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CRISIS LOGISTICS: THE ROLE OF DISASTER RELIEF IN SUPPLY CHAIN RISK MANAGEMENT FOR EMERGENCY RESPONSE

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Abstract

This study aims to investigate the obstacles regarding Supply Chain Risk Management (SCRM) addressing such timely pertinent issues as emergency response and how disaster relief works to moderate these effects. The research changes the focus toward complex contexts that are heavily disrupted and uncertain, particularly natural disaster and humanitarian crisis settings. The study assesses the intricate coupling in supply chain networks under distinctive disaster-impacted institutional settings through extensive fieldwork and sophisticated analytical methods. DATA was collected through a field survey of 150 logistics and disaster response employees from diverse non-governmental and relief organizations. The findings demonstrate that SCRM practices help boost readiness to cope with emergencies; nevertheless, many logistical and infrastructural limitations still prevent seamless case handling. Although disaster relief makes up the most considerable mediating effort to alleviate these barriers, significant gaps exist with a lack of coordination and overall pragmatism towards equal distribution of resources peripherally involved within such initiatives. This Study can benefit supply chain managers and relief organizations by providing valuable policy insights and guidance on operational issues that are important in dealing with risk and response to emergencies, such as resource allocation, collaboration between different sectors, and preemptive planning. This research offers unique insights into the role of SCRM in high-risk settings by illustrating the importance played by disaster relief in performing necessary bridging roles that connect operations and providing a novel perspective of preparedness practices through the lens of supply chain management.

Keywords: Risk Assessment, Risk Mitigation, Risk Monitoring, Emergency Response, Disaster Relief.

1. INTRODUCTION

For post-disaster and post-crisis supply chains, these factors can be even more challenging to manage. Arguably, the overall complexity of managing supply chain risks in emergency response situations is worse than they are elsewhere (Leckenby et al., 2014; Lohmer et al., 2022). Such areas usually face multiple logistical, infrastructural, and organizational issues that heavily burden supply chain operations The present study investigates the challenges of supply chain risk management (SCRM) in its reactivity nature when responding to emergencies, with strategic emphasis on disaster relief mediate role (Sarkis, 2022).

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Whether working for a local humanitarian agency or a logistics company, humanitarian emergency response in disaster-prone regions calls for resilience, agility, and coordination across supply chain actors (Lohmer et al., 2022). The unpredictable and often hostile circumstances in these local areas create boundaries that defer the smooth working of things (Guo, 2023). The risks must be addressed to successfully support relief efforts, as infrastructure can be extensively damaged, communication channels affected, and resources limited (Lohmer et al., 2022).

This makes Customer Relationship Management (SCRM) a crucial element of emergency response in such cases, as it deals with these disruptors and aims to alleviate any bottlenecks that may arise by delivering aid at its address (Awawdeh et al., 2022). It establishes the importance of disaster relief efforts, which are critical to bridging those gaps in the supply chain as they offer crucial resources, operational support, and coordination among stakeholders (Guo, 2023).

Despite this work, the study faces some clear challenges. Be it transportation issues, shortage of resources, or red-tape bureaucracy, all contribute to the sub-optimality of delivery. This investigation investigates how mediation between disaster and relief in overcoming these barriers is essential for supply chain resilience and responsiveness during times of disasters. This study addresses the following research questions:

RQ1: How do existing supply chain risk management practices impact emergency response capabilities in high-risk areas?

RQ2: To what extent does disaster relief serve as an effective mediator in overcoming these barriers to improve emergency response efficiency?

Answering these questions may provide insights that should address strategy toward SCRM practice enhancements, which will support the emergency response frameworks in disaster-affected regions.

2. LITERATURE REVIEW

2.1. Supply Chain Risk Management (SCRM)

SCRM is the proactive process of finding, assessing, and minimizing risks that could interrupt the flow of goods or services along a supply chain (Sarkis, 2022). Preparing, for instance, potential problems, natural disasters geopolitical instability, supplier issues, a cyber-threat that may affect operations reduce efficiency, and result in poor timely delivery of goods or services; SCRM strategies range from diversifying suppliers and creating contingency plans to real-time monitoring and creating resilient supply chains with strong partners/adaptable logistics networks (Jum’a et al., 2021).

Through the mitigation of these risks, businesses have continuous operations and lessen their exposure to adverse events they need to prepare for as well as respond quickly when unexpected disruption occurs, especially in fields like emergency response or aid humanitarians (Lohmer et al., 2022).

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2.2. Risk Assessment

Risk assessment is part of supply chain risk management (SCRM) and involves identifying potential risks that could delay or disrupt the flow of goods and services, especially in emergency response situations (George et al., 2019). Effective risk assessment is even more vital in disaster or crisis-affected areas that are inherently high-risk, as unpreventable events can heavily impact supply chain operations. Informed by a calmer assessment of threats and opportunities through predictive modeling and scenario planning, research has demonstrated that rigorous risk assessment tools aid firms in determining the likelihood and impact potential of economic downturns (Guo, 2023). In emergency response settings, especially within disasters, correct risk assessment can enable timely decisions to limit the impact on decisions and allow available resources to reach populations in need as soon as possible (Awawdeh et al., 2022).

2.3. Risk Mitigation

Risk mitigation within SCRM aims to minimize supply chain interferences regarding likelihood and impact proactively (Barreto et al., 2017). Emergency responsiveness entails writing backup plans, contingency measures, diversification of supply sources, and establishing buffer stock to respond to rapid demand increases (Guo, 2023). Evidence suggests that if organizations employ proper risk mitigation measures, they can continuously adjust based on unanticipated shocks and updates, improving their resilience. Similarly, having more than one source of supply or stockpiling resources in places where disasters occur can reduce the impediments that logistical bottlenecks create during disaster responses (Lohmer et al., 2022). Incorporating disaster relief as a mediating variable enables organizations to respond effectively to logistical and resource challenges, thereby intensifying the capacity of the supply chain against adversities (Feng & Cui, 2021)**.**

2.4. Risk Monitoring

One important aspect of SCRM is risk monitoring, which enables the team to monitor risks in real-time and adjust strategies as necessary changing conditions in emergent response scenarios where the situation is highly dynamic, timely risk monitoring becomes crucial Real-time technologies, like real-time tracking, data analytics, and advanced warning systems are being increasingly deployed to monitor supply chain risks in real-time (Wang et al., 2021; Jum'a et al., 2021). Such tools offer organizations timely insights into newly expressed threats and how they can swiftly respond to disruption by pinpointing problems early on and working to coordinate with relief efforts in disaster-prone areas, effective risk monitoring keeps supplies flowing at a steady clip while also identifying and adapting to challenges as they arise (Lohmer et al., 2022).

2.5. Emergency Response

SCRM is used to ensure the timely and effective delivery of emergency services and supplies needed by affected populations this means dynamic and agile supply chain management to respond to the specific circumstances imposed by disasters in affected

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areas (AQasrawi & Alafi, 2022). Disaster management literature has underscored the need for agile logistics and pre-staged resources to respond quickly to unexpected disasters. Working with humanitarian organizations, government agencies, and local communities is also an essential contribution by complementing the capacity to make stakeholders mobilize resources and offer a coordinated response (Lohmer et al., 2022). Due to impending disasters being emergencies and the high need for effective communication while operating on a short timeline, emergency response planning (Feng & Cui, 2021)**.**

2.6. Disaster Relief

Disaster relief is a key mediating variable in SCRM and exists between risk management and the implementation of emergency response systems (Chan et al., 2020). Disaster relief helps by adding the logistical, resources and coordination that is otherwise needed to overcome emergency response barriers (Ullah et al., 2021). Humanitarian agencies, like the UN and the Red Cross, can act as a linchpin of these disaster responses by providing an on-the-ground response and the tools and mechanisms necessary for rebuilding (Qasrawi & Alafi, 2022). Research indicates supply chains are more resilient to emergencies when disaster relief is incorporated into SCRM, as overcoming logistical and resource-based obstacles becomes the prime focus. This cascading effect in disaster management makes the supply chain more resilient by spreading out resources across regions and empowering businesses to respond faster (Hochrainer-Stigler et al., 2025). The themes identified in our literature review contribute to supply chain resilience for emergencies through risk assessment, risk mitigation, risk monitoring, and emergency response and disaster relief (AQasrawi & Alafi, 2022). This understanding of unique challenges within each dimension can better assist organizations in navigating the complexities that arise when managing supply chain risks in high-stakes environments, where a successful response to a disaster demands operational excellence (B. Li et al., 2023).

2.7. Resource Dependency Theory (RDT)

However, concerning the mediating role of external support such as disaster relief in supply chain risk management for emergency response, Resource Dependency Theory (RDT), as discussed earlier would be a more appropriate theory (Ullah et al., 2021). Resource Dependency Theory (RDT) states that organizations are instrumentally reliant on external resources to ensure that they remain stable and constant, especially within uncertain and disruptive environments (Shen et al., 2021). Supply chains located in disaster-affected areas are often shackled by problems such as lack of access to goods, bottlenecks for resources, and safety risks, which causes them to depend more on relief assistance to keep running (Abdali et al., 2021). These dynamics influence supply chain strategies, particularly during crises where disaster relief resources become necessary to help overcome these challenges (RDT). RDT recognizes that in emergencies, partners such as the United Nations and the Red Cross can be crucial sources of support and location assistance for humanitarian organizations (X. Li et al., 2022). Such partnerships not only provide immediate relief but also make the supply chain more compostable and

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resilient by filling in gaps caused due to a local shortage of resources (Mishchenko et al., 2021). RDT, through its ability to buffer external resources, helps organizations make the strategic decision to integrate disaster relief efforts into their regular supply chain operations so that in times of emergencies necessary services such as food water supply, and medical supplies can be ensured (Ullah et al., 2021). Here, enhanced supply chain resilience acts as one of the central tenets in the approach that matches supply chain risk management (SCRM) practices since it fortifies its ability to absorb shocks and improves aggregate outcomes during an emergency response (Shen et al., 2021). Considering the perspective of RDT, it shows that dependency on any disaster relief resources creates a mediating effect in terms of risk-reducing capacity which enables supply chains to serve much-needed things during disasters (Bahamid et al., 2022)**.**

2.8. Hypothesis Development

2.8.1. Risk Assessment and Disaster Relief

The limitation of supply chain risk management for emergency response could be better understood through the lens of Resource Dependency Theory (RDT), especially the concept of external support as a mediator between RDT and disaster relief, which plays an important role (Hubbard, 2020). So, on the one hand, RDT offers a view of organizations that are far less autonomous than many traditional theorists assume: firms must interact with their environments to reach stability and sustainability especially when the environment is characterized by high instability and disruption (Anton & Nucu, 2020). Supply chains in disaster-prone areas increasingly depend on external assistance for continuity of operations, especially after a natural disaster, due to several, logistical hindrances and security issues (Ullah et al., 2021). Since disaster relief resources are essential to overcome barriers when crises strike RDT is well-suited as a lens through which to view how these inter-dependencies form the basis for supply chain strategies. Risk assessment is one of the solid fundamentals in integrating modern supply chains for emergencies. In crisis-impacted areas, including disaster relief settings, evaluating risks like transportation delays, resource scarcity, and safety harms can assist humanitarian agencies in strategically preparing for disruption (Abdali et al., 2021). By conducting a complete risk assessment, organizations can create measures that address vulnerability and increase their ability to react quickly in case of an emergency. Integrating risk assessment into disaster relief planning can enable organizations to prepare for complexities and execute resource allocation more effectively, such that the movement of goods is not compromised (Anton & Nucu, 2020; X. Li et al., 2022). Based on this discussion, the study proposes the following hypotheses:

H1: Risk Assessment positively influences Disaster Relief.

H2: Risk Assessment positively influences Emergency Response.

2.8.2. Risk Mitigation and Disaster Relief

Risk mitigation aims to minimize the risk impact via the critical risks identified, preventing them from hindering the ability to achieve objectives (Ullah et al., 2021). In disaster-prone

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regions, for instance, risk mitigation in the supply chain can mean diversifying suppliers, ensuring backed contingency plans, and stockpiling inventories to deal with unforeseen surges (Qasrawi & Alafi, 2022). Such measures are paramount to avoid any disruption in disaster relief operations, which could be detrimental if aid is not delivered on time due to delays in movement and availability of resources (Anton & Nucu, 2020).

Strategic risk mitigation makes the supply chain more flexible and adaptable, enabling rapid adjustments in an emergency (Chan et al., 2020). Incorporating disaster relief as an aid in supportive capacity within risk mitigation further heightens the robustness of supply chains (Abdali et al., 2021). From this understanding, the study suggests the following hypotheses:

H3: Risk Mitigation positively influences Disaster Relief.

H4: Risk Mitigation positively influences Emergency Response.

2.8.3. Risk Monitoring and Disaster Relief

Emergencies are characterized by changing conditions and dynamic environments, hence the importance of ongoing risk monitoring (Abdali et al., 2021). By implementing real-time monitoring systems, as made possible through geographical information technology, organizations can monitor the disaster at the moment and make necessary adjustments to their operations so that minimum disruptions occur in disaster relief (Qasrawi & Alafi, 2022).

This ensures that the stakeholders are coordinated when issues arise and respond quickly if there is any course deviation in supply chain performance (Chan et al., 2020). Risk monitoring ensures that disaster relief is suitable for the existing conditions and, thus, more flexible in high-risk areas where external shocks are common (Qasrawi & Alafi, 2022). Therefore, the study proposes the following hypotheses:

H5: Risk Monitoring positively influences Disaster Relief.

H6: Risk Monitoring positively influences Emergency Response.

2.8.4. Disaster Relief and Emergency Response

Disaster relief provides the operational support and logistical capabilities needed for emergency response operations to address immediate needs (Guo, 2023). Timely disaster relief is often the difference between getting critical supplies like food, water, and medical help to communities suffering in crisis-impacted areas and integrating relief efforts within the supply chain system to promote effective and speedy response to disaster situations (Qasrawi & Alafi, 2022).

Such an integration not only provides timely assistance to impacted populations but also strengthens the resilience of supply chains to build towards long-term recovery (Abdali et al., 2021; Hubbard, 2020). Based on this rationale, the study introduces the following hypothesis:

H7: Disaster Relief positively influences Emergency Response.

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3. METHODOLOGY

The study surveyed 150 employees from their operations units only working in regional supply chain and emergency response operations directly impacted by the crises. The study therefore used a purposive sampling strategy to target those who had a relevant role in management functioning and supply chain responsibilities concerning emergency response. Survey questions were constructed based on previous studies to ensure validity and reliability (Cheah et al., 2024).

3.1. Data Analysis

The variance-based approach was implemented for the data analysis, as proposed by Purwanto, (2021), using Smart PLS 4 to handle data irregularities and nonmoral distributions typically typical in a humanizing setting. Since the data structure is complex, a modeling tool such as Smart PLS has been found ideal for this study, as it provides an understanding of associations among variables under the SCRM perspective in emergency response situations. However, Smart PLS, unlike the conventional SEM, predicts a correlation model of key factors influencing SCRM in disaster relief-mediated emergency responses considering the complex relationships among constructs (Cheah et al., 2024).

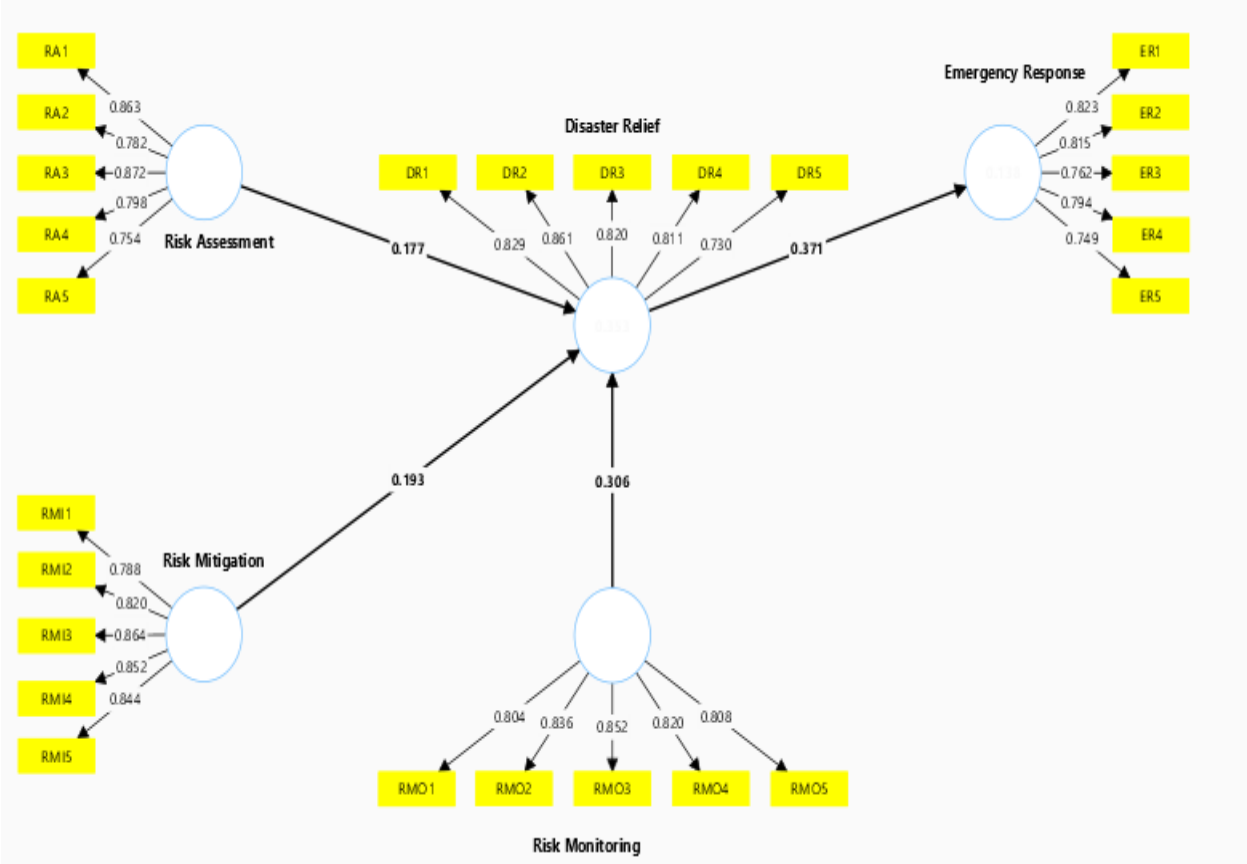

Figure 1: Research Model

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Table 1: Factor loadings

Constructs	Items	Factor loadings	Cronbach's Alpha	C.R.	(AVE)
Disaster Relief	DR1	0.829	0.869	0.906	0.658
	DR2	0.861			
	DR3	0.82			
	DR4	0.811			
	DR5	0.73			
Emergency Response	ER1	0.823	0.852	0.892	0.623
	ER2	0.815			
	ER3	0.762			
	ER4	0.794			
	ER5	0.749			
Risk Assessment	RA1	0.863	0.873	0.908	0.664
	RA2	0.782			
	RA3	0.872			
	RA4	0.798			
	RA5	0.754			
Risk Mitigation	RMI1	0.788	0.89	0.919	0.696
	RMI2	0.82			
	RMI3	0.864			
	RMI4	0.852			
	RMI5	0.844			
Risk Monitoring	RMO1	0.804	0.882	0.914	0.679
	RMO2	0.836			
	RMO3	0.852			
	RMO4	0.82			
	RMO5	0.808			

Table 1: Table 1 shows that the constructs disaster relief, emergency response, risk assessment/risk mitigation/risk monitoring are all highly reliable and valid constructs for studying supply chain risk management for emergency response. Item factor loadings are above the traditional cutoff of 0.70, indicating good individual item reliability as shown in Table 1, the Cronbach's Alpha for all constructs exceeds the threshold of 0.85, which means good internal consistency and implies that items within each construct measure the same underlying concept, all composite reliability (C.R.) values are also high and well above the threshold of 0.70 so that they further confirm the reliability of these constructs.

The averages of value extracted (AVE) for every construct are also higher than the minimum acceptable threshold level (0.50), which confirms that more than half the variance of their indicators on average are explained by the constructs well within a range therefore, indicative towards acceptance and establishment towards convergent validity. The results presented above indicate that the constructs are reliable and valid measures of what they were intended to measure factors important for managing supply chain risks in disaster-prone regions. Grounded in solid measurement, this work then supports a more detailed analysis exploring how disaster relief mediates the relationships of risk assessment, mitigation, and monitoring with effective emergency response **(**Purwanto, 2021).

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3.2 Structural Model

The two steps to validate a composite construct in the structural model are evaluations of discriminant validity and cross-validation. One of the most typical tests for that (HTMT) ratio is it should be below 1.

This criterion has been elaborated on in recent work by Cheah et al (2024). All HTMT ratios are listed in Table 2 and fall within acceptable ranges, confirming strong discriminant validity since each factor variable differs meaningfully from the other variables. These results highlight the reliability and validity of the measurement model, which is essential in examining supply chain risk management **(**Purwanto, 2021).

Table 2: HTMT

	Disaster Relief	Emergency Response	Risk Assessment	Risk Mitigation	Risk Monitoring
Disaster Relief					
Emergency Response	0.412				
Risk Assessment	0.611	0.666			
Risk Mitigation	0.537	0.456	0.732		
Risk Monitoring	0.622	0.734	0.866	0.616	

Table 2 shows the discriminant validity of disaster relief, emergency response, risk assessment, risk mitigation, and risk monitoring constructs, measured through Heterotrait-Monotrait Ratio (HTMT) values shown in Table 2. Similarly, a value below 0.85 for HTMT confirms that discriminant validity is established, which means that constructs are sufficiently distinct (Henseler et al., 2015).

The HTMT values indicate acceptable levels of discriminant validity between pairs of constructs, thus confirming that they are isolated facets related to supply chain risk management. For instance, the HTMT values between Disaster Relief and the other constructs are all less than 0.85, which means that disaster relief has high discriminant validity within the model.

Likewise, Emergency Response has low to moderate correlations with the other constructs, supporting its specificity within the framework. Nevertheless, the HTMT value between Risk Assessment and Risk Monitoring (HTMT = 0.866) is above the threshold but also indicates this close relationship between these constructs.

This could imply that some components of risk assessment and monitoring overlap within the specific emergency response, but both still provide essential information relevant to controlling disaster-related risks.

Finally, concerning the HTMT values presented in Table 2, the study concludes that the constructs exhibit discriminant validity and acetate capturing different aspects of supply chain risk management regarding emergency response, with disaster relief being an intervening/mediator variable for all these constructs (Cheah et al., 2024).

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Table 3: Fronell-Larcker

	Disaster Relief	Emergency Response	Risk Assessment	Risk Mitigation	Risk Monitoring
Disaster Relief	0.811				
Emergency Response	0.371	0.789			
Risk Assessment	0.535	0.557	0.815		
Risk Mitigation	0.476	0.385	0.648	0.834	
Risk Monitoring	0.547	0.616	0.761	0.55	0.824

Table 3 evaluates the discriminant validity of the constructs (disaster relief, emergency response, risk assessment, risk mitigation, and risk monitoring) in the model, Table 3 shows the values based on the Fornell-Larcker criterion. The values on the diagonal (in bold) represent the square root of AVE. In contrast, the off-diagonal values are inter-construct correlations, thus showing that according to the Fornell-Larcker criterion, each construct is expected to have a higher square root correlation with its AVE diagonal values than other constructs' off-diagonal values. Its value ensures that the variance for each construct is more significant with its indicators than other constructs, thereby supporting discriminant validity. This table shows that the upper diagonal values are more important than the lower off-diagonal correlations with different constructs. For instance, Disaster Relief has a high diagonal (0.811) compared to the relations with Emergency Response (0.371), Risk Assessment (0.535), Risk Mitigation (0.476), and Risk Monitoring (0.547). The pattern repeats in all constructs. All constructs are distinct and share more variance with their items than others. The most significant correlation between the constructs was between risk assessment and risk monitoring (0.761), which indicates that these two constructs are closely related to supply chain risk management for emergency response. Nonetheless, given that both constructs remain below the Fornell-Larcker threshold, they maintain enough discriminant validity to represent separate dimensions within the model. In general, the Fornell-Larcker results in Table 3 verify the distinct validity of constructs, thereby supporting the structure of the model. This validation is consistent with the goal of this study since it provides evidence for and suggests a unique role played by each construct in explaining SCM-RM based on the specific nature of disasters (Cheah et al., 2024).

Table 4: R2 Adjusted

Variable	R2	R2 Adjusted
Disaster Relief	0.353	0.346
Emergency Response	0.138	0.135

In table 4, However, Table 4 contains the R^2 and R^2 Adjusted values for all other constructs in between Disaster Relief and Emergency Response, which gives us a glimpse into what proportion of variance for these outcomes is accounted for by the predictor variables. The R^2 Adjusted for Disaster Relief is 0.346, which means the variance explained alongside the predictors included in the model accounts for about 34.6% of disaster relief. An R^2 Adjusted value of this moderate high close to one indicates that the predictors in our model (risk assessment, risk mitigation, and risk monitoring)

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explain disaster relief associated with supply chain risk management. This finding is consistent with the expectation that risk management practices contribute significantly to the ability of emergency response to support disaster relief. The R^2 Adjusted for Emergency Response Indicates that ~13.5% of its Variance is explained by the predictors in the model. Although this R^2 Adjusted value is below that of the disaster relief section, it still shows that predictors are relatively meaningful to understanding emergency response. This indicates that emergency response outcomes are a complex function of many factors, likely including additional external influences beyond the model, such as situational dynamics and real-time operational restrictions. Overall, the model is relatively effective at explaining Disaster Relief and somewhat effective in accounting for Emergency Response as measured by R^2 Adjusted values. Along with the significant global averages of disaster relief (0.085) + emergency response (−0.057), these values lend support to the study's quest for statistically relevant human ties between identifying and mitigating risk management practices followed by preventative measures, where disaster relief appears even more strongly correlated with its unique set of model predictors than emergency response **(**Purwanto, 2021).

3.3 Hypotheses Testing

The path hypotheses were tested using Smart PLS 4.0 software. The Structural Model evaluated the hypotheses using traditional regression analysis path coefficients analogous to beta weights. These path coefficients, which range from -1 to +1, indicate the strength and direction of relationships between variables. A coefficient close to zero signifies no relationship, while values closer to -1 or +1 represent strong negative or positive relationships, respectively. Statistical significance was assessed using the T-value and associated P-value, typically at a significance level of 0.05 or lower. More minor standard errors indicate greater precision, enhancing the accuracy of sample error estimates in representing the population. Table 2 presents the path coefficients, with P-values of 0.05 or lower, which support the testing of hypotheses and validate the structural model **(**Purwanto, 2021; Cheah et al., 2024).

Table 5: Hypotheses testing estimates "Total effect"

Hypo	Relationships	Standardized Beta	Standard Error	T-Statistic	P-Values	Decision
H1	Disaster Relief -> Emergency Response	0.371	0.086	4.298	0	Supported
H2	Risk Assessment -> Disaster Relief	0.177	0.083	2.14	0.032	Supported
H3	Risk Assessment -> Emergency Response	0.066	0.037	1.797	0.072	Unsupported
H4	Risk Mitigation -> Disaster Relief	0.193	0.072	2.684	0.007	Supported
H5	Risk Mitigation -> Emergency Response	0.072	0.031	2.314	0.021	Supported
H6	Risk Monitoring -> Disaster Relief	0.306	0.088	3.484	0	Supported
H7	Risk Monitoring -> Emergency Response	0.114	0.047	2.403	0.016	Supported

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The hypotheses are shown in Table 5 the relationships between constructs in the model, within the scope of supply chain risk management for emergency response, are highlighted through the hypothesis testing results in Table 6. H1: Disaster Relief and Emergency Response have a positive relationship is strongly supported by standardized beta 0.371, which is significant at $p < 0.000$. The result supports that effective disaster relief operations greatly improve the responsiveness of emergency response, strengthening the claim of disaster relief's mediating role in the model. Furthermore, risk assessment positively impacts disaster relief (H2), supported by beta 0.177 and P-value 0.032, which shows that proactive risk assessment enhances the implementation of disaster relief operations. However, the t-test reveals that there is no evidence (P-value of 0.072 with a beta of 0.066) for the direct relationship between Risk Assessment and Emergency Response (H3). This indicates that risk assessment may contribute to improvements in disaster relief but may have a more restricted influence on emergency response, possibly only affecting differences through its effects on disaster relief. Risk Mitigation positively influences Disaster Relief (H4) at beta 0.193 & P-value 0.007, which means that risk mitigation and preparation ensure continued support of relief efforts during disasters. Such an anticipation-led risk management opportunity also positively reflects the Emergency Response (H5) with a positive beta of 0.072 and P value significance at 0.021, thus indicating that executing such risk management also directly influences better emergency response. In addition, the effect of Risk Monitoring on Disaster Relief (H6) with a beta of 0.306 indicates that continuous tracking of risk outsourcers is crucial to operating disaster relief efficiently. The significant coefficient of Risk Monitoring (H7), with a beta of 0.114 and P-value of 0.016, confirms that continuous review of risks also builds direct capabilities in emergency response. These results affirm the role of disaster relief as a central mediating factor in the model, with risk assessment, mitigation, and monitoring also appearing to perform significantly in their support of emergency response and disaster relief efforts. Such alignment illustrates the necessity of implementing integrated supply chain risk management practices, which evolved from systemic knowledge to obtain better outcomes during extreme situations (Cheah et al., 2024).

Table 6: Hypotheses testing estimates "Indirect effect"

Hypo	Relationships	Standardized Beta	Standard Error	T-Statistic	P-Values	Decision
H8	Risk Assessment -> Emergency Response	0.066	0.037	1.797	0.072	Unsupported
H9	Risk Mitigation -> Emergency Response	0.072	0.031	2.314	0.021	Supported
H10	Risk Monitoring -> Emergency Response	0.114	0.047	2.403	0.016	Supported

The results of the hypotheses testing for indirect effects of Risk Assessment, Risk Mitigation, and Risk Monitoring on Emergency Response are shown in Table 6 to assess if these constructs indirectly influence emergency response through potential mediators-disaster relief. There is no support for the indirect effect of Risk Assessment on

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Emergency Response (H8; standardized beta = 0.066; T-statistic = 1.797, P-value = 0.072). However, this result does indicate that risk assessment has an impact through the path of disaster relief on emergency response, but not a significantly indirect one in this model. The indirect effect of Risk Mitigation on Emergency Response (H9) is supported with a standardized beta = 0.072, T-statistic = 2.314, and P-value = 0. 021. The positive effect of risk mitigation on emergency response via disaster relief indicates that, by enhancing disaster relief, proactive risk reduction strategies indirectly improve emergency response performance.

Hypothesis H10 on the indirect effect of Risk Monitoring on Emergency Response standardized beta = 0.114, T-statistic = 2.403, P-value = 0.016) where $p < 0.01$ is also supported by the data test result in Table 8. This indicates that sustained tracking of risks indirectly contributes to emergency response through the mediating role of disaster relief, emphasizing the need for immediate risk monitoring as this allows a prompt reaction. In conclusion, these findings indicate that risk assessment is not a significant indirect predictor of emergency response, whereas, among others, risk mitigation and risk monitoring positively affect emergency response when mediated by disaster relief. This underlines the importance of disaster relief as an association-level synchronizer in boosting emergency response through integrated supply chain risk management practices (Cheah et al., 2024).

4. CONCLUSION AND FUTURE DIRECTION

The research emphasizes the importance of preparedness and suggests disaster relief as a moderator for improving emergency response capabilities in a supply chain risk management (SCRM)-based environment. Based on the Resource Dependency Theory (RDT), our results reveal that successful SCRM practices are necessary to overcome challenges and issues arising from logistics disruptions, damaged infrastructure, and limited resources available in disaster-prone regions.

Disaster relief is critical to close these gaps as it provides an infrastructure that allows supply chains to run smoother during a disaster. Incorporating disaster relief into SCRM will give organizations forward-looking capabilities to react during crises. The research illustrates those collaborations with humanitarian organizations and dependency on third-party resources, as propounded by RDT, positively impact supply chain resilience and responsiveness. It serves two purposes: First, it dramatically reduces the damages caused by disruptions in today's supply chains.

Research offers essential insights to policymakers working in humanitarian logistics, organizations that manage emergency supplies, and national and global supply chain managers to forge partnerships, use more resources to build resilient infrastructure, and develop adaptive frameworks for emergency response. These recommendations can aid in creating more substantial and timely supply chains that better assist the affected populations during a crisis. The paper lays a foundation for future research about disaster relief of SCRM, especially where risks are higher, and may enhance our understanding

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of ways to develop emergency response capability and supply chain resilience in challenging environments.

The present study provides some strategic recommendations that can contribute to better supply chain risk management (SCRM) and more responsive supply chains in the case of emergencies, with disaster relief as an essential mediating experience. Better collaboration and coordination between humanitarian actors and supply chain management providers must be established.

Creating joint operational plans and solid information-sharing channels will allow responses to be coordinated and engaged rapidly in crises. Resilient infrastructure is another area that needs investment to tackle logistical challenges. To supplement it to avoid supply chain disruption, establishing resilient logistics networks and incorporating advanced technologies like live tracking and risk assessment solutions can make your supply chains more efficient before and between crises.

Another area is boosting local capacity. Local capacity building to respond preemptively to emergencies increases supply chain robustness while bolstering community resiliency. The suggestions also include promoting policies allowing for the rapid provision of international humanitarian assistance, including establishing corridors, abolishing obstacles to access, and protecting humanitarian workers. It is necessary to support and use the function of humanitarian organizations in general in coordinating assistance so that aid can be taken to those who need it on time. Lastly, continuous monitoring and evaluation of the supply chain work to ensure that organizations are aware of new risks that arise while still maintaining the flexibility and resilience required in most emergencies.

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