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Enhancing Supply Chain Resilience Through Supply Chain Finance: Moderating Role of Supply Chain Disruption

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Abstract

Developing countries face economic disruptions due to financing limitations generated by traditional financing practices. Although supply chain finance (SCF) is recognized as a significant financing strategy in academic literature, it is still overlooked as a proactive financial strategy to mitigate disruptions. Recent research has examined SCF as a strategic approach, and how it mitigates disruptions caused by funding system deficiencies, ultimately enhancing supply chain resilience SCR. We extensively reviewed the current literature and tested hypotheses using partial least squares structural equation modeling (PLS-SEM) with survey data collected from manufacturing firms in Pakistan. Our study findings indicate that the adoption of SCF is primarily influenced by three factors: collaboration, the role of financial institutes, and digitalization. Furthermore, our research offers empirical evidence supporting the use of SCF to enhance SCR. Moreover, we validate that the role of supply chain disruption SCD is negative but significant in the relationship between SCF and SCR. This paper fills a gap in the current stream of literature by empirically investigating the impact of SCF on achieving SCR. The novelty of this study lies in integrating the antecedents and consequences of SCF adoption into a single framework.

Keywords: Supply chain finance, supply chain resilience, supply chain disruption, digitization.

1. Introduction

Businesses have benefited greatly from globalization, however. the increased interconnection has made companies more vulnerable to disruptive events in their supply chains. The increasing complexity and technical progress, along with the worldwide reach of corporate activities, heighten the risk of both expected and unexpected disruptions, highlighting the vulnerabilities present in supply chains (Koh et al., 2019; Roscoe et al., 2022). The vulnerabilities can result in various disruptions, originating either internally or from external sources (Bier et al., 2020; Pettit et al., 2013). Disruptions can have significant consequences, particularly when their effects are amplified, potentially causing instability in the entire supply chain structure (Ho et al., 2015; T. Wu et al., 2006). Signs of these vulnerabilities have been evident in many disturbances observed in the past, showing increasing patterns. These disruptive events, whether stemming from natural occurrences or human-made factors such as political and economic instability, perpetually introduce an element of unpredictability and risk into the functionality of supply chains (Macdonald & Corsi, 2013). Over the past decades, a series of disruptive occurrences has emerged in the world and has influenced economies, societies, and businesses significantly (Altay & Ramirez, 2010; Z. Yu et al., 2021). Whatever the events of disruption occur, they always cause a savior amount of financial losses for example disruptions have been palpable, as evidenced by the 2011 floods in Thailand, which inflicted substantial losses amounting to USD 1 billion on Intel (Ivanov et al., 2014). Similarly, the 2015 truck driver strikes in Brazil resulted in a USD 184 million loss to the pork and poultry industry (Shashi et al., 2020). Most importantly the financial crisis of 2008-09, which had a critical effect on the financial capacity of developed countries, accentuated the importance of the significance of surpassing financial limitations (Jia et al., 2020).

Many organizations across a range of industries attempt to redesign a supply chain that was unplanned and was later aligned (Revilla & Sáenz, 2014), in an effort to design and reconfigure them with a more effective means of predicting disruptions and their effects (Shin & Park, 2021). The current shift towards constructing more resilient and forward-thinking supply chains reflects an emerging consensus among industry practitioners and academic researchers that contemporary supply chain management has disproportionately emphasized optimization (Alkhudary et al., 2024; Han et al., 2020). Developing a resilient supply chain model is the backbone of this process and is a critical factor for addressing such disruptions coping effectively and returning to normal after the event (Shishodia et al., 2023). The SCR becomes a key priority for modern organizations to be efficient in an increasingly complex and fast-changing world. Its strongest point lies in serving as a proactive risk mitigation strategy (Aslam et al., 2020).

The following are the strategies followed by companies that want to attain supply chain resilience. For example, they will use the new technology to advance integration in the network of supply, energy management, and productivity (Setiawan et al., 2023). It is of utmost importance to enhance the resilience of supply chains by implementing methods to prevent and respond to risks. These strategies include measures to restore normal operations (Asortse & Denga, 2023). Besides, other ways can help a company have a higher level of redundancy; this includes: maintaining safety stock levels, using more than one mode of transportation, as well as working with backup suppliers (Ivașcenco, 2023). However, the literature lacks content on how financial constraints caused by disruptive events affect resilient supply chains and how the financial constraints can be alleviated. The current research seeks to fill this gap by introducing SCF as a new proactive financial intervention that would counter the challenges limiting the build-up of resilience in supply chain processes.

However, one significant issue that prompts much concern in the conditions of developing countries is the existing uncertainty and instability of the business environment and the lack of resources and funds, which, in turn, causes financial institutions to hesitate and avoid offering financing to firms (Ng et al., 2020; Nguyen & Lee, 2021). The traditional sources of financing demand collateral, leading to a relatively higher cost of capital and incremental liabilities incurred over time that negatively impact the continued sustainability and profitability of ventures (Iqbal & Nosheen, 2023; Jrad, 2023). They suggest that an increase in loan defaulting discourages financial institutions from offering more credit (Baidoo et al., 2020; Palazuelos et al., 2018). This reluctance on the part of the financial institutions not only disrupts the supply chain of suppliers but also diminishes the power of profitability of the financial service provider since they may be unable to evaluate the potential return on investments (Wang et al., 2020).

Hence, the adoption of SCF emerges as a potential strategic solution for tackling the challenges highlighted above strategically and innovatively. It would be pivotal to consider how SCF can help achieve greater operational efficiency, reduce costs, and manage risks: all of which are key factors that drive business performance (Beka Be Nguema et al., 2022). Through enhancing working capital and ensuring that the supply chains increase their efficiency in the proper flow of funds, SCF assists firms in overcoming some of the financial barriers and ensuring efficiency in supply chain management (Zhang et al., 2019). The strategic deployment of SCF practices would allow businesses to gain stature in the ever-evolving business space while bringing value to all entities in the chain (Li et al., 2023; S. Wang et al., 2023).

SCF, however, still has low levels of uptake, especially when it comes to emerging economies, due to aspects like awareness, availability of financial intermediaries, infrastructures, risks in the supply chain, and culture. Additionally, existing literature indicates that the adoption of SCF is bolstered by factors that should mitigate hesitancy towards its adoption, thereby offering theoretical and practical justification for its implementation, a subject that has been inadequately addressed in previous research (Huang et al., 2022). In developing countries, alleviating hesitancy may hinge on selected factors addressing transparency in transactions through digitization, ensuring the reliability of transaction execution by financial service providers, and fostering collaboration among supply chain partners to realize mutual benefits from transactions. These three factors (digitization, role of financial service provider, and collaboration) are regarded as essential prerequisites for the adoption of SCF, given their pivotal role in both the practical implementation and theoretical underpinnings of SCF adoption strategies.

The study in hand employs the Resource-Based View (RBV) theory, making a noteworthy theoretical contribution. RBV looks at a company's resources to see how good they are (Barney, 1991). It breaks down supply chain activities into the individual and collective resources of a firm (Hitt et al., 2015) to explain how the distribution of these resources across the supply chain impacts the competitive advantage of both the focal firm and the entire supply chain (Dubey et al., 2019). Therefore, by promoting a more inclusive and cooperative method of handling financial disruptions inside the supply chain, SCF can boost operational efficiency and the coordination of all the partners in the chain, ultimately strengthening overall SCR, hence creating a win-win situation for all the participants.

The following portions of this paper are organized as follows: The next section presents a comprehensive analysis of relevant literature, as well as the development of research hypotheses. Section 3 elaborates on the research methods utilized in the study. Subsequently, Section 4 delves into the examination of findings, embracing both theoretical and practical ramifications, while also acknowledging the limitations of the study.

2. Literature Review and Hypotheses Development

2.1 Supply Chain Resilience

The concept of a resilient supply chain is a different way of thinking that focuses on helping enterprises decrease the susceptibility of their supply chains to harm or disruption (Shishodia et al., 2023). Resilience has become increasingly popular in the past decade, particularly in emerging areas of research such as catastrophe management and supply chain risk management (Ponomarov & Holcomb, 2009). Previously, resilience was primarily defined as the ability of an organization to bounce back from disruptive events and minimize the negative impacts on the organization. For example, (Fiksel, 2006) describes resilience as “the capacity of an organization to survive, adapt and grow in the

face of turbulence". (Lengnick-Hall et al., 2011) refers to organizational resilience as "the firm's ability to effectively absorb and develop situation-specific responses to disruptive events". However, recent research has extended the advantages of developing SCR. While reviewing the literature available in the recent past this fact is established that building up resilience in the supply chain is today's business necessity for organizations operating in complex and volatile environments. Its primary advantage is that it can act as an effective prevention measure to minimize the risks involved (Aslam et al., 2022). For every disruption or vulnerability within the supply chain, the necessary measures can be taken by organizations through a thorough check of the supply chain. This approach greatly reduces the effect of unexpected occurrences such as natural disasters or political changes, SCD inclusive (Nikabadi et al., 2021; Parast & Shekarian, 2019). A resilient supply chain also exhibits significant flexibility to new and dynamic market conditions, client demands, and the environment; this makes disruptions have shorter spans together with reduced costs linked to interruptions (Wamba et al., 2020). Furthermore, these strategies of resilient supply chain explain the increase in customer satisfaction and customer loyalty (Singh et al., 2019). Customers can be assured of firm assurance in delivering the product or services and this also establishes a strong bond between businesses and their customers (Pires Ribeiro & Barbosa-Povoa, 2018). It is also important to note that SCR also incorporates some strategic benefits on cost aspects as well because disruption if not well managed, adds to cost. These costs can be managed within a resilient supply chain through sufficient planning and protection as it preserves both financial structures and performance (Li et al., 2017; Y. Wang et al., 2023). Therefore, scholars in the field continue to emphasize the achievement of SCR through the implementation of various strategies to explore its uniqueness as an outcome of an undisrupted supply chain management system. Consequently, this study enriches the research stream by introducing SCF as a financial strategy for achieving SCR.

2.2 Supply Chain Finance Adoption and Supply Chain Resilience

SCF refers to a bundle of financial instruments that are implemented to have greater control over the financial flows in a supply chain (Guida et al., 2021). SCF is a new kind of financial product emerging these days, enabling to solve the issues of tight working capital and low liquidity for collaborating business partners (Chang et al., 2022; Yu et al., 2021). Hence, its adoption is influenced by various factors. In the societal capital angle, both structural capital and cognitive capital precede interpersonal capital which leads to the acceptance of SCF (Wu et al., 2021). Collaboration of a supply chain (SCC) brings a fair contribution to SCF and this relationship justifies the information quantity and quality while it can be moderated by dependence on clientele finance (Li et al., 2023). In an SCF adoption process by SMEs, there are factors such as attitude toward SCF, social influence, and the adoption intention of SCF that, based on their level, lead to the actual adoption of SCF (Li et al., 2021). Partnering, external collaboration, digitization, and financial institutions are the enablers of SCF among the manufacturing firms which have positive

impacts on Supply Chain Effectiveness SCE, while also reducing the risk (Beka Be Nguema et al., 2020a).

Through time a large number of theoretical studies and empirical studies revolve and enter the discussion of different factors determining the adoption of the SCF. The review showed the adaptation of SCF is the key to the success of developing countries and it also showed the failure of less empirical evidence for its adoption (Beka Be Nguema et al., 2022; Chakuu et al., 2019). Consequently, this research notes the three most paramount and the least aspects considered in SCF adoption. The present research study aims to contribute to bridging the knowledge gap of which factors are considered imperative for SCF adoption because of their immediate requirement and how they affect the SCF. They are selected through the assessment of the impact of different aspects of the relationship as has been seen in the literature. To fill this gap, the presented study seems to establish three key factors where the first being collaboration (Bi et al., 2022; Caniato et al., 2016). Collaboration is one of the cornerstones of success in the implementation of SCF as it develops the relationships among the supply chain partners and improves the sharing of information (Li et al., 2023). Collaboration in the supply chain as a factor in "collaborative communication" has gained significant relevance in achieving SCF performance (Wu et al., 2021). In addition, working relationships among small and medium-sized companies (SMEs) could be structured and implemented to take advantage of the SCF viewpoint, resulting in collaborative network building and increased competitiveness (Zaman, Khan, & Kusi-Sarpong, 2023). Fundamentally, collaboration becomes an inseparable part of the SCF implementation process as it provides mutual information exchange, promotes relationship building, and eventually delivers better performance of the whole supply chain.

The other most important competitive factor for SCF implementation is digitization (Ali et al., 2020). Digitalization pertains to the adoption and use of SCF, since it has a role in reducing risks, improving efficiency, reducing costs, and increasing transparency in supply chain processes and transactions (Ali et al., 2019; Chen et al., 2021). By the use of digital media and technology, businesses not only attain a multiple order of stability and resilience but also as well get a collaborative supply chain network while interacting with suppliers and customers, and stakeholders (Seyedghorban et al., 2020). Companies can utilize digital tools for analyzing the data where they can gain information regarding the operations of the supply chain system that aims at improving overall supply chain performance (Zaman, Khan, Qabool, et al., 2023). Furthermore, digitalization strategies aim at other goals like; cost optimization, enhanced production throughput, building robust risk management frameworks, and enhanced operational performance (Al Tera et al., 2024). In our study, we consider the general purpose of digitization to be the optimization of processes connected with SCF and the increase in transparency. Therefore, this factor is significant.

In light of promoting SCF, the financial institutions make a significant contribution by linking the several relevant players in the value chain (Ali et al., 2019; Beka Be Nguema et al., 2020b). Banks and financial markets are key players in the implementation of SCF since they involve the provision of funding. They act as a source of information and promote the exchange of activities within the supply chain (Darby et al., 2022). Financial institutions assist in the application of SCF by manufacturing companies for the enhancement of supply chain effectiveness (SCE) (Beka Be Nguema et al., 2020a). Supply chain transparency is a topic that is especially important to SCF. However, it is currently uncertain when and how the advantages of transparency will become apparent. It is necessary to clarify the connection and obstacles between supply chain transparency and SCF (Gelsomino et al., 2022). SCF has provided a solution to the issue of insufficient capital for small and medium-sized firms. However, financial institutions face significant credit risks (Liu, 2021). Thus, one cannot evaluate the value of SCF adoption without considering that financial institutions are significant in this area.

Consequently, it is possible to reason that systematically:

- H1: Collaboration has a positive effect on the adoption of SCF.
- H2: Digitization can play as much constructive role as it can positively influence SCF adoption.
- H3: The participation of financial institutions creates a favorable impact on the adoption of SCF.

Resilience-building has become essential in the modern business environment, particularly within global supply chain networks (Katsaliaki et al., 2022; Tukamuhabwa et al., 2015). Companies vehemently reject this condition and allocate substantial resources to implement various risk mitigation strategies to fortify their supply chain and prevent any future disruptions from having an impact (Singh et al., 2019). Supply chain finance is essential for the development of supply chain resilience. It contributes to the improvement of the financial performance of supply chain stakeholders, hence increasing the overall resilience of the supply chain (Shi & Mena, 2021). Managers can apply a financial lens to identify potential weaknesses within their supply chain systems and strengthen their supply base relationships (Brusset & Teller, 2017). SCF bridges supply chain governance and SCR, bringing together the two entities to achieve operational efficiency goals. (Joshi et al., 2023). In addition, by adopting digital technology, supply chain governance has a positive moderating effect on SCF (Lu, Wang, et al., 2023). Therefore, it is concluded that SCF strengthens the supply chain networks by improving operating capabilities, good governance, and managing disruption.

Given the literature evidence outlined above, this research puts forth the following hypothesis:

- H4: The SCF employs a positive influence on SCR.

2.3 Moderating Role of Supply Chain Disruption

Disruptive events bring about the main obstacle in modern supply chain management and as a result, both operations and financial aspects are affected (Filbeck et al., 2016). This effect on logistics has been extensively documented in numerous studies (Khoirani et al., 2022; W. Liu et al., 2023; Scholten et al., 2020) as disruptions in supply chains seriously diminish companies' competencies because of the fact that they disrupt the flow of goods and materials which is a fundamental condition for the business operations. This may cause hearings for unduly high costs of operations or shortage in material availability, which in turn reduces the profitability. However, this causes industries such as coal mining sectors to find alternative solutions to mitigate the risks early by adopting financial risk early warning systems (Adhisti & Rahadi, 2022). The COVID-19 outbreak is nothing but an example of SCD that brought imponderable uncertainties into the industries that used to deal with supply and distribution business processes, drastically ruining their economic flows (Fares & Lloret, 2023). The COVID-19 aftermath featured a considerable plethora of formidable dilemmas for supply chain operations contextualized by increased uncertainties, supply unavailability, and instability of the market (Saleheen & Habib, 2022). In supply chain breakage, there are immediate and distant adverse effects that emphasize the necessity of resilient infrastructure and companies' processes (Guan et al., 2022). Moreover, supply chain disturbances tend to decrease the shareholder's value in small and medium-sized corporations as the financial and environmental turbulence appears to have more effect (Alora & Barua, 2021). Therefore, this recommendation stir is to have the supply chain encounter these challenges by implementing effective risk management and improved integration. Not only the financial impact but also as expected the operational incompetence may be weighed against the SCF which is more of a counterbalance to such unwanted incidences. Consequently, the mitigation of SCD stands as a foremost concern for practitioners, policymakers, and academia alike. Therefore, in light of these considerations, this study posits the following hypothesis.

- H5: SCD moderates the relationship between SCF and SCR.

Figure 1 depicts the proposed research model, illustrating the anticipated relationships between predictor variables and the criterion variable. In this path model, collaboration, the role of financials, and digitization are hypothesized to impact SCF. SCR is further hypothesized to be influenced by both SCF. Additionally, SCD is posited to moderate the relationship between SCF and SCR. This model expands upon the Resource-Based View (RBV), explaining how the three factors (collaboration, financial institutions, and digitization) act as drivers for the adoption of SCF. It further explores how SCF, as a key financial strategy, is used in enhancing firm resilience within supply chain management by mitigating disruptions, particularly within the manufacturing sector.

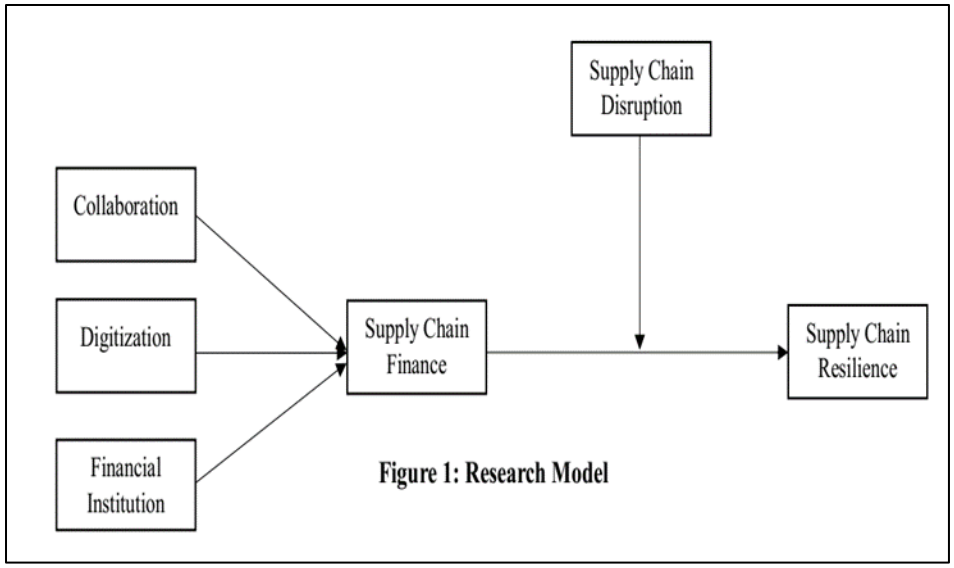

Figure 1: Research Model

3. Research Methodology

3.1 Sample and Data

The research focuses on six sub-sectors (food, textiles, apparel, coke & petroleum, chemicals, pharmaceuticals) of Pakistan's manufacturing sector due to their significance. Data collection challenges in developing countries were addressed by surveying a wide range of manufacturing firms using a carefully designed questionnaire. The selection of the survey instrument was determined by its effectiveness in collecting information from knowledgeable and qualified people who are directly involved with supply chain activities as well as their work on manufacturing operations. The target respondents for this survey included the CEOs/general managers, senior managers, managers/deputy managers, assistant/middle managers, and other professionals involved in supply operations. Since the survey instrument was administered in the use of an official language other than English, a methodical approach referred to as "double translation protocol" adopted guidelines suggested by (Harkness et al., 2010). In this process, the English questionnaire was level of precision by translating it to Urdu through a 'translate back translate" approach. The translation process was carried out by two bilingual Urdu professors it is done by making sure that the language used and culture implied are accurate. Structural equation modeling (SEM) was chosen for data analysis. A total of 1240 questionnaires were distributed, resulting in 299 usable responses (24% response rate). Details on the sample and participants are provided in Tables 1 and 2.

Table 1 presents an overview of the firms included in the sample. This information derives from the Economic Survey of Pakistan for the fiscal year 2022-23. Within this study, only

six sub-sectors have been noted as specific foci among the twenty-two present sub-sectors of the manufacturing industry. This is because it is based on their collective significance for overall production in the manufacturing sector in Pakistan that these industries owe much of their influence to the dominance possessed by the rest of the industry. In reality, with that put together, they make up 61% of the sum of all the manufacturing output in the country while Table 2 provides a participant's profile.

Table 1: Organization Representation in the Sample

Industry	**Frequency**	**%**
Food	51	17
Textile	63	21
Wearing Apparel	42	14
Coke & Petrol. Products	34	11
Chemicals	67	22
Pharmaceuticals	42	14
Organization history		
1–5 years	14	5
6–10 years	42	14
11–15 years	30	10
16–20 years	55	18
21–25 years	73	24
26 years and above	80	27
Not provided	5	2
Sales (in PKR)		
1–10 m	19	6
11-20 m	38	13
21–30 m	42	14
31–40 m	72	24
41–50 m	66	22
Greater than 50 m	40	13
Not provided	22	7

Table 2: Respondent Description

Designation	**Frequency**	**%**
CEO/general manager	97	32
Senior manager	85	28
Manager/deputy manager	55	18
Assistant/middle manager	42	14
Others	9	3
Not provided	11	4
Experience		
1–5 years	46	15
6–10 years	61	20
11-15 years	42	14
16–20 years	67	22
21 years and above	75	25
Not provided	8	3

3.2 Measures

What the present study does is thoroughly determine content and face validity as to the scale items evaluated during their research. Instrument validation was conducted via a comprehensive literature review which sought for scales that are pertinent, robust, and significant to the instrument. The aim is to include just those scales and items compatible with the main goal of the research. The SCF scale including 4 items was borrowed from a prior study (Zhang, 2015) and reported a high internal consistency ($\alpha = .875$). With three items, the digitization scale is adopted from (Choi, 2013) and shows a high reliability of $\alpha = .812$. The collaboration scale, measuring three items and having a satisfactory reliability coefficient in terms of α value equal to 0.861 was taken from (Simatupang & Sridharan, 2005). Likewise, the scale used to measure The Role of Five Institutes consists of three items and has acceptable internal consistency $\alpha = 0.861$ was borrowed from (Zhang, 2015). The measure of disruption is the scale developed in some previous works (Bode et al., 2011; Zsidisin et al., 2010), though assumed to have a high level of internal consistency, as calculated with Cronbach's alpha coefficient 0.834 and consists of four items. Finally, the measure of SCR proposed by (Ambulkar et al., 2015; Brandon-Jones et al., 2014) includes five questions that have shown excellent internal consistency and reliability, with an alpha value of 0.940. The control variables are the type of manufacturing industry,

organizational history, annual sale of the firms, position of the respondents and their experience years.

4. Empirical Findings

PLS-SEM was employed in this research owing to several significant factors. The model developed based on predictive modeling proves that the PLS-SEM is indeed more beneficial than the conventional CB-SEM (Rigdon, 2012; Shmueli et al., 2016). PLS-SEM has been described as suitable for assessing the predictive accuracy of a theoretical model (Hair et al., 2019). Further, the bias is relatively small when using PLS-SEM to estimate the CFA models as compared to the CB-SEM (Sarstedt et al., 2016). First, we check the common method bias (CMB) result to ensure that the outcome is valid and not affected by common method variance. Then, in another step, we used confirmatory factor analysis (CFA) to assess the overall goodness of fit of this model to ensure the stability of the factors and the discriminant validity. The next step involved structural equation modeling, where with a path analysis applied to the structural model, the direct effects of the variables and interactions through path analysis and slope analysis were tested.

4.1 Common Method Biases

CMB is caused by the inflation of associations one variable has on another after a research study uses a particular method to collect data, such as the use of self-report surveys for measuring several constructs in that very same investigation. This effect is a methodological bias that affects the interpretation of empirical results and influences the validity general of findings from conducted research (Podsakoff et al., 2011). In our analysis, we use CMB by applying the Variance Inflation Factor (VIF) values in the inner model. In Table 2, we found that the values of VIF for all variables in our analysis were below the threshold of 3.33 (Kock, 2015). As a result, it can be claimed that our model is without CMB. As such, we can claim that the issue concerning CMB distorting or inflating relationships between variables in our study has been effectively minimized.

4.2 Assessment of Measurement Model

The application of confirmatory factor analysis (CFA) fulfilled the goals of validating the distinctiveness of items that defined their reliability as well as validity. This meant evaluating both convergent and discriminant validity. Convergent validity was assessed via different measures, among which are also average variance extracted (AVE), factor loadings, and composite reliability. High values of reliability coefficients (alpha), revealed a high robustness for internal consistency across all constructs.

Table 3: Construct Reliability and Validity

	Items	VIF	Loadings	C.Alpha	CR	AVE
Collaboration				0.807	0.816	0.633
	COLL 1	1.847	0.841			
	COLL 2	1.645	0.794			
	COLL 3	1.816	0.809			
	COLL 4	1.587	0.737			
Digitization				0.747	0.752	0.664
	DIGI 1	1.560	0.826			
	DIGI 2	1.453	0.787			
	DIGI 3	1.478	0.830			
Financial Institution				0.767	0.784	0.682
	FI 1	1.650	0.825			
	FI 2	1.450	0.783			
	FI 3	1.651	0.866			
Supply Chain Finance				0.832	0.834	0.665
	SCF 1	1.884	0.812			
	SCF 2	1.951	0.826			
	SCF 3	2.022	0.853			
	SCF 4	1.606	0.771			
Supply Chain Resilience				0.811	0.811	0.57
	SCR1	1.683	0.776			
	SCR 2	1.561	0.739			
	SCR 3	1.542	0.747			
	SCR 4	1.776	0.792			
	SCR 5	1.482	0.719			
Supply Chain Disruption				0.720	0.722	0.543
	SCD 1	1.338	0.724			
	SCD 2	1.331	0.753			
	SCD 3	1.498	0.757			
	SCD 4	1.385	0.713			

For the measurement model a combined discussion of Table 3 and Figure 2 to a more holistic approach for evaluating variance inflation factors (VIFs) loadings, reliability coefficients (Cronbach's alpha and composite reliability), and average variance extracted AVE anchor each variable in our study. All constructs possess satisfactory reliability with Cronbach's alpha values over that of the recommended threshold of 0.7, as specified by (Kline, 1999), with the lowest figure being 0.713 for SCD. Item loadings on their respective constructs consistently exceed the threshold of 0.7 (Hair et al., 2019), indicating robust construct validity. Furthermore, AVE values for all constructs are above the acceptable threshold of 0.5 (Fornell & Larcker, 1981), confirming convergent validity. Although some VIF values are high, suggesting potential multicollinearity, the overall findings affirm our measurement constructs' reliability and validity, enhancing our research model's credibility.

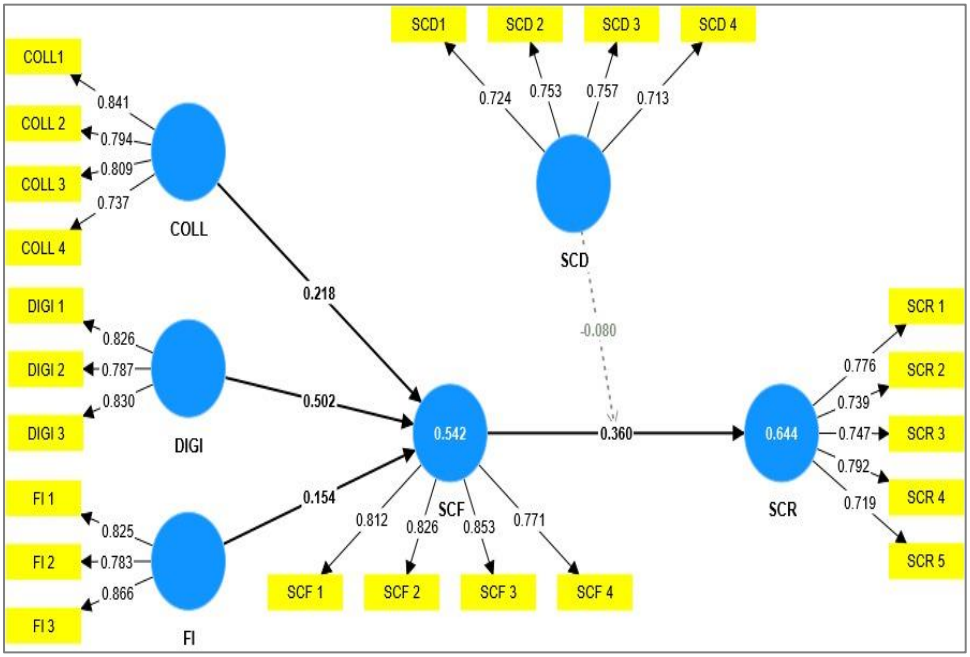

Figure 2: Confirmatory Factor Analysis of Measurement Model

Table 4: Fornell Lacker

	COLL	DIGI	FI	SCD	SCF	SCR
COLL	0.796					
DIGI	0.451	0.815				
FI	0.433	0.581	0.826			
SCD	0.527	0.600	0.616	0.737		
SCF	0.512	0.691	0.541	0.627	0.816	
SCR	0.585	0.650	0.563	0.736	0.701	0.755

The Fornell-Lacker test, which is a highly commonly employed criterion, is used to see whether or not the constructs under investigation, are different from each other. This factor is explained in Table 4. When the square root of the variance extracted (AVE) for every construct is significantly larger than the correlations with the constructs in the model implies that discriminant validity has been established.

In our research, all of the constructs exceed this threshold as their square root AVE values are higher than their correlations, with constructs. This strongly supports that every construct is capable of capturing a dimension in our framework and shows clear discriminant validity (Fornell & Larcker, 1981).

4.3 Structural Model Assessment

The estimation of the structural model includes application for diverse analytical techniques including path analysis, mediation moderation, and slope with PLS-SEM as a framework. The following described procedural step serves to check the validity of hypotheses and verify whether the model obtained is appropriate within a resilient supply chain setting. Factoring occurs upon incorporating empirical evidence for β-values, standard errors (SD), and t -values. To assess the robustness of these findings, the PLS bootstrapping approach was utilized with 5000 samples based on the methodology developed by (Hair et al., 2017).

Table 5: Path Coefficient

	β	Standard Deviation	t-Statistic	P Values
Collaboration -> Supply Chain Finance	0.218	0.046	4.777	*** (0)
Digitization -> Supply Chain Finance	0.502	0.051	9.774	***(0)
Financial Institution -> Supply Chain Finance	0.154	0.058	2.670	**(0.008)
Supply Chain Finance -> Supply Chain Resilience	0.360	0.061	5.940	***(0)
Supply Chain Disruption -> Supply Chain Resilience	0.481	0.057	8.494	***(0)
Supply Chain Disruption x Supply Chain Finance -> Supply Chain Resilience	-0.080	0.034	2.340	*(0.020)

*P<0.05 ** p<0.05 ***P<0.005

Hypotheses are considered validated when the probability value (p) is less than 0.05 and the t-value exceeds 1.96. These criteria signify statistical significance and lend support to the proposed hypotheses. Tables 5 and 6 furnish corroboration for the anticipated relationships among variables, taking into account both direct and indirect influences on SCR. Additionally, the moderating effect on the relationship between SCF and SCR is also discernible.

The analysis confirms the hypothesized relationships as follows.

1) Collaboration > Supply Chain Finance: The path coefficient (β) is 0.218, with a standard deviation of 0.046. The t-statistic is 4.777, indicating a highly significant relationship ($p < 0.001$). This suggests that Collaboration exhibits a positive effect on SCF, supporting Hypothesis (H1).
2) Digitization > Supply Chain Finance: The path coefficient (β) is 0.502, with a standard deviation of 0.051. The t-statistic of 9.774 also indicates a highly significant relationship ($p < 0.001$). This implies that Digitization is positively associated with SCF, confirming Hypothesis (H2).
3) Financial Institution > Supply Chain Finance: The path coefficient (β) is 0.154, with a standard deviation of 0.058. The t-statistic of 2.670 indicates a significant relationship ($p < 0.01$). This shows that the involvement of financial institutions is positively linked with SCF, hereby validating Hypothesis (H3).
4) Supply Chain Finance > Supply Chain Resilience: The path coefficient (β) is 0.360, with a standard deviation of 0.061. The t-statistic is 5.940, indicating a highly significant relationship ($p < 0.001$). This demonstrates that effective supply

chain finance significantly enhances supply chain resilience, in support of Hypothesis (H4).

5) Supply Chain Disruption > Supply Chain Resilience: The path coefficient (β) is 0.481, with a standard deviation of 0.057. The t-statistic is 8.494, showing a highly significant relationship ($p < 0.001$). This suggests that SCD positively influences SCR, possibly because resilience mechanisms are activated in response to disruptions.
6) Supply Chain Disruption x Supply Chain Finance > Supply Chain Resilience: The interaction term has a path coefficient (β) of -0.080, with a standard deviation of 0.034. The t-statistic of 2.340 indicates a significant relationship ($p < 0.05$). The presence of a negative coefficient indicates that the relationship between SCD and SCF has a diminishing impact on SCR. Therefore, although SCF and disruptions individually enhance resilience, their combined impact is somewhat counterproductive.

Furthermore, we performed simple slope tests to enhance our comprehension of the conditional effect. Figure 3, presented below, illustrates the relationship between SCF and SCR. The study also indicates that SCD alters the strength of the associations between SCF and SCR. Specifically, the association between SCF and SCR is weaker in the context of high SCD to lower levels of disruption. These findings support Hypothesis 5, suggesting that the positive impact of SCF on SCR diminishes as the level of SCD increases.

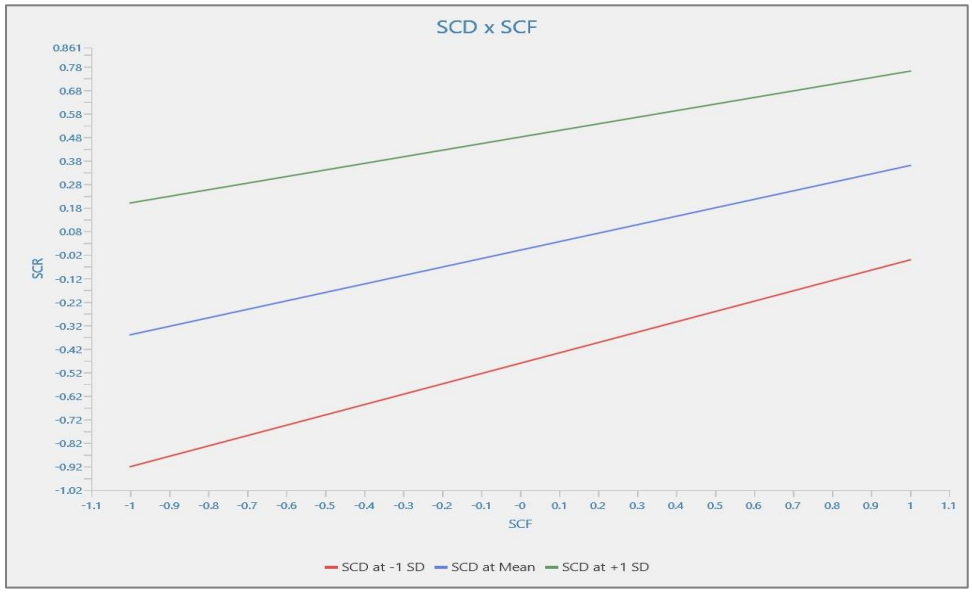

Figure 3: Slope Analysis

5. Discussion

It is very hard for firms particularly in the manufacturing line in developing countries to achieve the target set for effective reduction of their overall SCR. The rationale for this study stems from the fact that it will clarify whether and how the SCF can facilitate the attainment of SCR. Therefore, the main purpose is to provide evidence that supports the claim that SCF can help strengthen the sustainability of the manufacturing sector in Pakistan and, therefore, reinforce the continuity of industries in which it operates. This study highlights the basic factors that need consideration before making decisions on SCF adoption. Our findings are very helpful in forming a clear understanding of the chief drivers of collaboration, the role played by financial institutions, and the significance of digitization in the successful implementation of SCF. The study demonstrates that collaboration is a very important factor in implementing SCF because aspects such as the degree of collaboration with partners and the increased frequency of communication have a positive influence on achieving a high level of supply chain performance (Ma et al., 2020; Zaman, Khan, & Kusi-Sarpong, 2023). The study provides empirical proof that digitization is a significant element in driving the use of SCF, as demonstrated by the outcomes of this research. The reason for this is that it simplifies the execution of financial operations, enables real-time monitoring and control of such transactions, and delivers precise information (Al Tera et al., 2024; Ali et al., 2019; Lu, Song, et al., 2023). Another significant external factor that has emerged within the context of the present study is the involvement of financial institutions. Among all the sources, financial institutions are known to be the most reliable source providing SCF (Ali et al., 2019; Beka Be Nguema et al., 2020a). They provide essential monetary services, which also help in the financial and liquidity assistance to the members of the supply chain (Gelsomino et al., 2016). They also assist in controlling and averting such risks, improving cash generation, and making sure that supply chain operation does not get crippled through lack of adequate funding. in its turn, offers beneficial outcomes which are beneficial in terms of SCF deals relationships that have a positive influence on the business partners who are engaged in cooperation (Caniato et al., 2016; Chen et al., 2023). These findings also support earlier studies' conclusions that continue supporting the fact, collaboration, financial institutions, and digitization are necessary antecedents for SCF that expand the previous literature (Ali et al., 2020; Beka Be Nguema et al., 2020c; Bi et al., 2022; Li et al., 2023; Lu, Song, et al., 2023; Somjai et al., 2019; Wang et al., 2020; Zaman, Khan, & Kusi-Sarpong, 2023).

The direct and significant association between the SCF and the SCR confirms that SCF as a financial management technique facilitates the development of a resilient supply chain. In other words, one of the key concepts that SCF enlarges SCR is to improve cash flow, manage and minimize such financing risks, as well as provide the flexibility needed to prepare for adverse event occurrences, responses, and recoveries. This points to the fact that SCF should be integrated with other supply chain management practices in designing

as well as improving sustaining supply chains as concluded by other scholars (Polyviou et al., 2020; Yuan & Li, 2022). Overall, the negative correlation between SCD and SCF for resilience underscores the complexity entailed in the handling of financial flows during disruptive circumstances. While SCF and disruptions separately increase resilience, disseminating these concepts can provide factors that reduce resilience. Our research provides interesting insights into SCF and SCR under the moderating role of SCD. We suggested that to overcome the foregoing difficulties, organizations should adopt a strategic risk management program, improve their ability to adapt and respond to changes, strengthen their financial resilience, and engage in coordinated financial planning. If organizations can address the complexities within the interaction of these factors, they can optimize the benefits within SCF, and enhance their capability to withstand and recover from disruptions. This serves to show how the implementation of new strategies is essential for sustaining SCR in light of shocks.

5.1 Theoretical Implications

Reflected in the following analysis, the study offers the following significant research contributions to the supply chain management literature. Firstly, it provides empirical evidence for the role of SCF as a financial strategy in fostering SCR, a core requirement for long-term survival that has not been well covered in previous literature. Secondly, the study identifies key antecedents for SCF adoption—collaboration, the role of financial institutions, and digitization—and demonstrates that these are pivotal factors, especially in a developing country context. Therefore, our findings contribute to the advancement of SCF theory, which has so far lacked solid theoretical underpinnings (Martin & Hofmann, 2019). Thirdly, through these findings, the resource-based view (RBV) is advanced by showing how relational propositions proposed by researchers can enhance supply chain functionality. This approach involves analyzing supply chain operations by breaking them down into individual and collective firm resources (Hitt et al., 2015). It makes it possible to establish how competitive advantages are established through available resources such as SCF and therefore have a positive impact on the overall supply chain especially in the achievement of SCR. Ultimately, in order to achieve greater competitiveness, the study suggests that companies should perceive disruptions in the supply chain as a significant and ever-changing notion that might provide challenges, but also provide an opportunity to strengthen resilience (Dubey et al., 2019). The study also reveals the immediacy of the connection between SCF and SCR under the influence of SCD. This provides a more enriching understanding of the topic and fills a noteworthy omission in the present body of knowledge and research in supply chain management.

5.2 Practical Implications

This study has practical and important implications for supply chain executives and manufacturing business owners, especially in developing countries. The study proved that SCF is the best financing tool for optimizing working capital, performance, capital expenses, and risk management. SCF duties improve industrial operations.

Our conceptual approach offers new ways for industrial companies to use SCF. Managers should recognize that SCF can unify suppliers and buyers, building industry trust and dedication. SCF can benefit financial organizations, notably banks, who are trusted in developing nations. Digitizing financial transaction processes reduces data loss and makes transactions transparent and fair. These factors create a win-win situation for Supply Chain Financing users and providers.

No matter their size, developing nation enterprises face limited resources, structural changes, and long-term interest payments for collateral-based financing. Such challenges mostly affect manufacturing executives and managers. The research findings resolved these crucial challenges and empowered companies to maintain their industry presence. Using the SCF financing strategy, they can reduce accounts receivables, increase production capacity, boost sales turnover, secure resources, and achieve the desired profit margins, improving operational efficiency and SCR.

5.3 Limitations and Future Research Directions

It is important to consider the study's limitations when evaluating its conclusions, as this will facilitate more research. The limited sample size of cross-sectional research poses a constraint. Non-response bias should be considered, notwithstanding the inclusion of significant industrial sectors to enhance generalizability. Kindly be aware that this study was carried out in a nation that is in the process of becoming more advanced. Although the challenges under investigation have an impact on both developing and affluent countries, the available resources to address these concerns vary. We advise exercising prudence when extrapolating our discoveries to contexts beyond poor nations.

It should be noted that the study only focuses on the manufacturing sector, hence its findings can only be applied to supply chains in the manufacturing industry and not to service supply chains. The constructs utilized in our research must be tailored to the distinct attributes of manufacturing and service supply chains, rather than focusing on the absence of disruptions in service supply chains. Future research in the service business can incorporate significant elements from our study and duplicate the research model.

The study is limited by focusing solely on the minimum factors necessary for the implementation of SCF. Future research could explore additional factors such as information exchange, bargaining power, and supply chain integration, which may also influence the adoption of SCF. While this study has demonstrated that SCR is a critical outcome for the smooth functioning of supply chain management, incorporating various disruption mitigation factors, such as supply chain capabilities, could enhance the existing model and provide a more comprehensive analysis. As SCF is an innovative tool that minimizes financial constraints and may act as an intervening construct with advanced value-added concepts in the field of supply chain management, including supply chain dynamic capabilities and supply chain process integration.

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