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The Influence of Customer Relationships on Supply Chain Risk Mitigation in International Logistics

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Abstract

Adequate transportation and administration of products and resources across borders are crucial in the logistics industry, particularly in locations such as the China-Pakistan Economic Corridor (CPEC). However, other hazards are associated with this, including global disputes, geopolitical tensions, trade battles, natural catastrophes, terrorist threats, and security breaches, all of which can disrupt the supply chain. These hazards highlight the need for robust supply chain risk management (SCRM) strategies to ensure the seamless distribution of products and services in the face of adversity. To address these challenges, this study examines the impact of customer relationships (CR) on supply chain risk management in the CPEC logistics sector. A survey conducted across various transportation and logistics firms' sites obtained data from 500 staff members. After removing 50 partial replies, 450 total responses were considered. The information also includes reactions for operational supply chain risk management (OSCRM), organization performance (OP), strategic supply chain risk management (SSCRM), and customer relationship (CR). To evaluate the respondents of the survey questionnaire using the Likert scale. Partial least squares structural equation modeling (PLS-SEM) is utilized to validate the hypothesis, which is used for statistical analysis, validation of structural models, and measurement models. The measurement model established the measure's validity and reliability, while other approaches demonstrated discriminant validity. The structural model is employed to identify the significant relationships between CR and SCRM in the logistics sector. The findings emphasize CR's importance in managing the supply chain's inherent constraints, contributing to CPEC's sustainability. Overall, this research attempts to enhance understanding of the complex relationship between CR and SCRM in the dynamic world of global logistics.

Keywords: China-Pakistan Economic Corridor; Customer Relationship; Strategic Supply Chain Risk Management; Logistics Sector; Operational Supply Chain Risk Management; Organization Performance; Supply Chain Risk Management.

1. Introduction

The modern corporate landscape depends on interconnection, with companies negotiating a complex network of links and exchanges inside their supply chains (SC). These networks, which include manufacturers, suppliers, transportation entities, distributors, and retailers, represent the complex interplay with goods, data, and financial resources. However, this delicate performance is not without difficulties since the numerous dangers associated with supply chain activities represent ongoing threats. Delicate, these operations require considerable attention to detail for proper performance [1, 2]. Organizations are connected as nodes within a more extensive network, not isolated entities

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in the enormous commerce ecosystem. Every company action is associated with others, creating a web of relationships required for operational continuity. Even seemingly independent companies are linked together by collaborative activities, blurring the borders between internal activities and external relationships [3]. This interconnection emphasizes the nature of supply chain networks, where relationships between firms exceed individual boundaries to create collective efficiency [4]. As management sciences advance, an emphasis on holistic problem-solving and connecting entities with common interests becomes more critical [5]. Among the numerous issues firms face, risk management appears to be a crucial concern, with researchers looking into various aspects of volatility and susceptibility within supply and distribution chains [6]. From market difficulties to logistical challenges, the range of hazards comprises numerous elements that require proactive mitigation techniques [7]. Furthermore, the relationship between supply chain risk management (SCRM) and value creation emphasizes the need for performance optimization in organizational success [8]. However, measuring and evaluating performance remains difficult, filled with competing goals and environmental complexities [9]. The evaluation of success includes multiple factors and levels, reflecting the varied character of the company's performance [10].

This study highlights the necessity for supply chain organizations to proactively manage risks and uncertainties to maintain the uninterrupted flow of products and services. An analysis of the impact of customer interactions on SCRM practices in the CPEC logistics sector can yield important insights into developing robust supply chains resilient to a range of disturbances. By providing valuable solutions for handling global logistics difficulties like trade disputes, security risks, and environmental hazards, this research adds to the body of knowledge already in existence. It improves the overall resilience of supply chains in the region [11]. Furthermore, the research findings are given more depth and rigor by the technique used in this study, which involves surveying transport firms using the Likert scale and partial least squares structural equation modeling (PLS-SEM) for hypothesis validation. This study offers a strong foundation for comprehending interpersonal connections' crucial role in reducing risks and improving operational efficiency within supply chain networks by empirically validating the significance of customer relationships (CR) in SCRM and supply chain resilience. Policymakers, business professionals, and academics looking to improve the sustainability and competitiveness of logistics processes in the context of CPEC will find these insights quite helpful [12]. Finally, by emphasizing the role of CR dynamics in forming SCRM strategies and enhancing supply chain resilience, our research adds to the larger conversation on supply chain management. This study highlights the significance of proactive mitigation techniques and holistic problem-solving methods in guaranteeing the long-term sustainability of logistical operations within intricate economic frameworks such as the China-Pakistan Economic Corridor (CPEC). It also emphasizes the interconnectedness of supply chain networks and the necessity of collaborative approaches to risk management. Through a thorough analysis of these dynamics, this research intends to pave the path for stronger and more resilient supply chains that can handle the challenges of an increasingly linked and turbulent global marketplace.

1.1. Key Contribution

- This research offers techniques for efficiently navigating global logistics issues to improve supply chain resilience in the face of various risks, including trade disputes, natural disasters, terrorist threats, and security breaches.
- To enhance sustainability, this study investigates how consumer relationships affect SCRM in CPEC logistics.
- To conduct a survey of transportation enterprises using the Likert scale and PLS-SEM for hypothesis validation.
- To validate the importance of CR in SCRM, recognizing its critical role in supply chain resilience.

2. Literature Review

2.1. Operational Supply Chain Risk Management (OSCRM)

The study investigated the connection between "supply chain risk management (SCRM) practices, supply chain integration (SCI), and supply chain performance (SCP)" in Southern Vietnam, with a focus on the moderating role of SC social responsibility [13]. It offered perceptions of how these elements affect the region's overall SC performance. The study's scope was restricted to the Southern Vietnam region, which may limit its generalizability. The research enhanced the data processing perspective on risk management by investigating the relationship between SCI and SCRM to increase operational performance [14]. They used "covariance-based structural equation modeling (CB-SEM)" to validate the hypothesis. Findings showed that supplier, customer, and internal integration substantially impacted SCRM. It depended on SC partners integrating effectively.

The author examined the connection between SCI and performance, as well as the role of "supply chain resilience (SCR)" [15]. A survey of several industries demonstrated that SCR is essential in improving SC performance, emphasizing its significance in modern SC management methods. Its limited industrial focus or regional reach could affect its generalizability. The article investigated current developments in "academic operational risk management

(ORM)" from a data analytics perspective [16]. They focused on identifying recent developments in ORM connected to every natural and artificial disaster that has disrupted various societies. It was highlighted that ORM has been made more accessible by using data analytics tools and methods, as well as the application of analytical tools for monitoring systems and their integration into operational decision-making, including predictive modeling. We needed a significant investment in the analytics infrastructure. The impact of SCI facilitated by information technology (IT) on business operations was examined in the study [17]. It investigated the various characteristics of integration and their impact on performance. Limitations include potential biases in self-reported data and an emphasis on operational achievement rather than broader business results.

2.2. Strategic Supply Chain Risk Management (SSCRM)

The research discussed the global SC hazards and mitigation measures. They used an online survey to gather information on various industries to manage the global SC risks during the internationalization process, and they discovered the optimal risk mitigation profiles for all sectors [18]. The findings indicated that data sharing, network impacts, and connection development were the most effective methods for reducing risk—restricted capacity to generalize across industries. The author evaluated the "supply chain risks (SCR)" for Pakistan's logistics sector [19]. They suggested a new "fuzzy VlseKriterijumska Optimizacija IKompromisno Resenje (VIKOR)-criteria importance through inter-criteria correlation (CRITIC)" technique for assessing long-term SCR. According to the findings, organizational risks should be considered the greatest, whereas environmental risks have the most negligible impact. The findings were significant for the logistics sectors performing in the CPEC regarding risk mitigation and sustainability—required knowledge of decision analysis and fuzzy logic.

The article examined the relationship between crucial proactive risk mitigation measures, such as SC resilience, flexibility, adaptability, and SCRM performance, to address the issue of mitigation techniques and SCRM performance [20]. The "partial least squares (PLS)" technique was utilized to examine the data. The results demonstrated that SCRM performance was positively correlated with SC resilience and responsiveness. It might take a lot of resources to implement. The study presented a conceptual framework for analyzing the driving forces for the "legal" approach [21]. They used "structural equation modeling (SEM)" to test their hypothesis. The results demonstrated that while establishing a quality management system was strongly correlated with lean SC strategies, market location, as an internal component, had a more substantial influence on supporting the agile approach than on lean. The research examined the required adherence to organizational objectives and the impact of proactive risk reduction techniques on SCRM performance among Turkish manufacturing enterprises [22, 23]. It offered essential processes within the Turkish manufacturing sector using empirical analysis to show substantial connections between adopting such measures and improved risk management outcomes. However, the study's perspective was restricted to this particular industrial and geographic setting.

2.3. Organizational Performance (OP)

The author investigated the connection between SCRM and standardized management systems [24]. They examined the impact of standardizing management systems on risk management procedures. Possible limitations include the potential oversimplification of intricate supply chain dynamics and different industry contexts that affect generalizability. The article evaluated the impact of security concerns on e-SC in the distribution and logistics industry of the "United Arab Emirates (UAE)" [25]. It emphasized the need for information security protocols to increase operational efficiency and lower risks. However, the study's focus was restricted to a particular industry and geographic area, which may limit the ability to reach broader implications.

The study offered a global paradigm for managing SC risks that uses text mining to identify problems unique to particular regions [26]. It emphasized recognizing and controlling these risks to run an efficient SC. However, it doesn't thoroughly examine implementation difficulties and practical applications. The impact of SC disruption risk drivers on organizational performance in Chinese SC was discussed in the research [27]. Key risk factors and their effect on performance are identified through empirical evidence. However, because of its geographical concentration, it could not be applied to contexts outside of Chinese SC. The author examined the effect of integrating several critical SC partners in organizational performance [28]. In the analysis phase, the PLS-SEM technique was selected, and the results exposed a substantial impact of all hypothesized study molds and a crucial moderating effect of confidence on the connection between SC partner integration and organizational performance. It depends on the confidence of SC partners.

2.4. Customer Relationships (CR)

The article assessed the influence of SSCM, "competitive advantage (CA), and customer relationship management (CRM)" on Legislative initiatives. The research results were analyzed using "Smart PLS" [29]. The findings indicated that SSCM and CRM were highly associated with organizational performance. SCM and CRM strategies must be in synchronization. The study investigated SCRM in the context of big data and disasters in the global logistics sector

[30]. It examined risk-mitigation strategies and highlighted the value of technology integration and data analytics. However, the study's problems could be related to its emphasis on theoretical frameworks instead of real-world implementation techniques.

The research proposed a comprehensive paradigm that blends "knowledge management (KM)," CRM success, and "Innovation Capacities (IC)". They employed confirmatory factor analysis and SEM with "Analysis of Moment Structures (AMOS)" to evaluate the hypotheses. The results recommended that KM affects CRM success, which drives IC, and KM affects IC via CRM performance—needed for CRM and knowledge management techniques that work. The author investigated CRM, inventiveness, and financial success in the winery sector [31]. They analyzed how various combinations of CRM and innovation methods contribute to improved firm performance, providing insights into best practices for wineries—restricted applicability outside of the wine industry. The article investigated the connection between SCRM, integration, and transformational leadership in Vietnamese manufacturing organizations [32]. Through survey data, it was discovered that transformational leadership and integration have a beneficial relationship that improves SCRM. Reliance on self-reported data and possible cultural biases were among the limitations.

The precise effect of customer connections on supply chain risk management (SCRM) procedures within the logistics sector of economic corridors like the China-Pakistan Economic Corridor (CPEC) is one topic the literature study might throw light on. Although connections play a crucial role in supply chains, there may be a lack of knowledge regarding how these ties significantly affect risk assessment, mitigation, and identification tactics in intricate logistical operations [33]. By exploring this topic in greater detail, we will find important information that can guide the development of more focused and efficient risk management strategies adapted to CPEC logistics. While research has highlighted the value of proactive mitigation strategies and comprehensive approaches to problem-solving, there may be chances to assess how well various measuring frameworks and models capture the influence of customer interactions on SCRM results [34]. Through a critical analysis of the extant literature on resilience measurement and supply chain performance evaluation, researchers can distinguish gaps in the current practices and suggest novel avenues for better-integrating customer relationship dynamics into the supply chain risk management techniques.

The literature evaluation can also examine how the world's logistics difficulties are changing, including new dangers like geopolitical unpredictability, cybersecurity threats, and climate change effects, and how this affects supply chain resilience in the CPEC area. While trade disputes and natural catastrophes have been emphasized in past research as classic hazards, there may be gaps in our understanding of how new and complex threats are changing supply chain dynamics and requiring creative risk management methods. To improve supply chain resilience in a quickly evolving setting, researchers can foresee future risk scenarios and build adaptive methods by investigating these developing difficulties and their possible effects on SCRM practices in CPEC logistics. Extensive research on Supply Chain Risk Management (SCRM) and its integration has shown a significant gap in understanding the combined influence of sustainability, resilience, and industry-specific factors on SCRM performance in various global settings. While present research frequently focuses on individual aspects or specific areas, there is a critical need for comprehensive assessments that consider numerous dimensions. This study seeks to address this knowledge gap by providing insights and approaches for optimizing SCRM initiatives, ultimately improving organizational performance and strengthening customer connections. By addressing these gaps, the goal is to provide organizations with the skills they need to negotiate complex supply chain difficulties effectively and sustainably in different global settings.

2.5. Hypothesis Development

This study proposes the following hypothesis:

- H1: Operational supply chain risk management (OSCRM) impacts organizational performance (OP). (OSCRM → OP).
- H2: Strategic supply chain risk management (SSCRM) positively impacts OP. (SSCRM → OP).
- H3: The Customer Relationships (CR) have an essential effect on OP. (CR → OP).
- H4:CR moderates the interaction between OSSRM and OP. (OSCRM →CR→ OP).
- H5: CR moderates the connection between SSCRM and OP. (SSCRM →CR→ OP).

3. Research Methodology

Figure 1 depicts the study's conceptual structure, including the primary independent variables, OSCRM and SSCRM. The dependent variable is OP, and the moderating variable is CR, which arises from the relationship between these components. Figure 2 displays the methodology flow.

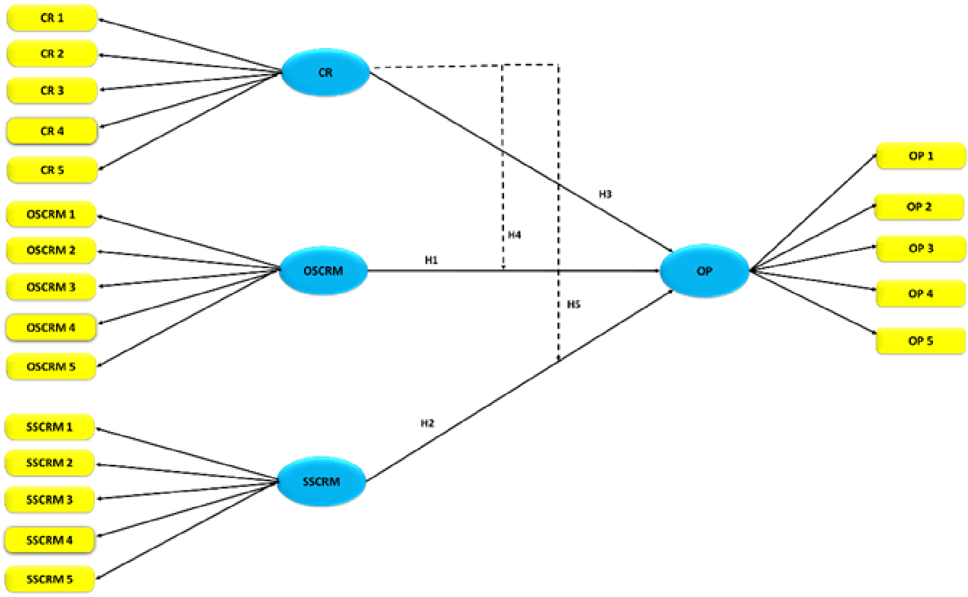

Figure 1. Conceptual framework

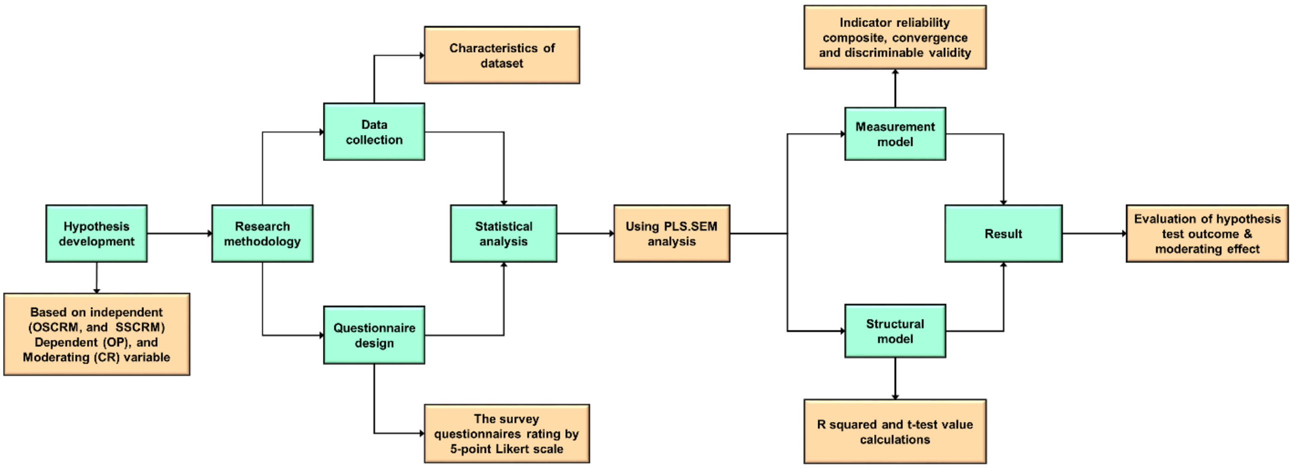

Figure 2. Methodology flow

- Independent variables: The researcher modified or controlled factors to determine their impact on the dependent variable.
- Dependent variable: The outcome variable is impacted by the independent variable.
- Moderator variable: A factor that affects the relationship between independent and dependent variables.

3.1. Data Collection

The dataset provides information about 450 employees working in ten transportation and logistics companies across diverse locations ("Gwadar, Omara, Qasim, Pasni, Gilgit, Peshawar, Quetta, Karachi, Tianjin, and Kashgar") (see Figure 3), including gender, age, education, employment status, years of experience, job position, department, company size, and location. Five companies were selected in the private sector ("Qasim, Pasni, Quetta, Karachi, Khashgar"), and the other 5 companies were chosen in the public sector (Gwadar, Omara, Gilgit, Peshawar, Tianjin). Both sectors contain ports and hubs based on the selected locations. It also includes survey responses from several categories, like OP, SSCRM, CR, and OSCRM. Table 1 displays information on the participants' profiles. Figure 4(a-c) shows the company size, legal status, and location classification. The data were calculated using Equation 1.

$$\text{Percentage} = \frac{\text{Value}}{\text{TotalValue}} \times 100$$

e.g., Male: 230 (1)

$$\text{Percentage} = \frac{230}{450} \times 100 = 0.512 \times 100 = 51.2\%$$

Similarly, the values in other categories were calculated.

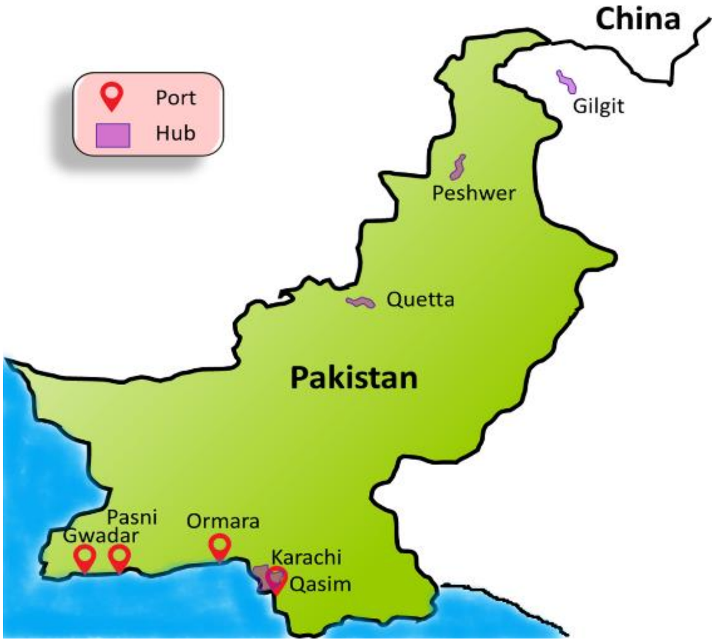

Figure 3. Research site of Pakistan

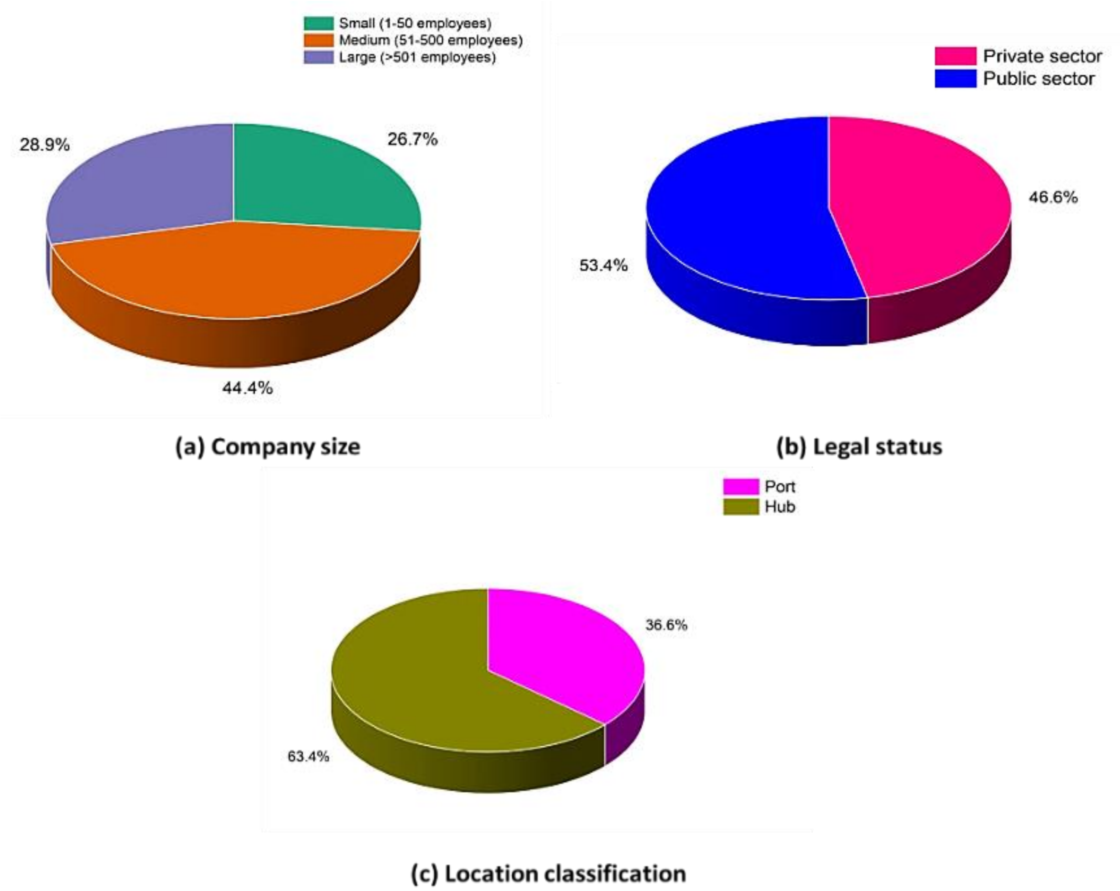

Figure 4. (a) organizational size (b) legal status (c) location classification

Table 1. The features of the demographic

Characteristics			Frequency	Percentage (%)
Gender	Male		230	51.2
	Female		220	48.8
Age	18-24		30	6.6
	25-34		125	27.8
	35-44		125	27.8
	45-54		120	26.7
	55 and above		50	11.1
Education	High School or equivalent		100	22.2
	Bachelor's degree		200	44.5
	Master's degree		100	22.2
	Doctorate or higher		50	11.1
Employment Status	Full-time employee		250	55.6
	Part-time employee		100	22.2
	Contract worker		50	11.1
	Self-employed		50	11.1
	Unemployed		-	-
Years of Experience	Less than 1 year		150	33.4
	1 to 5 years		100	22.2
	6 to10 years		50	11.1
	11 to 15 years		100	22.2
	>16 years		50	11.1
Job Position	Managerial/Executive		80	17.8
	Administrative/Support Staff		130	28.9
	Operations/Logistics		120	26.7
	Sales/Marketing		70	15.5
	Other (please specify)		50	11.1
Department	Supply Chain		120	26.7
	Customer Care		120	26.7
	Human Resource		80	17.7
	Operations/Logistics		80	17.7
	Sales/Marketing		20	4.6
	Finance		30	6.6
	IT/Technology		-	-
	Other (please specify)		-	-
Company Size	Small (1-50 employees)		120	26.7
	Medium (51-500 employees)		200	44.4
	Large (>501 employees)		130	28.9
Location	Ports	Gwadar	50	11.1
		Omara	30	6.6
		Qasim	45	10
		Pasni	40	8.8
	Hub	Gilgit	55	12.3
		Peshawar	60	13.4
		Quetta	35	7.9
		Karachi	50	11.1
		Tianjin	45	10
		Kashgar	40	8.8
Legal status	Private sector		210	46.6
	Public sector		240	53.4
Location Classification	Port		165	36.6
	Hub		285	63.4

3.2. Questionnaire Design

500 questionnaires were distributed across various locations, revealing 450 complete replies after 50 incomplete responses were deleted. The first stage in this approach is to create a questionnaire with five essential elements.

- Demographic Information: The eleven questions in this section were meant to elicit further information from the respondents.
- Operational Supply Chain Risk Management (OSCRM): This section had five questions that examined identification risk, operational risk reduction, monitoring effectiveness, supplier collaboration, and adaptive SCRM strategies.
- Strategic Supply Chain Risk Management (SSCRM): This segment consisted of five questions that evaluate strategic SCR planning frequency, long-term mitigation, efficacy, prediction, and importance of financial consideration.
- Organization performance (OP): This section included five questions that evaluate satisfaction with organizational performance.
- Customer Relationship (CR): The final section included five questions that evaluate customer satisfaction with communication, feedback collection, customization, response to issues, and relationship-building activities.

450 survey respondents rated by 5 point Likert scale, on a scale of not at all (1) to always (5), very poorly (1) to very well (5), ineffective (1) to extremely effective (5), not at all (1) to extremely, (5), never (1) to always (5), to a very small extent (1) to a very large extent (5), very dissatisfied (1) to very satisfied (5), very unstable and declining (1) to very stable and growing (5), inefficient and ineffective (1) to extremely effective (5), very slow and unresponsive (1) to very fast and responsive (5).

3.3. Statistical Analysis

PLS-SEM analysis was performed in this study using Smart PLS (4.1.0.0) software. The foundation of "PLS-SEM" is the presumption that the measured variable quantity does not accurately represent the concepts under investigation. The terms visible and latent variables or constructs refer to observed and unknown factors. Two parts make up the PLS-SEM model. The first, a measurement model, examines how apparent and latent variables relate. The other, called the inner structure model, shows the relationships between the latent variables.

4. Result and Discussion

4.1. Evaluation of Measurement Model

The measuring model was evaluated to ensure the indicators utilized were valid and consistent. It was tested using established approaches, including indicator reliability, composite, convergence, and discriminant validity. Two reliability measures, "composite reliability (CR) and Cronbach's alpha (α)" were used to assess construct reliability. The α values ranged from 0.70 to 0.90, whereas the CR values also fell within this range. Standardized factorial loadings were employed to evaluate factorial validity, and all items received scores between 0.50 and 0.76, indicating factorial validity. Convergence in validity, determined by "Average Variance Extracted (AVE)," was between 0.50 and 0.70, showing that the items are highly convergent. The validity and reliability analyses are displayed in Table 2. Figure 5 shows the assessment of a measurement model graphically. Equations 2 to 4 calculate loading, AVE, CR, and α. Table 2 provides a complete study of the validity and reliability of each construct in the measuring model. The analysis covers factor loadings, Average Variance Extracted (AVE), Cronbach's alpha (α), and composite reliability (CR) values. These indicators support the model's resilience by evaluating its consistency, validity, and dependability across multiple aspects of Supply Chain Risk Management (SCRM).

$$AVE = \frac{\sum(Squared\ Loading\ of\ Indicators)}{\sum(Variance\ of\ Indicators)} \tag{2}$$

The squared loading of every indicator on its corresponding latent variable is the "squared loading of indicators." Each indicator's variance is known as the "variance of indicators.

$$CR = \frac{(\sum Squared\ Loading\ of\ Indicators)^2}{(\sum Squared\ Loading\ of\ Indicators)+\sum(Measurement\ Error)} \tag{3}$$

where each indicator's squared loading on its corresponding latent variable is known as the "squared loading of indicators. Quantification: The error variance of any indication is called an error.

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum(Variance\ of\ Indicators)}{Variance\ of\ Total\ Scale}\right) \tag{4}$$

In this case, K is the number of elements (indicators). The variation of every indication is known as the variance of indicators. The variance of the total scores between all items is known as the variance of the overall scale.

Table 2. Analyzing the validity and reliability

Construct	Items	Loading	AVE	α	CR
OSCRM	OSCRM 1	0.65	0.591	0.799	0.790
	OSCRM 2	0.60			
	OSCRM 3	0.58			
	OSCRM 4	0.70			
	OSCRM 5	0.62			
SSCRM	SSCRM 1	0.68	0.593	0.792	0.800
	SSCRM 2	0.72			
	SSCRM 3	0.64			
	SSCRM 4	0.61			
	SSCRM 5	0.59			
OP	OP 1	0.75	0.664	0.857	0.864
	OP 2	0.71			
	OP 3	0.68			
	OP 4	0.70			
	OP 5	0.67			
CR	CR 1	0.76	0.684	0.869	0.873
	CR 2	0.73			
	CR 3	0.70			
	CR 4	0.69			
	CR 5	0.72			

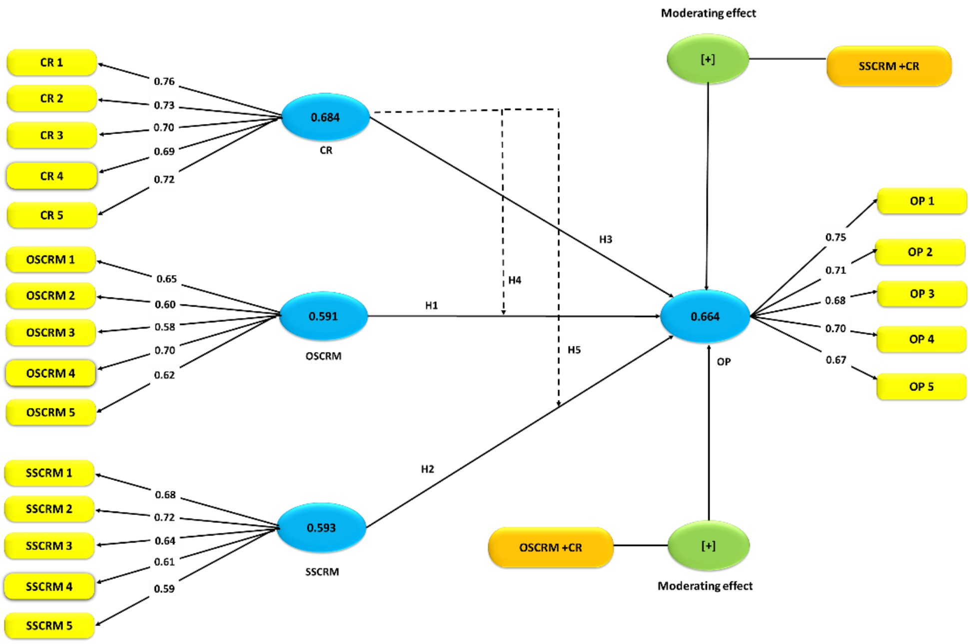

Figure 5. A visual representation of the overall measurement model's assessment

Examining the relationships between the constructs yields adequate results for discriminant validity. Because of this, each item adds more to its construct than the structures of those around it. Tables 3 to 5 demonstrate this finding. The variance associated with a create and its measures, as determined by the root square of the AVE, is also shown to be larger than the variance provided by the constructs alone, as determined by the correlations among the constructs.

The square root of the AVE on the variable determines the diagonal values. To improve discriminant validity, with a more modern strategy called the "hetero trait-mono trait (HTMT) ratio." According to this methodology, the HTMT ratio should be <0.85, as in our study.

Table 3. Overall correlation

Correlation	OSCRM	SSCRM	OP	CR
OSCRM	0.769	-	-	-
SSCRM	0.139	0.770	-	-
OP	0.051	0.009	0.814	-
CR	0.227	0.160	0.301	0.827

Table 4. Correlation for Public Sector

Correlation	OSCRM	SSCRM	OP	CR
OSCRM	0.663	-	-	-
SSCRM	2.188	0.771	-	-
OP	2.357	0.252	0.824	-
CR	0.565	0.049	2.009	0.802

Table 5. Correlation for private sector

Correlation	OSCRM	SSCRM	OP	CR
OSCRM	0.895	-	-	-
SSCRM	0.169	0.801	-	-
OP	0.032	0.313	0.641	-
CR	0.121	0.421	0.321	0.872

4.2. Assessment of Structural Model

It is analyzed by determining the relations among the hidden (latent) variables to control the remaining interactions across constructs. The jackknife and bootstrap methods are typical nonparametric model testing methods used in PLS. Since the bootstrap method is believed to be more efficient than the alternative, it was utilized in this instance. It provides two crucial aspects of the structural models, R^2 and t-value, comparable to a t-test. The bootstrap results can be used to test model prediction ability (R^2). R^2 values vary from 0 to 1. Higher numbers indicate greater explanatory ability. In a two-tailed test, a t-value greater than 1.96 is deemed statistically significant at 0.05. Tables 6 to 8 show the model fit. Table 6 presents a summary of the model fit, including R^2 values that indicate the proportion of variation explained by the latent variables. Additionally, corrected R^2 values take into consideration the number of predictors. t values measure the statistical significance of associations, with values greater than 1.96 indicating significance at 0.05. Tables 7 and 8 provide similar evaluations for the private and public sectors.

Table 6. Overall Model Fit

Latent Variables	R^2	R^2Adj	t values
OSCRM	0.520	0.514	2.00
SSCRM	0.481	0.475	1.96
OP	0.624	0.619	2.15
CR	0.572	0.566	2.05

Table 7. Model Fit for the Private Sector

Latent Variables	R^2	R^2adj	t values
OSCRM	0.490	0.481	1.98
SSCRM	0.460	0.451	1.94
OP	0.600	0.590	2.08
CR	0.540	0.531	2.02

Table 8. Model Fit for the public sector

Latent Variables	R^2	R^2adj	t values
OSCRM	0.510	0.503	1.99
SSCRM	0.470	0.463	1.95
OP	0.610	0.605	2.10
CR	0.560	0.554	2.03

The ratio of the exogenous latent variables (independent variables) to the endogenous latent variable (dependent variable) in terms of variance explained is called. R^2. Equation 5 is the calculation for it.

$$R^2 = 1 - \frac{Total\ Variance\ of\ Endogenous\ Variable}{Residual\ Variance\ of\ Endogenous\ Variable} \tag{5}$$

The unexplained variance remaining after regressing the endogenous latent variable on the exogenous latent variables is known as the residual variance of the endogenous variable. The entire variance of the endogenous latent variable is known as the "endogenous variable's variance."

An alternative form of R^2 that penalizes the quantity of exogenous latent variables in the model is called adjusted R^2. Equation 6 is the calculation for it.

$$\text{Adjusted } R^2 = 1 - \frac{(1-R^2)\times(N-1)}{N-k-1} \tag{6}$$

N is the total sample size in this case. The number of independent variables in the model that are exogenous latent variables is denoted by k.

In a regression model, the T-value indicates how strongly each predictor and dependent variable correlates. Equation 7 provides information on the statistical significance of the relationship.

$$T = \frac{b}{SE_b} \tag{7}$$

where the standard error of the coefficient estimate is denoted by SE_b and b is the coefficient estimate for the predictor variable.

f^2 values, "small (0.02), medium (0.15), and large (0.35)". The total, direct, and indirect effects of variables are shown in Tables 9 to 11. Table 9 displays the overall effects of latent variables on OSCRM, SSCRM, OP, and CR, which show significant associations with large, medium, and small effects, respectively. Tables 10 and 11 show the direct and indirect effects, respectively, with substantial implications across multiple dimensions. These findings shed light on the complicated processes inside the structural framework. The structural framework for overall, private, and public sectors is demonstrated in Tables 12 to 14. Figure 6 shows the structural analysis output and the SEM technique results, emphasizing significant path coefficients between the key constructs. Tables 12 to 14 provide insights into the entire structural model across sectors, highlighting major hypotheses supported by strong beta, p, and T values. Notably, both the private and public sectors demonstrate identical patterns of relationship dynamics, underscoring the importance of OSCRM, SSCRM, and CR in determining operational performance. These tables demonstrate a complete understanding of supply chain risk management in distinct corporate scenarios.

Table 9. Total effect

<table>
<tr><th>Latent Variables</th><th>Betta</th><th>R^2</th><th>f^2</th><th>p – values</th><th>f^2 effect</th><th>Status</th></tr>
<tr><td>OSCRM</td><td>0.65</td><td>0.36</td><td>0.234</td><td rowspan="4"><0.001</td><td rowspan="3">Large</td><td rowspan="2">Supported</td></tr>
<tr><td>SSCRM</td><td>0.85</td><td>0.49</td><td>0.445</td></tr>
<tr><td>OP</td><td>0.90</td><td>0.64</td><td>0.576</td><td rowspan="2">Well, Supported</td></tr>
<tr><td>CR</td><td>0.80</td><td>0.25</td><td>0.160</td><td>Medium</td></tr>
</table>

Table 10. Direct effect

<table>
<tr><th>Latent Variables</th><th>Betta</th><th>R^2</th><th>f^2</th><th>p – values</th><th>f^2 effect</th><th>Status</th></tr>
<tr><td>OSCRM</td><td>0.60</td><td>0.36</td><td>0.216</td><td rowspan="4"><0.001</td><td rowspan="3">Large</td><td rowspan="2">Supported</td></tr>
<tr><td>SSCRM</td><td>0.70</td><td>0.49</td><td>0.343</td></tr>
<tr><td>OP</td><td>0.80</td><td>0.64</td><td>0.521</td><td>Well, Supported</td></tr>
<tr><td>CR</td><td>0.50</td><td>0.25</td><td>0.125</td><td>Small</td><td>Supported</td></tr>
</table>

Table 11. Indirect effect

Latent Variables	Betta	R^2	f^2	p – values	f^2 effect	Status
OSCRM	0.05	0.36	0.009	<0.001	Small	Supported
SSCRM	0.15	0.49	0.056		Medium	
OP	0.20	0.64	0.064		Medium	
CR	0.30	0.25	0.135		small	Well, Supported

Table 12. Overall structural model

Hypothesis and Connections	β	p – values	Std. error	t – values	Hypothesis supported
H1: OSCRM → OP	0.60	<0.001	0.08	7.5	Supported
H2: SSCRM → OP	0.70		0.09	8.0	Supported
H3: CR → OP	0.80		0.07	11.5	Well, Supported
H4: OSCRM → CR → OP	0.50		0.10	5.0	Supported
H5: SSCRM → CR → OP	0.60		0.10	6.0	Supported

Table 13. Private sector structural model

Hypothesis and Connections	β	p – values	Std. error	t – values	Hypothesis supported
H1: OSCRM → OP	0.55	<0.001	0.09	6.0	Supported
H2: SSCRM → OP	0.65		0.08	8.5	Supported
H3: CR → OP	0.75		0.06	12.5	Well, Supported
H4: OSCRM → CR → OP	0.45		0.10	4.5	Supported
H5: SSCRM → CR → OP	0.55		0.10	5.5	Supported

Table 14. Public Sector Structural Model

Hypothesis and Connections	β	p – values	Std. error	t – values	Hypothesis supported
H1: OSCRM → OP	0.65	<0.001	0.07	9.5	Supported
H2: SSCRM → OP	0.75		0.06	12.0	Supported
H3: CR → OP	0.85		0.05	17.0	Well, Supported
H4: OSCRM → CR → OP	0.55		0.08	6.5	Supported
H5: SSCRM → CR → OP	0.65		0.09	7.0	Supported

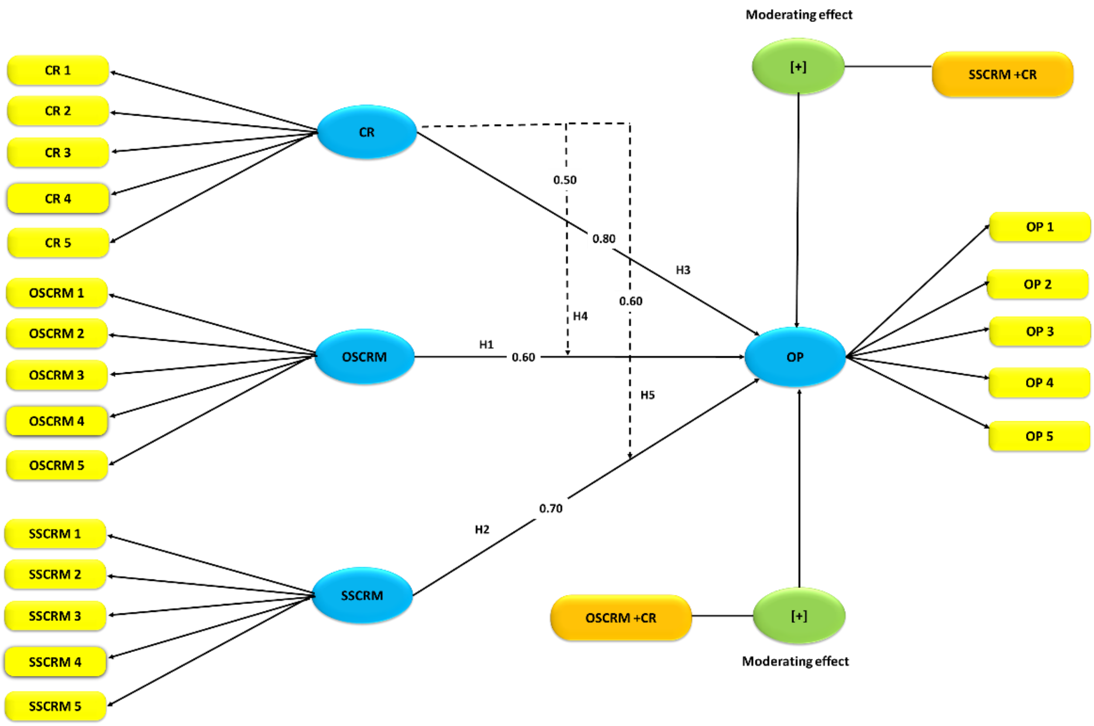

Figure 6. Evaluation of the overall structural model

5. Discussion

According to the summary of the hypothesis test findings, all developed hypotheses in the public and private sectors have strong support (see Table 15). OSCRM, SSCRM, and CR show significant effects on OP, with differing degrees of effect sizes. The results highlight the value of customer relationships and risk management techniques in increasing OP in the logistics industry, especially in light of the CPEC. Table 15 contains a thorough summary of hypothesis test results, demonstrating high support for all proposed hypotheses in the public and private sectors. OSCRM, SSCRM, and CR all have significant effects on OP, with various effect sizes, highlighting the importance of customer connections and risk management strategies in improving OP, particularly in the logistics business and the context of CPEC.

Table 15. Summary of hypothesis test outcomes

Hypothesis	Path Coefficient	Status
Overall		
H1: OSCRM → OP	0.60	Supported
H2: SSCRM → OP	0.70	Supported
H3: CR → OP	0.80	Well, Supported
H4: OSCRM → CR → OP	0.50	Supported
H5: SSCRM → CR → OP	0.60	Supported
Private Sector		
H1: OSCRM → OP	0.55	Supported
H2: SSCRM → OP	0.65	Supported
H3: CR → OP	0.75	Well, Supported
H4: OSCRM → CR → OP	0.45	Supported
H5: SSCRM → CR → OP	0.55	Supported
Public Sector		
H1: OSCRM → OP	0.65	Supported
H2: SSCRM → OP	0.75	Supported
H3: CR → OP	0.85	Well, Supported
H4: OSCRM → CR → OP	0.55	Supported
H5: SSCRM → CR → OP	0.65	Supported

The analysis of moderating effects demonstrates that CR substantially impacts the relationship between OSCRM, SSCRM, and OP. The interaction between OSCRM and OP is generally supported, although the link between SSCRM and OP is highly endorsed. This pattern is similar across both commercial and public sectors, showing the importance of customer interactions in increasing OP via efficient SCRM measures (see Table 16). Table 16 shows the moderating effects of hypotheses, demonstrating CR's significant impact on the link between OSCRM, SSCRM, and OP. While the contact between OSCRM and OP is usually approved, the connection between SSCRM and OP is widely accepted in both the private and public sectors. These findings highlight the critical role of customer contacts in enhancing OP through effective SCRM measures, emphasizing the importance of complete strategies that incorporate SCRM, CR, and OP variables for organizational performance, particularly in dynamic market situations such as CPEC.

Table 16. Summary of moderating effects of hypothesis test results

	Hypothesis	Path Coefficient	Status
Overall	H4: OSCRM → CR → OP	0.50	Supported
	H5: SSCRM → CR → OP	0.60	Well, Supported
Private	H4: OSCRM → CR → OP	0.45	Supported
	H5: SSCRM →CR → OP	0.55	Well, Supported
Public	H4: OSCRM → CR → OP	0.55	Supported
	H5: SSCRM → CR → OP	0.65	Well, Supported

The study's hypotheses were tested to understand the links between different constructs better. OSCRM had a direct impact on OP (H1; $\beta = 0.60, p < 0.001$). The correlation between SSCRM and OP was significant impact was supported directly (H2; $\beta = 0.70, p < 0.001$). The hypothesis that CR has a directly substantial impact on OP was well supported (H3; $\beta = 0.80, p < 0.001$). The hypothesis that a CR moderates the connection between OSSRM and OP was supported (H4; $\beta = 0.50, p =< 0.001$). The CR, a moderating variable of connection between SSCRM and OP, was supported (H5; $\beta = 0.60, p =< 0.001$). Furthermore, the analysis of moderating factors indicated the importance of CR in affecting the relationship between SCRM techniques and OP. This highlights the necessity of developing strong CR in delivering OP outcomes, particularly in the logistics business, as demonstrated by the CPEC. The study's outcomes offered valuable insights into the connection between SCRM, CR, and OP, highlighting the importance of businesses implementing comprehensive strategies incorporating these elements to succeed in today's dynamic market environments.

6. Conclusion

In conclusion, the study explores the critical connection between supply chain risk management (SCRM) and customer contacts in the China-Pakistan Economic Corridor (CPEC) logistics industry. A thorough analysis of 500 people involved in CPEC logistics and transportation yielded crucial new information about how customer relationships affect SCRM procedures. The study used partial least squares structural equation modeling (PLS-SEM) to create strong relationships between customer relationships and supply chain risk management (SCRM) in logistics. The Likert scale was used to evaluate customer relationships, operational performance, sustainable supply chain risk management (SSCRM), and operational supply chain risk management (OSCRM).

The results highlight how important it is to have good customer relationships to manage the intricacies of the supply chain and improve operational efficiency in the logistics division of CPEC. The study adds to the sustainability of CPEC operations by illuminating the complex interactions between customer connections and SCRM. Still, it provides insightful information for resolving supply chain issues in the rapidly changing global environment. Although the study's significant contributions, it is imperative to recognize its limits. The generalizability of the findings may be limited by the possible disparities in survey responses and the concentration on a particular area, like CPEC. Therefore, future research efforts could expand the scope to cover diverse global logistics contexts enabling a more thorough knowledge of efficient SCRM tactics across various industries and locations. Subsequent research may investigate technology innovations and sector-specific methodologies to augment risk mitigation strategies, thereby fortifying global resilience and flexibility in the logistics domain. By expanding upon the groundwork established by this study, scholars can enhance their comprehension and application of productive SCRM techniques to tackle the dynamic obstacles and intricacies of the modern logistical environment.

This study essentially acts as a springboard for more research projects that will improve SCRM procedures and promote sustainable logistics operations in a world that is becoming more dynamic and interconnected daily. Through ongoing investigation into the relationship between supply chain resilience and customer interactions, academics may help shape novel approaches that improve operational effectiveness, reduce risks, and foster long-term success in the logistics sector.

7. Declarations

7.1. Author Contributions

Conceptualization, M.I. and I.U.; methodology, M.I. and Z.J.; software, M.I., Q.Z., and I.U.; validation, Z.J., W.A., and I.U.; formal analysis, M.I., W.A., and I.U.; investigation, Z.J. and Q.Z.;writing—original draft preparation, M.I. and I.U.; writing—review and editing, Z.J. and Q.Z.; visualization, I.U., W.A., and Z.J.; supervision, J.Z.; project administration, J.Z.; funding acquisition J.Z. All authors have read and agreed to the published version of the manuscript.

7.2. Data Availability Statement

The data used to support the findings of this study are available from the corresponding author upon request.

7.3. Funding

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7.4. Conflicts of Interest

The authors declare no conflict of interest.

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