & Bhat, 2014). There were 50 items in the questionnaire that included the demographics of 6 items.

We adopted a 5-point Likert scale starting from 1 as 'Strongly Disagree' and 5 as 'Strongly Agree'. All the reliabilities of constructs were previously established in literature but due to changes in demographics we have established reliability again with a threshold criterion of Cronbach Alpha greater than 0.6 ("Research Methods for Business: A Skill Building Approach : Uma Sekaran, John Wiley (1992), Second Edition, 428 Pp., £60.95," 1993)

### **Research Tool**

We used SPSS 17 for the analysis and to check the descriptive of the data. And for the analysis of our conceptual framework, we used Smart PLS version 3.0. Smart PLS is the structural equation modelling (SEM) technique, which is considered effective for analyzing the mediation and moderation effects (J. F. Hair et al., 2017). Since our model was complex in nature and had mediating variable therefore, Smart PLS was preferred.

## **Results**

### **Measurement Analysis**

In the measurement model analysis, first we performed the descriptive analysis test using the SPSS 17 to ascertain the descriptive statistical analyses. Secondly, we performed the reliability test on our data to check the Cronbach's Alpha values should be greater than threshold criterion of 0.6. Lastly, we performed the validity tests where we check the convergent validity through confirmatory factor analysis (CFA) and the discriminant validity test by following the criteria of (Fornell & Larcker, 1981). All the mentioned tests of reliability and validity are performed using Smart PLS version 3.0.

**Profile of the Respondents**

The profile of the respondents showed that 129 (48.7%) responses were filled by females and 136 (51.3%) were filled by males. Out of 265 responses 128 (48.5%) were the people ranging from 20-29. The major share of the respondents belonged to the textile (24.6%) and pharmaceutical (25%) industry. Moreover, 35% of our respondents had an experience of 4-6 years in the company.

**Descriptive Statistics**

In the descriptive statistic, skewness and kurtosis values were analyzed to determine the univariate normal distribution of the collected data of the respondents through questionnaire. The criteria for the range of skewness is -1 to +1 and for kurtosis the criteria ranges between -2.5 to +2.5 (Park, 2015). The results of the descriptive statistics shows that all our construct’s range between the skewness criteria of -1 to +1 and for the kurtosis criteria of -2.5 to +2.5 (see Table 1.) The descriptive analysis results include mean, standard deviation, skewness, and kurtosis.

*Table 1. Descriptive Analysis*

	Mean	Std. Dev.	Skewness	Kurtosis
Flexibility	4.05	0.64	-0.96	0.71
Agility	3.95	0.62	-0.71	-0.21
Supply Chain Alertness	3.96	0.64	-0.58	-0.44
Robustness	3.93	0.66	-0.56	0.12
Preparedness	3.94	0.64	-0.81	0.83
Supply Risk	3.96	0.60	-0.71	0.19
Process Risk	3.92	0.61	-0.60	0.15
Demand Risk	3.92	0.60	-0.56	0.18
Environmental Risk	4.00	0.61	-0.85	0.72

**Construct Reliability & Validity**

For measuring the internal consistency, we performed the reliability analysis using PLS Algorithm in the Smart PLS v3. The maximum iteration was selected to be 300, the result depicted the Cronbach’s Alpha (CA), composite reliability (CR) and the average variance extracted (AVE) see Table 2 below. The threshold criteria for the Cronbach’s Alpha to be accepted is that the value of Cronbach’s Alpha should be greater than 0.6 (Sekaran, 1993). And for the convergent validity the criteria for the average variance extracted (AVE) should be greater than 0.4 (Joseph F Hair et al., 2010).

*Table 2. Construct Reliability and Validity*

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Demand Risk	0.76	0.84	0.51
Environmental Risk	0.71	0.82	0.53
Process Risk	0.78	0.85	0.54
Agility	0.69	0.81	0.52
Alertness	0.76	0.84	0.51
Flexibility	0.71	0.82	0.54
Preparedness	0.67	0.80	0.50
Robustness	0.68	0.80	0.51
Supply Risk	0.70	0.82	0.53

The above Table 2 shows that Cronbach’s Alpha of all the constructs are greater than the criterion of 0.6 (Sekaran, 1993). The highest Cronbach’s Alpha is of the construct ‘Process Risk’ (Cronbach’s a = 0.78) and the lowest reliability of the construct ‘SC Preparedness’ is 0.67.

Moreover, the composite reliability of all the constructs is greater than 0.8 meeting the criteria of composite reliability should be greater 0.7 (Wang et al., 2003). Therefore, we conclude that all our constructs were reliable.

For the convergent validity to be established, the average variance extracted (AVE) of all our constructs are above the criteria of 0.4 (Joseph F Hair et al., 2010). Therefore, all the constructs used in this study were valid, consistent and had no measurement error.

**Discriminant Validity**

Discriminant validity tests establishes the uniqueness of the correlated variables and variables are divergent and distinct in nature (J. F. J. Hair et al., 2009). The analysis to check the discriminant validity of the constructs was performed by following the guidelines and the criteria of (Fornell & Larcker, 1981) and the new criteria of Hetrotrait-Monotrait ratio (HTMT) introduced by (Henseler et al., 2015) which measures the similarity between the latent variables.

*Table 3. Fornell-Larcker Criterion*

	DR	ER	PR	SCAg	SCAI	SCF	SCP	SCR	SR
<b>Demand Risk</b>	0.71								
<b>Environmental Risk</b>	0.65	0.73							
<b>Process Risk</b>	0.68	0.55	0.73						
<b>Agility</b>	0.61	0.54	0.55	0.72					
<b>Alertness</b>	0.54	0.50	0.51	0.70	0.72				
<b>Flexibility</b>	0.55	0.50	0.45	0.65	0.57	0.73			
<b>Preparedness</b>	0.58	0.50	0.48	0.58	0.63	0.56	0.71		
<b>Robustness</b>	0.54	0.53	0.47	0.62	0.69	0.57	0.67	0.71	
<b>Supply Risk</b>	0.69	0.57	0.61	0.55	0.59	0.52	0.65	0.58	0.73

From the above Table 3, discriminant validity test done using Smart PLS depicted that the Fornell-Larcker’s analysis of the square roots of the average variance extracted (AVE) were greater than each pair of the correlation fulfilling the requirements of discriminant validity. Hence, our constructs are divergent from each other.

*Table 4. Heterotrait-Monotrait Ratio (HTMT)*

	SCAg	SCAI	SCF	SCP	SCR	SCRM
<b>SCAg</b>						
<b>SCAI</b>	0.698					
<b>SCF</b>	0.651	0.57				
<b>SCP</b>	0.577	0.626	0.558			
<b>SCR</b>	0.624	0.685	0.569	0.674		
<b>SCRM</b>	0.665	0.626	0.591	0.648	0.621	

The Hetrotrait-Monotrait ratio (HTMT) results for the discriminant validity to be established has the criteria for the pairs of the latent variables to be lower than 0.90 (Gold et al., 2001). The results of the HTMT as shown in the above Table 4, have the values for all the construct are below 0.8. Hence, meeting the criteria therefore, all our constructs are discriminant from each other.

**Model Fit**

The R square and adjusted R square were tested (see Table 5). And the results showed the adjusted R square of agility (SCAg) and flexibility (SCF) were 0.532 and 0.406 respectively, and the adjusted R square of the dependent variable risk management (SCRM) was 0.568. All the adjusted R squares are above the criteria of 0.33 therefore, this is classified as moderate.

Table 5. R Square

	R Square	R Square Adjusted
SCAg	0.537	0.532
SCF	0.413	0.406
SCRM	0.577	0.568

The model fit analysis as shown in the Table 6 that the Standardized Root Mean Square Residual (SRMR) is 0.04, the acceptance criteria for the model to be fit is that the SRMR value should be less than 0.08 however, the cutoff value of 0.1 is acceptable (Henseler et al., 2014). Moreover, the Normed Fit Index (NFI) showed the value of 0.96 that is above the criteria of 0.90 (Bentler & Bonett, 1980) therefore, our model is acceptable fit.

Table 6. Model Fit

	Saturated Model	Estimated Model
SRMR	0	0.04
d_ULS	0	0.04
d_G	0	0.03
Chi-Square		35.48
NFI	1	0.96

In addition to adjusted R square and model fit, we also tested the multicollinearity between the variables using PLS algorithm. The results of variance inflation factors (VIF) for all the constructs were greater than 1 hence, there was no multicollinearity found in our variables (Fornell & Larcker, 1981; Joseph F Hair et al., 2010).

Moreover, we performed the blindfolding procedure to determine the Q2 values. The acceptance criteria for the predictive relevance is that the Q2 should be above than zero (Henseler et al., 2009). The results showed the Q2 values of SCAg (Q2 = 0.526), SCF (Q2 = 0.394) and SCRM (Q2 = 0.552) that are greater than zero. Therefore, predictive relevance of our model was established.

### **Structural Equation Modeling Analysis**

In this structural model analysis, we had first validated the higher order construct using the repeated indicator approach. After validation of the higher order construct “SCRM”, we used all the latent variables in the model. Later, we examined the path coefficients and specific indirect effect for determining mediations effects using the Smart PLS version 3.0. For the assessment of the structural model of our framework, we used bootstrapping approach using 5000 as sub samples and obtained T-statistics and P-values.

#### **Validation of Higher Order Construct**

In our study, we used risk management (SCRM) as the higher order construct which consists of four 1<sup>st</sup> order constructs as the four pillars of SCRM i.e. supply risk (SR), demand risk (DR), process risk (PR) and environmental risk (ER) (Schlegel & Trent, 2015). We used the repeated indicator approach in the PLS algorithms where the first-order constructs were reused in the second-order construct. We validated the construct by checking their factor loadings as greater than 0.5. All the items that we retained had the factor loadings greater than 0.5 (see Figure 2).

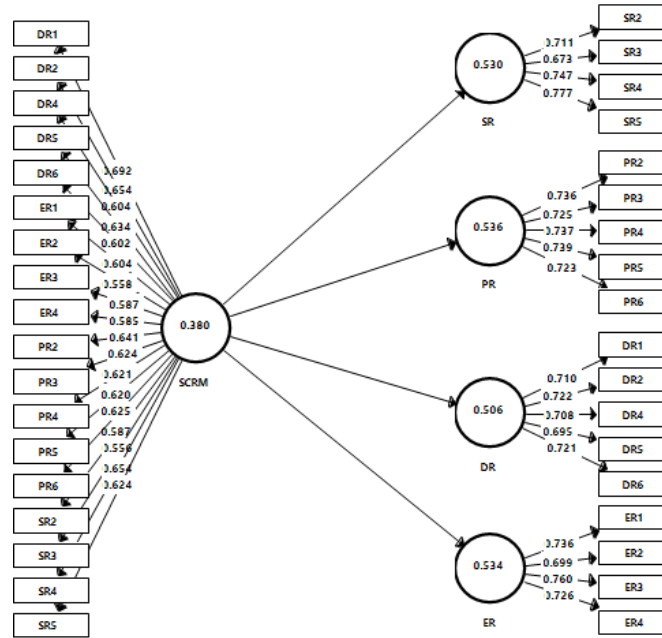


Figure 2. Higher Order Construct

### Structural Equation Modeling Using Smart PLS

After the validation of the higher order construct “SCRM”, we validated all the other constructs in our study. We used PLS algorithm approach with the maximum iteration of 300 to check all the factor loadings of the items of the constructs and retained the items with the factor loading of above 0.5 as shown in the Figure 3 below.

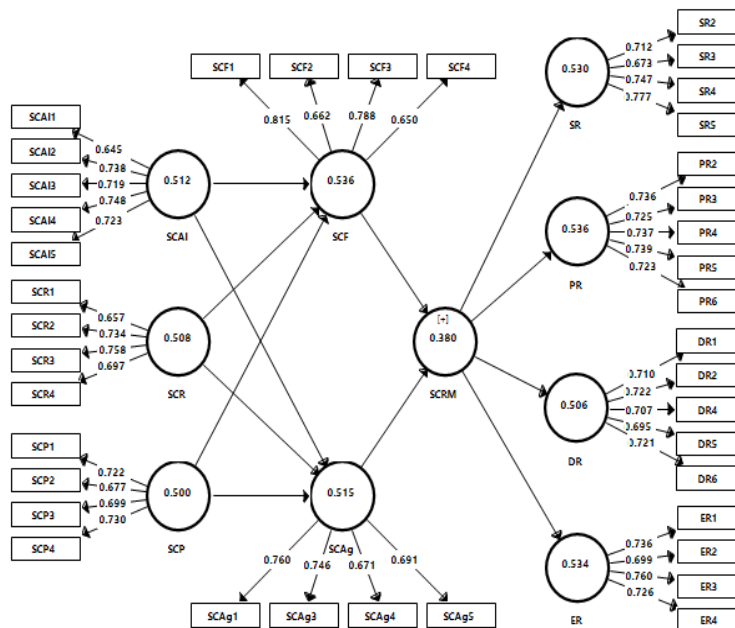


Figure 3. Validation of All Constructs

**Latent Variables Framework**

After validation of all the constructs, we used all latent variables in our model (see Figure 4). The structural analysis was done on the framework using the bootstrapping approach and we obtained T-statistics and P-values for the assessments of path coefficients (see Table 7) and specific indirect effects (see Table 8).

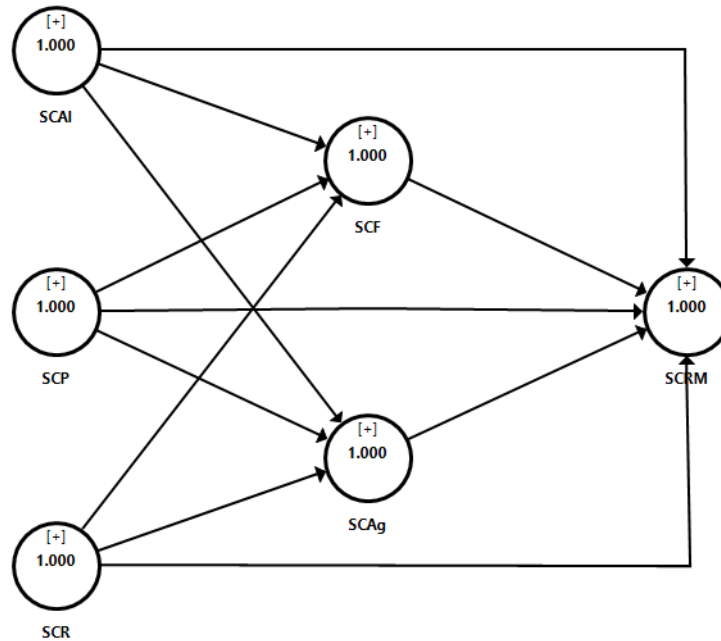


Figure 4. Latent Variable Framework

**Path Coefficient and Specific Indirect Effect**

We used bootstrapping with a sub sample of 5000 in order to determine the path coefficients (T statistics and P values) for the analysis of the hypothesis (H1, H2 and H3) see Table 7. We further hypothesized the mediating effect of flexibility (SCF) and agility (SCAg) therefore, we conducted a bootstrapping to obtain the specific indirect effects for the analysis of the mediating relationship of the above two variables between SCAI & SCRM, SCR & SCRM and SCP & SCRM (see Table 7).

Table 7. Path Coefficient

		T Statistics	P Values	Hypothesis
<b>H1</b>	SCAI → SCRM	1.456	0.145	Not Supported
<b>H2</b>	SCR → SCRM	1.498	0.134	Not Supported
<b>H3</b>	SCP → SCRM	3.762	0.000	Supported

The direct effects of resilient capabilities (SCAI, SCR and SCP) were tested with SCRM. The result showed that the effect of SCAI on SCRM (T Statistics = 1.456, P Value = 0.145,  $P > 0.05$ ), SCR on SCRM (T Statistics = 1.498, P Value = 0.134,  $P > 0.05$ ) were insignificant hence we rejected the hypothesis (H1 & H2). Whereas, the effect of SCP on SCRM (T Statistics = 3.762, P Value = 0.000,  $P < 0.05$ ) was significant therefore, we accepted the hypothesis H3. As H1 and H2 were not supported therefore, we conclude that there is no effect of alertness (SCAI) and robustness (SCR)

on risk management (SCRM). Whereas, H3 was supported hence, there is a positive effect of preparedness (SCP) on risk management (SCRM).

*Table 8. Specific Indirect Effect*

Hypothesis	Effects	T Statistics	P Values	Hypothesis
H4a	SCAI → SCF → SCRM	1.46	0.144	Not Supported
H4b	SCR → SCF → SCRM	1.394	0.163	Not Supported
H4c	SCP → SCF → SCRM	1.706	0.088	Not Supported
H5a	SCAI → SCAg → SCRM	3.412	0.001	Supported
H5b	SCR → SCAg → SCRM	1.687	0.092	Not Supported
H5c	SCP → SCAg → SCRM	1.922	0.055	Not Supported

The results of specific indirect effect in the above Table 8 showed the mediating effect of agility (SCAg) is significant between SCAI and SCRM (T Statistics = 3.412, P Value = 0.001, P < 0.05). Therefore, the hypothesis H5a was accepted. All the other hypothesis showed the insignificant effect as flexibility (SCF) was not playing a mediating role between SCAI & SCRM (T Statistics = 1.46, P Value = 0.144, P > 0.05), SCR & SCRM (T Statistics = 1.394, P Value = 0.163, P > 0.05) and SCP & SCRM (T Statistics = 1.706, P Value = 0.088, P > 0.05). Similarly, agility (SCAg) was also not mediating the effect between SCR & SCRM (T Statistics = 1.687, P Value = 0.092, P > 0.05) and SCP & SCRM (T Statistics = 1.922, P Value = 0.055, P > 0.05). Hence, the hypothesis: H4a, H4b, H4c, H5b and H5c were rejected.

### **Discussion and Conclusion**

In this study, we used a dynamic capability view to establish the effect between alertness (SCAI), robustness (SCR), preparedness (SCP) and risk management (SCRM). As per our knowledge, this is among the first researches where the direct effect of SCAI on SCRM, SCR on SCRM and SCP on SCRM was analyzed. Moreover, in this study we also analyzed the mediating effect of flexibility (SCF) and agility (SCAg). The reason behind conducting this study was to analyze the capabilities that could reduce the impact of disruptions in the smooth functioning of supply-chain operations in Pakistan. Due to geographical location and the political conditions in Pakistan, the occurrence of uncertainties and the volatility of risks arising from the internal processes and external environmental factors such as suppliers, customers and environment are higher which has a greater impact on the performance of the manufacturing industries of Pakistan (Rafique, 2015).

The hypothesis of the effect of alertness (SCAI) on the risk management (SCRM) was tested to determine whether the firm’s alertness to the changes coming from macroeconomic factors or threats from the suppliers or changes in the demand patterns can reduce the risks and increase the performance of the organization. Our empirical study showed no significant effect of SCAI on SCRM (see Table 7) as the geo-political conditions of Pakistan are volatile. The frequent changes of the macroeconomic factors and behavioral shift of the suppliers and customers are widely effected since the occurrence of Covid-19 (Husain Khurram, 2020). The major shifts in behavior of conducting businesses have created more uncertainties and aroused risks that organizations are facing problems to be alerted with (Shafi et al., 2020).

The hypothesis of the effect of robustness (SCR) on the risk management (SCRM) was insignificant as shown in the Table 7. The empirical findings of our study showed no effects of the organizational capability to withstand changes without shifting their existing network (Afraz et al., 2021b). The frequent waves of Covid-19 in Pakistan and government policies to impose lockdowns have widely impacted the way businesses operates in Pakistan (Hassan Naqvi, 2020). With unavailability of the labor forces, shortages of raw materials and financial losses, the

operations of the manufacturing industries are severely impacted causing them to shift their patterns and processes to operate. Hence, the robustness to face the challenges is lacking in the companies of Pakistan (Regional Office Hub in Thailand, 2020).

The hypothesis of effect of preparedness (SCP) on risk management (SCRM) was analyzed in this study. The empirical findings of our research showed the significant effect of SCP on SCRM (See Table 7). The findings of our analyses is consistence with the findings of (Li et al., 2017) as the companies have made the policies to align strategies with the partners, and to build strategic partnerships in order to reduce the risks. The manufacturing organizations in Pakistan are preparing to form alliances and selection of reliable suppliers and partners to prepare themselves to sustain in times of uncertainties.

The hypothesis for the mediating effect of agility (SCAg) and flexibility (SCF) were also examined in our study. The empirical findings do not support the hypothesis of the SCAg and SCF between the three resilient capabilities and SCRM. The SCAg and SCF are the reactive capabilities (Eckstein et al., 2015; Sezen, 2008) whereas, SCAl, SCR and SCP are the proactive capabilities (Afraz et al., 2021a; Li et al., 2017). Therefore, SCAg and SCF does not play a mediating role between the independent and the dependent variable (see Table 8).

The resilient capabilities (RSCC) are essential for companies to develop resistance towards risks arising from the internal processes or from the external sources such as suppliers, customers, and environment. The strengths of the companies supply chain operation could be established more by developing the flexibility and agility in operations through which companies will be able to respond back effectively with the disturbances and disruptions in the supply chain (Aslam et al., 2020; Can Saglam et al., 2020; Iranmanesh & Rajagopal, 2017). Although the resilient supply-chain capabilities (RSCC) such as alertness (SCAl) and robustness (SCR) strengthens the companies to reduce the impact of the uncertainties but in the developing nations like Pakistan, the level of volatility and the risks arises from the environment are naturally higher (Rafique, 2015). In the recent years, the Covid-19 and its after affects have made it difficult for the manufacturing companies in Pakistan to develop the capabilities that would impact the supply chain performance and protect the organizations from the threats and preserve supply chain operations (Shafi et al., 2020; UNCTAD, 2020). With frequent lockdowns and restrictions in operations, the manufacturing companies in Pakistan are struggling to deal with the financial losses. The recessions and the economic downturn in Pakistan (Hassan Naqvi, 2020) has been the major reason that impacted the performance of the manufacturing industries operating in Pakistan.

### **Managerial Implication**

Several researches in the past have already highlighted the importance of developing the resilient capabilities and how that could help in improving financial performances and business development. Through the findings of our study, the managers of the manufacturing companies would be able to understand more about the complexities of the developing nations and how these capabilities have an impact on the performance of the supply chain operations. The development of new markets and increase in the competitive environment has made the companies more focused in gaining advantages and increase their profitability by reducing and handling the day-to-day disruptions in the smooth functioning of the supply chain functions. This research will help managers to develop preparedness (SCP) as company's capability to strategically partner with the suppliers and involve them in the decision-making processes has a significant effect on the risk management (SCRM) of the companies (see Table 7). Moreover, the

effectiveness of the manufacturing processes could be handled efficiently by developing the preparedness (SCP).

Although, the results of our research showed insignificant direct relationships of alertness (SCAI) and robustness (SCR) with the risk management (SCRM) but these capabilities are the well balanced and dynamic bunch of capabilities that complement each other. The managers of the companies should work on developing these two capabilities (SCAI & SCR) as they both complement preparedness (SCP). The company's capabilities to stay alerted about the changes happening in the market or the changes of the macroeconomic factors allow them to be prepared and withstand the supply chain operations.

### **Limitations & Future Research**

Although, Karachi is the hub of businesses in Pakistan and a lot of large-scale manufacturing companies are operating here but there is a chance for the findings of this research may not be generalized to the manufacturing companies operating in others cities of Pakistan or the cities of other developing nations because of the different geo-political factors and internal processes and values. For the future researches, the scope of the study could expand to gathers the data belonging to the manufacturing companies operating in and across all the major cities of Pakistan, moreover, the future researcher could compare the findings of the study conducted in the other developing nations operating in the different geographical location across the world.

Additionally, from the different resilient supply-chain capabilities including: supply chain visibility (SCV), preparedness (SCP), supply chain timeliness (SCT), supply chain promptness (SCPt), alertness (SCAI), agility (SCAg), and robustness (SCR), we examined the direct effects of SCAI, SCR, and SCP. In the future research the other supply chain capabilities could be examined to understand their effects and how they could be develop to withstand the organizational performances and reduces the risks arising from the directions involving suppliers, customers, processes and environment (Schlegel & Trent, 2015).

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