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RESEARCH PAPER

Quantifying the Mediating Effect of Resilience in Supply Chain: Empirical Evidence from Oil and Lubricant Industry

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ABSTRACT

The study is undertaken to evaluate the facets of Supply Chain Resilience, Capabilities, and Performance within the Oil and Lubricant Industry of Pakistan. In this explanatory research, a model is developed to validate the premise of drafting value-creating supply chain resilience to assist and implement supply chain management strategies in trading companies. The study exploits the primary data source from at least 306 professionals working in Oil and Lubricant Industries in Pakistan. The structural Equation Technique is used to analyze data from the respondents. The research finding depicts that the antecedent of Supply Chain Resilience mediates positively between Supply Chain Capabilities and Supply Chain Performance of the company. Robust Supply Chains have a more positive impact on performance versus Agile Supply Chains. To increase Supply Chain Resilience, companies should make their supply chain more Robust by improving their Supply Chain Capabilities, Risk Strategies as well as Supply Chain Management Strategies.

Introduction

Supply chain management is related to the organization of material and information across the organization, utilizing the facilities, i.e., the vendors, manufacturing, assembling of products, and the distribution channels (Thomas & Griffin, 1996). It is considered a backbone for creating foundations and infrastructure within societies and businesses. Expanding global markets, technology, and rapid exchange of information, ideas, goods, and services has turned the world into a giant network that means the supply chain is everywhere. It starts from the concept of the product till the after-sale service. There was no or little concept of the supply chain in previous decades. Still, it has become an essential part and need of business to compete in the local and international market over the recent decade (Esper et al., 2007). At the start of COVID-19, it was initially observed as a Chinese local matter. But it adversely affected the global supply chains; reportedly, 95% of Fortune 1000 firms that had supply chain integration with China experienced disruptions and issues in the flow of operations. Supply Chain Resilience (SCR) has been studied extensively in the literature and its impacts on smooth functioning global SCM networks. Yet, these pandemic disruptions brought new talks to the forefront. Apart from the recent pandemic of 2019, numerous incidents have threatened the Supply Chains of companies worldwide associated with terrorism, political and economic crises. Under the umbrella of Supply Chain, Supply Chain Resilience (SCR) is an evolving subject (Hohenstein, 2018).

The Oil and Lubricant (O&L) Industry is a complex trade with corresponding complex processes across its supply chain. O&L has been a significant impact on the global and local economy. Despite being a high-risk industry, many supply chain strategies are copies of other sectors. This is because few players are compared to other industries in O&L; these players include clients and contractors(Pedwell et al. 1998).

Every supply chain is vulnerable in today's tempestuous environment (Knemeyer et al., 2009). In recent times, numerous researches have been conducted to understand supply chain resilience patterns, from investing in Supply Chain Capabilities to making the system agile and robust. Investment control is necessary to increase the company's profit and sustain its competitive position.

Literature Review

Supply Chain Management

In the 1980s, Oliver and Webber, the logistics consultants, coined and initially specified the term Supply Chain Management (Pfohl & Gomm, 2009). They urge that the SCM be viewed as an interconnected concept. Strategic decisions are required at a higher level of organization to manage the complete chain efficiently and effectively (R. K. Oliver, 2012). Before the term SCM was invented, studies started on the alignment and organization of multiple functional units along the supply chain (Felea & Albăstroiu, 2013). Remarkable studies carried out like Bowersox (1969) on collaboration, Hanssmann (1959) on inventory control in production, and Forrester's (1958) for complex processes in the area of production. However, after the SCM term was invented, research scholars' attention in the SCM research field has steadily grown (Lalonde, 1997). Supply chain integration has become vital because of intense global competition and the need for cross-company collaboration (Felea & Albăstroiu, 2013). SCM's applicability has been thoroughly discussed during the last two decades, leading to several diverse methods and meanings (Pfohl & Gomm, 2009).

Some scholars describe SCM as a pure management philosophy; others call it a flow of products from a supplier to its customer. Few others called it a management system (Tyndall et al., 1998). Christopher & Peck (2004) defines SCM as an interconnected web system of entities arranged harmonizing that produces added value goods or services across upstream and downstream links for the end customer. Sunil and Peter (2006) describe Supply chains as a group of entities connected and aimed to satisfy consumer demand. Likewise, Hassan & Abbasi (2021) view SCM as a specifically involved series in the upward and downward streams from a supplier to the consumer of goods, resources, finance, and information. Since the advent of SCM in the 1980s and the initial impetus to monitor the movement of products and related information via a network. The supply chain has evolved, and more facets are explored (Aday & Aday, 2020).

Supply Chain Resilience

Early studies of the 2000s, including Esper et al. (2007) and Sunil and Peter (2006), increased the interest in SCR. Apart from management studies, Resilience has also been researched in other areas, including metallurgy, ecology, psychology, and sociology. For instance, material scientists examined how things revert to their natural shape while ecologists investigated living structures restored after a disruption (Marak & Pillai, 2018). On the other hand, psychologists and individuals working in sociology studied people and society's capabilities of being resilient due to a loss. Likewise, other scholars explored the role of individual capabilities regarding Resilience (Nguyen, 2022).

There is no universal definition of Supply chain resilience since it is an evolving field (Hohenstein, 2018). Rice and Sunil made the initial attempt to describe the term resilience concerning SCM, and their description was built from an organizational point of view. In SCM, Resilience is seen as a capability to respond and restore regular activities of business disruption due to an unpredictable disturbance. Such as that triggered by a terrorist attack, pandemic, or as a result of a natural catastrophe. The same kind of definition given by Christopher and Peck (2004) and Shafi et al. (2020) describe Resilience as a system's ability to tolerate outside shocks and rapidly reinstate the original state. Further, Ponomarov & Holcomb (2009) have developed the most detailed and technically established concept of Resilience. According to them, Resilience is characterized as the adaptive capacity to plan for, react to, and recover from unforeseen events by preserving the processes' consistency at the optimal degree of the communication controlling the structure and work.

Ponomarov and Holcomb (2009) address Supply Chain Resilience from a theoretical perspective and offer an applied viewpoint and philosophical resilience structure through a multidisciplinary and multidimensional literary analysis. Their work helps enhance understanding of SCR and discusses and fixes theoretical shortcomings in current literature. SCR's theoretical basis having its multiple dimensions has been studied; however, the study is insufficient to provide interaction of these dimensions. Another study carried out by Leat and Revoredo-Giha (2013) on agricultural SCR aims to define the critical risk involved in making a Supply Chain resilient, emphasizing delivering primary goods and the intrinsic difficulties they face. The study explains how risk control and stakeholder cooperation contribute to improved Supply Chain stability and decreased Supply Chain vulnerability through backward and forward collaboration. On the other hand, Irshad (2021) studied the dimension of risks in Supply Chains to a greater extent.

Hypotheses Development

This research study's foundation is based on the previous work undertaken by Christian (2018) in the subject area that examines and considers the Supply Chain Capabilities (SCC) as a resource point of view. Companies intentionally encourage and build their supply chain capabilities to promote efficiency and retain competitive advantages (Ponomarov & Holcomb, 2009). The appropriate mix of these capabilities helps a company's supply chain respond effectively to the disruptions and related problems created by an unpredictable market environment. Furthermore, the researchers also suggest a significant SCR effect on organizational performance (Fan & Stevenson, 2018). Mentzer et al. (2001) investigate the firm performance concerning the significance of vendor selection and their engagements with the buyer's firms.

Supply Chain Orientation

Companies are increasingly implementing cooperative systems to take advantage of today's corporate climate's growing issues and ambiguity and enhance productivity and effectiveness (Stank et al., 2005). It can be seen as an alternative to develop governance structures and minimize ambiguity within a supply chain that builds stronger sustainable relationships, such as with lead suppliers. The supply chain's strategic focus is increasingly important (Ponomarov & Holcomb, 2009). The study conducted by Patterson et al., (2003) expands the understanding of disruption in Supply chains. The study also states that Supply Chain Orientation (SCO) requires the firm's aptitude to restore its position after the impacts of disruption. Fan & Stevenson (2018) have studied the mediation effect of Supply Chain Agility on Supply Chain Orientation and Performance. The cross-sectional study on Indian manufacturing firms signifies that S.C. Orientation and S.C. Agility positively affect S.C. Performance. Further, supply chain resilience includes the types of orientation, i.e., flexible

and control direction. Few research scholars defined Supply Chain orientation as a multilayered formation requiring confidence, dedication, leadership, interpersonal skills, and top management support (Ponomarov & Holcomb, 2009).

Supply Chain Management Strategies

A study urges that a business predict and plan for possible future disruptions to minimize threats and vulnerability; entities working in the supply chain must have the ability to predict multiple scenarios and incorporate possible alternatives and techniques to avoid detrimental impacts on the supply chain (Wieland, 2021). Asma (2021) studies that introducing redundancies and more excellent stability helps enterprises reduce the risk for instability and improve the durability of the supply chain. Gunasekaran et al., (2004), in their study regarding SCR, proposed global sourcing strategies to support Resilience in supply chains. Pickett et al. (2015)also stress the role of SCM Strategies on Agility and Robustness of the Supply Chain.

Risk Management Capabilities

Risk Management Capabilities are as critical as any other supply chain capabilities concerning Resilience. Risk management skills have an essential role in developing a risk management culture for an enterprise, and they can also strengthen the resilience aspect in the supply chain (Dehgani & Jafari, 2019). Brusset & Teller (2017) also studied the moderating role of supply chain risks between the SCC and Resilience. They stated that external supplier risk perception motivates the managers to enhance their integration competencies and thus raise Resilience. Fan & Stevenson (2018) urged to adopt a holistic approach for Supply Chain Risk Management. The study signifies the importance of Risk diagnosis in the supply chain through its probability and impacts analysis. The survey conducted by Namdar et al. (2018) attempts to quantify the risk attitude for decision-makers and expands further knowledge on kinds of risks, i.e., disruption and operational risk. On the other hand, it is also studied that the increased orientation in risk control contributes to the advancement of strength within the supply chain (Wieland & Wallenburg, 2013).

Agility

Hohenstein (2018) urges that the Supply Chains may face disruptions at some stages of their maturity; however, there must be a system to recover from the disorders quickly without absorbing any adverse effects. A swift reaction towards disruption helps the chain rebound rapidly and dramatically, decreasing the overall negative (Toorajipour et al., 2021). Earlier studies also suggested that the disruption negatively affects the supply chain's efficacy. Later studies conducted signify the beneficial impact on the competence of a supply chain of the agile modules of robust capabilities by substantially minimizing the turnaround time (Mastos et al., 2021). Esper et al., (2007) also took the effect of Agility on Supply Chain Performance (SCP). Dehgani & Jafari (2019) also studied the influence of Information Technology on Agility in Supply Chains.

Robustness

Robustness is the cornerstone of a firm's buoyant capacity, decreasing the risk of disturbances and avoiding possible adverse effects as a robust supply chain setup (Hohenstein, 2018). Their study also suggested that an enterprise must develop an engaging strategy to minimize potential disruptions. Yang et al. (2009) also urged that it is essential for organizations to forestall and effectively prepare and deal with prospective troubles. Hamel & Välikangas (2003) stressed the value of advanced skills to recognize the pattern of

uncertainties that influence viability in Supply Chains. Zhao & You (2019) urges Robust Supply Chains' importance to depict Resilience in times of disruptions and uncertain situations.

H_1: Agility mediates the relationship between Supply Chain Orientation and Supply Chain Performance in Pakistan's Oil and Lubricant industry.

H_2: Agility mediates the relationship between Supply Chain Management Strategies and Supply Chain Performance in Pakistan's Oil and Lubricant industry.

H_3: Agility mediates the relationship between Risk Management Strategies and Supply Chain Performance in Pakistan's Oil and Lubricant industry.

H_4: Robustness mediates the relationship between Supply Chain Orientation and Supply Chain Performance in Pakistan's Oil and Lubricant industry.

H_5: Robustness mediates the relationship between Supply Chain Management Strategies and Supply Chain Performance in Pakistan's Oil and Lubricant industry.

H_6: Robustness mediates the relationship between Risk Management Strategies and Supply Chain Performance in Pakistan's Oil and Lubricant industry.

Conceptual Framework

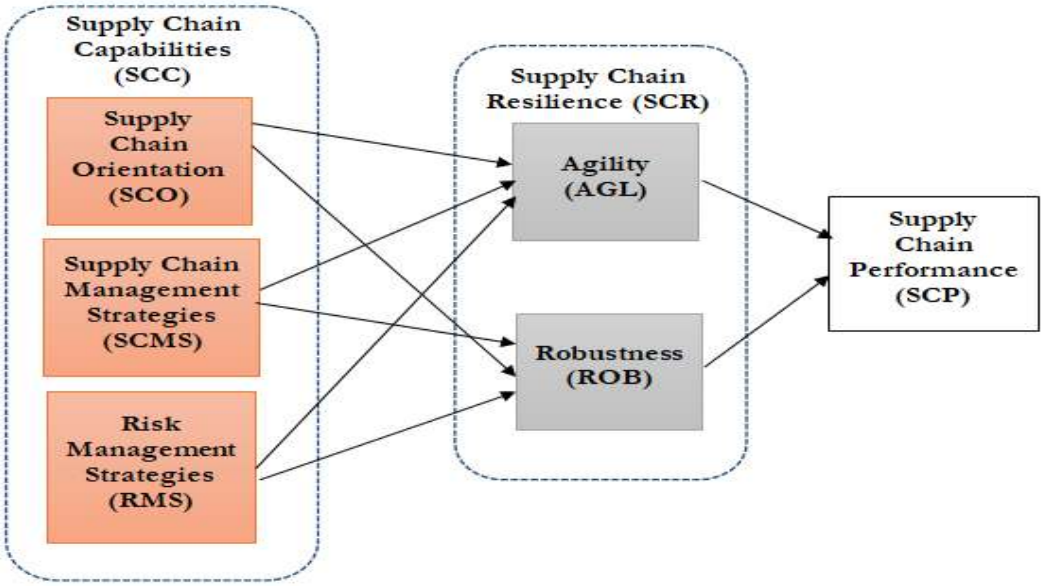

Figure 1 Conceptual Framework

Material and Methods

An empirical, methodological approach is followed for this study based on a resource-based perspective given by Prahalad & Hamel (1994). Firms from Oil and Lubricant (O&L) industry have been approached to provide their responses through an online questionnaire survey, further analyzed through Structural Equation Modelling (SEM) using SMART PLS. It is a reasonably cost-effective and secure way of gathering data, and further, the responses are easily quantifiable and can be evaluated using statistical

techniques (Ponomarov & Holcomb, 2009). Cause and effect relationships are considered an important research area and such interactions focus on various market concerns. Past complex approaches have been developed in economic and social science, such as causal analysis or structural equation analysis for multivariate analyses (Polyantchikov et al., 2017). The structural equation approaches have grown firmly in supply chain management for multivariate computational data analysis (Wieland & Wallenburg, 2013). An online survey through google forms was created for collecting the required data because the online web approach has advantages over paper-based surveys, including cost-effectiveness, accessibility, efficiency, and data analysis. The target group was professionals working in Pakistan's Oil and Lubricant Industry, and data were collected for four months starting Sep 2021 to Dec 2021. A sample of 306 respondents is taken from the personnel to know the relationship as calculated by G Power. Purposive sampling has been used in this study because we need to quantify and analyze the responses from experts working in Pakistan's Oil and Lubricant industry. The subject sampling technique is when the people are sorted out from a pre-specified group and then sampled (Tukamuhabwa et al., 2015).

Results and Discussion

Descriptive Statistics

A total of 306 responses have been collected from Pakistan's Oil and Lubricant Industry. These respondents are mostly the trading companies engaged in the business of Petroleum Marketing as well as Lubricant manufacturing and distribution business. Demographic characteristics are given in the table below

Table 1
Demographic Characteristics of the Sample

Description Sample Size = 306		**Frequency**	**Percent**
Designation	Manager	103	33.6
	Executives	76	24.8
	Asst. Manager	69	22.5
	Head of Department	58	18.9
Education	Masters & Above	201	65.7
	Graduate	93	30.3
	Intermediate	12	3.9
Department	Supply Chain	169	55.2
	Procurement	57	18.6
	Sales & Marketing	36	11.7
	Operations	23	7.5
	Finance	13	4.2
	Other	8	2.6
Company Age (in years)	7-9	87	28.4
	10-12	83	27.1
	4-6	66	21.5
	1-3	45	14.7
	13 & Above	25	8.1
Company Size (No. of employees)	51 to 150	102	33.3
	Below 50	86	28.1
	Above 400	68	22.2

	151 to 400	50	16.3
Gender	Male	282	92.1
	Female	24	7.8

Source: Author's estimation

Measurement Model

The measurement model is the pre-test before the hypothesis testing, confirming that all the data and measures are satisfactory for further analysis. It is composed of two main categories of tests: reliability and validity. There are two types of reliability: loading values of individual items whose threshold value is 0.7. We see all the loading values are greater than 0.7. The other time is construct reliability, for which Cronbach alpha and composite reliability are used. The threshold value for both is also 0.7. From the table below, we see that all the constructs have values greater than the threshold. While the validity is divided into two major types, convergent and discriminant validity. For the convergent validity, AVE values are used. The threshold for this is 0.5, we see below the table all the constructs have AVE values greater than0.5. For the discriminant validity, Fornell Larcker criteria are used. Table 3 shows that all the AVE square values are greater than the horizontal and vertical values below. It shows that our data is valid and reliable for further analysis.

Table 2
Reliability and Validity

Construct	Items	Loadings	Cronbach's Alpha	CR	AVE
Agility	**AGL1**	0.905	0.886	0.921	0.745
	AGL2	0.861			
	AGL3	0.822			
	AGL4	0.862			
Risk Management Strategies	**RMS1**	0.914	0.848	0.895	0.741
	RMS2	0.797			
	RMS3	0.867			
Robustness	**ROB1**	0.884	0.888	0.923	0.749
	ROB2	0.841			
	ROB3	0.822			
	ROB4	0.913			
Supply Chain Management Strategies	**SCMS1**	0.665	0.723	0.825	0.542
	SCMS2	0.718			
	SCMS3	0.721			
	SCMS4	0.831			
Supply Chain Orientation	**SCO1**	0.797	0.741	0.853	0.662
	SCO2	0.907			
	SCO3	0.726			
Supply Chain Performance	**SCP1**	0.950	0.878	0.925	0.805
	SCP2	0.851			
	SCP3	0.888			

Table 3
Fornell-Larcker Criterion

	AGL	RMS	ROB	SCMS	SCO	SCP
AGL	***0.863***					
RMS	0.611	***0.861***				

ROB	0.649	0.447	***0.866***			
SCMS	0.659	0.684	0.527	***0.736***		
SCO	0.494	0.439	0.629	0.652	***0.814***	
SCP	0.565	0.397	0.782	0.427	0.407	***0.897***

Structural Model

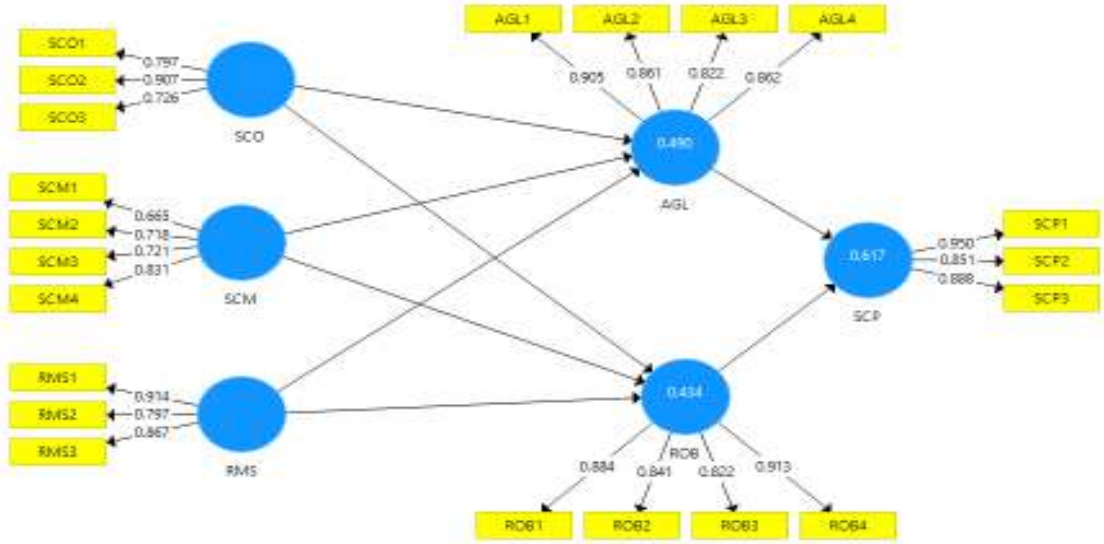

Figure 2 Model

Mediation Analysis

Table 4 of the mediation analysis shows that there are a total of 6 mediating relationships in our model upon which our six hypotheses are based. From the table, we see that Agility only mediates the relationship of the RISK Management Strategy because of its significant value. In comparison, the Robustness mediates the association of Risk Management Strategy and Supply Chain Orientation.

Table 4
Values for Mediation

Relationships	β	S.D.	t- stats	p-value
RMS → AGL → SCP	0.03	0.018	1.983	**0.024**
RMS → ROB → SCP	0.121	0.039	3.12	**0.001**
SCMS → AGL → SCP	0.037	0.024	1.575	0.058
SCMS → ROB → SCP	0.063	0.048	1.305	0.096
SCO → AGL → SCP	0.012	0.01	1.194	0.116
SCO → ROB→ SCP	0.357	0.055	6.456	**0.000**

R Square

The table 5 shows that R square value. This shows that 45.7% variation in the supply chain performance due to the variables which are present in the model of this study.

Table 5

R Square				
	β	SD	t statistics	p value
SCP	0.457	0.042	10.775	0.000

Conclusion, Limitations, and Recommendations

The study improves knowledge and understanding of the subtle phenomenon of Supply Chain Resilience (SCR) for the Oil and Lubricant Industry of Pakistan, thus giving a new viewpoint to the literature, which usually focused on the analysis of the focal firms (Wieland & Wallenburg, 2013, Tukamuhabwa et al., 2015). In this sense, the study contributes to providing a broader viewpoint of Resilience in Supply Chain for Oil and Lubricant Industry by analyzing various dimensions of Supply Chain Capabilities, including Supply Chain Orientation (SCO), Risk Management Strategies, and Supply Chain Performance. The study has recommended the following managerial implications to organizations based on current findings. Utmost importantly, organizations should emphasize developing and maintaining the pool of suppliers to reduce their dependency upon them. Key suppliers should be considered for long-term legal documentation and other preventive measures to avoid harm and undue reliance on those suppliers.

Based on the findings of this study and the shortcomings and unresolved questions found, a range of methods is created to further scientific research. Since the items in the survey were rated subjectively, for further study, a more quantitative approach is advised to test Robustness, Agility, and Supply Chain Performance. These requirements may either be applied by using business insights such as service levels like OTIF, delivery times, and downtimes or by measuring results by enabling customers or suppliers to obtain reviews rather than by the organization itself. Furthermore, future examinations can include more elements and increase the demographic horizon by involving other industries. Supply Chain Integration can be taken as a mediating variable in studies to evaluate firms' Resilience. This research was carried out to study the spend analysis and commodity strategy within the oil sector in Pakistan. This is an exploratory study because there is a lack of such research from the literature review. This research does not engage in statistical tools, instead focuses more on the current trends within the industry. It talks about the constructs and their potential transition towards variables. Despite several constraints to data collection, such as the secrecy and sensitivity in the chosen industry and area of research, the data revealed the current trends for commodity strategy formulation. This study has also introduced spend analysis and displayed the expected results of spend analysis usage. Significant findings for each inquisition were identified through majority responses and were used to build an argument in the discussion stage. It is hoped that explanatory research could be carried out in the future based on this exploratory research.

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