

HOW COORDINATING, INFORMATION SHARING, AND INFRASTRUCTURE DRIVE HUMANITARIAN SUPPLY CHAIN RESPONSIVENESS IN MALAYSIA

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Abstract. This research study examines the determinants of humanitarian supply chain responsiveness in Malaysia, with a focus on information sharing, inter-agency coordination, and logistics infrastructure. Using a quantitative approach, the data were collected from 238 disaster response stakeholders and analysed using structural equation modelling. The research findings reveal that all three factors significantly influence responsiveness, with inter-agency coordination emerging as the strongest predictor, followed by the information sharing and logistics infrastructure. The results demonstrate that the responsiveness is a systemic capability shaped by the integration of relational, informational, and physical resources. In the Malaysian context, recurring flood disasters highlight the need for coordinated and efficient relief operations. This research study contributes to humanitarian logistics literature by providing empirical evidence from a developing country and extending the application of resource-based and coordination theories. The research findings offer practical and policy insights for strengthening disaster management systems and improving response effectiveness in Malaysia.

Keywords: *humanitarian supply chain, supply chain responsiveness, disaster logistics, inter-agency coordination, Malaysia*

Introduction

Humanitarian supply chains operate in environments characterised by urgency, uncertainty, and resource constraints, where the effectiveness of logistics operations directly influences the survival and well-being of affected populations. Unlike commercial supply chains that prioritise efficiency and cost optimisation, humanitarian supply chains emphasise responsiveness, flexibility, and rapid deployment under extreme conditions (Kovács and Spens, 2007). Responsiveness, in this context, reflects the ability of organisations to react quickly to disaster events, mobilise resources efficiently, and deliver aid to affected communities in a timely manner. Recent literature highlights that responsiveness is not merely a function of speed but also of coordination, information accuracy, and infrastructure readiness (Dubey et al., 2020; Maghsoudi and Pazirandeh, 2016). Humanitarian operations often involve multiple actors, including government agencies, non-governmental organisations, and private logistics providers, all of whom must operate within disrupted environments where information is incomplete and infrastructure may be compromised. As such, responsiveness emerges as a systemic capability rather than an isolated operational outcome. Malaysia provides a compelling context for examining humanitarian supply chain responsiveness due to its frequent exposure to flood disasters, particularly during the monsoon season. These events consistently test the capacity of national disaster management systems. Despite the presence of structured frameworks such as Directive No. 20 under the National

Disaster Management Agency, operational inefficiencies persist, particularly in information sharing and coordination among stakeholders (Mohammed Zain et al., 2023). This suggests that formal governance structures alone are insufficient to ensure effective disaster response, thereby necessitating empirical investigation into operational determinants of responsiveness.

Background of the study and problem statement

The field of humanitarian logistics has evolved significantly over the past two decades, moving from descriptive case studies toward more analytical and empirical research. Early work by Kovács and Spens (2007) established the foundation by distinguishing humanitarian logistics from commercial logistics, highlighting its unique challenges such as demand unpredictability, infrastructure disruption, and multi-stakeholder coordination. Subsequent research has identified key enablers of humanitarian supply chain performance. Information sharing has been recognised as a critical factor influencing visibility, decision-making quality, and operational coordination (Dubey et al., 2020). Accurate and timely information enables organisations to assess needs, allocate resources effectively, and reduce duplication of efforts. Similarly, inter-agency coordination has been shown to enhance alignment among stakeholders, thereby improving response efficiency and reducing operational fragmentation (Maghsoudi et al., 2018). Logistics infrastructure also plays a crucial role in determining the effectiveness of humanitarian operations. Infrastructure constraints such as damaged roads, limited transport capacity, and inadequate warehousing can significantly delay relief efforts. In disaster-prone environments like Malaysia, where floods frequently disrupt transport networks, infrastructure readiness becomes a key determinant of response capability. Despite these insights, empirical research focusing on the Malaysian context remains limited. Existing studies have identified coordination and information challenges but often rely on qualitative approaches. There is a lack of quantitative evidence examining how these factors collectively influence responsiveness in humanitarian supply chains. This study addresses this gap by developing and testing a model that integrates information sharing, coordination, and infrastructure as key determinants of responsiveness.

Humanitarian supply chains in Malaysia continue to experience challenges in achieving timely and effective disaster response despite established institutional frameworks. Recurring flood events have revealed persistent issues such as delays in aid distribution, duplication of efforts, and mismatches between supply and demand. These challenges indicate that responsiveness remains suboptimal, raising concerns about the effectiveness of current disaster management practices. One of the primary issues relates to information sharing. Inefficient information exchange among stakeholders can result in delayed decision-making and reduced situational awareness. Studies have reported problems such as information redundancy, lack of real-time data integration, and limited communication tools during disaster response operations (Mohammed Zain et al., 2023). These limitations hinder the ability of organisations to coordinate effectively and respond promptly. Another critical issue is inter-agency coordination. Humanitarian operations involve multiple organisations with different mandates, systems, and priorities. Without effective coordination mechanisms, these differences can lead to operational inefficiencies, including duplication of efforts and resource misallocation (Maghsoudi et al., 2018). Coordination challenges are particularly pronounced in Malaysia, where disaster response involves federal, state, and local

authorities alongside non-governmental actors. Logistics infrastructure presents an additional challenge. Flood disasters often damage transport networks and disrupt supply chain operations, limiting access to affected areas. Even when resources are available, inadequate infrastructure can delay their delivery, reducing overall responsiveness. Furthermore, there is a lack of quantitative studies that examine these factors within a unified framework in the Malaysian context. While previous research has identified individual challenges, there is limited empirical evidence on how information sharing, coordination, and infrastructure jointly influence responsiveness. This gap restricts the ability of policymakers and practitioners to prioritise interventions effectively.

Research questions and research objectives

This study seeks to answer the following research questions: (1) What is the effect of information sharing on humanitarian supply chain responsiveness in Malaysia? (2) What is the effect of inter-agency coordination on humanitarian supply chain responsiveness in Malaysia? (3) What is the effect of logistics infrastructure on humanitarian supply chain responsiveness in Malaysia? (4) To what extent do information sharing, inter-agency coordination, and logistics infrastructure collectively influence responsiveness in humanitarian supply chains in Malaysia? The objectives of this study are as follows: (1) To examine the effect of information sharing on humanitarian supply chain responsiveness in Malaysia. (2) To analyse the effect of inter-agency coordination on humanitarian supply chain responsiveness in Malaysia. (3) To determine the effect of logistics infrastructure on humanitarian supply chain responsiveness in Malaysia. (4) To assess the combined influence of information sharing, coordination, and infrastructure on humanitarian supply chain responsiveness in Malaysia.

Significance of the study, scope of the study and theoretical foundation

This study contributes to theory, methodology, and practice in several important ways. Theoretical Contribution: The study extends humanitarian supply chain literature by empirically examining responsiveness as a key performance outcome within a developing country context. It integrates information sharing, coordination, and infrastructure into a unified model, thereby strengthening theoretical understanding of responsiveness drivers. Methodological Contribution: The study adopts a quantitative approach, addressing the current imbalance in the literature where qualitative methods dominate. By applying structural equation modelling, the research provides statistically robust evidence on the relationships among key variables. Practical Contribution: The findings offer actionable insights for practitioners involved in disaster management, including government agencies, NGOs, and logistics providers. The study identifies key operational factors that can be improved to enhance response effectiveness. Policy Contribution: The study provides evidence-based recommendations for policymakers to strengthen Malaysia's disaster management framework. By identifying critical determinants of responsiveness, the research supports more targeted and effective policy interventions.

This study focuses on humanitarian supply chain operations in Malaysia, with particular emphasis on flood disaster response. The research examines three independent variables, namely information sharing, inter-agency coordination, and

logistics infrastructure, and one dependent variable, which is humanitarian supply chain responsiveness. The study adopts a quantitative approach using survey data collected from stakeholders involved in disaster relief operations, including government agencies, non-governmental organisations, and logistics providers. The findings are intended to reflect current practices and perceptions within the Malaysian humanitarian logistics ecosystem. This study is grounded in the resource-based view and coordination theory. The resource-based view suggests that organisational performance depends on the effective utilisation of valuable and strategic resources. In humanitarian supply chains, capabilities such as information sharing systems, coordination mechanisms, and infrastructure readiness can be considered strategic resources that influence responsiveness (Dubey et al., 2020). Coordination theory emphasises the importance of managing interdependencies among actors. In humanitarian contexts, multiple stakeholders must work together under time pressure and uncertainty. Effective coordination ensures alignment of activities, reduces duplication, and enhances overall performance (Maghsoudi et al., 2018). Together, these theories provide a strong foundation for understanding how operational capabilities influence responsiveness in humanitarian supply chains.

Conceptual framework and hypotheses

This study proposes that information sharing, inter-agency coordination, and logistics infrastructure positively influence humanitarian supply chain responsiveness.

H1: Information sharing has a positive and significant effect on humanitarian supply chain responsiveness.

H2: Inter-agency coordination has a positive and significant effect on humanitarian supply chain responsiveness.

H3: Logistics infrastructure has a positive and significant effect on humanitarian supply chain responsiveness.

Literature review

Humanitarian supply chain management

Humanitarian supply chain management refers to the planning, implementation, and control of efficient and effective flows of goods, information, and services from origin to beneficiaries in disaster-affected areas. Unlike commercial supply chains, humanitarian supply chains are driven by urgency, unpredictability, and the objective of alleviating human suffering rather than profit maximisation (Kovács and Spens, 2007). The humanitarian context introduces several operational complexities. Demand is highly uncertain, infrastructure is often damaged, and multiple stakeholders operate simultaneously with varying objectives and capabilities. These conditions create a need for supply chains that are flexible, adaptive, and responsive (Van Wassenhove, 2006). Humanitarian supply chains must operate across different disaster phases, including preparedness, response, and recovery, each requiring different capabilities and resource configurations. Recent studies have emphasised the increasing professionalisation of humanitarian logistics, with a shift toward adopting private-sector practices such as performance measurement, integration, and digitalisation (Dubey et al., 2020). However, the transferability of these practices remains context-dependent, particularly

in developing countries where institutional constraints and infrastructure limitations persist.

Responsiveness in humanitarian supply chains

Responsiveness is widely recognised as a critical performance dimension in humanitarian supply chains. It refers to the ability of the supply chain to react quickly and effectively to changes in demand and environmental conditions (Christopher, 2016). In humanitarian settings, responsiveness is directly linked to the speed and accuracy of relief delivery. Scholars argue that responsiveness encompasses multiple dimensions, including reaction speed, flexibility, adaptability, and service reliability (Holguín-Veras et al., 2013). In disaster scenarios, responsiveness determines how quickly affected populations receive essential supplies such as food, water, and medical aid. Delays in response can exacerbate human suffering and increase mortality risks. Empirical research has consistently identified responsiveness as a key outcome variable influenced by organisational and operational factors. Dubey et al. (2020) found that information visibility and collaboration significantly enhance agility, which in turn improves responsiveness in humanitarian supply chains. Similarly, Altay and Green (2006) highlighted that effective coordination and resource allocation are essential for achieving rapid response in disaster relief operations. In the Malaysian context, responsiveness is particularly important due to the frequency of flood disasters. The recurring nature of these events requires supply chains that can respond quickly and consistently, despite variations in location, severity, and infrastructure conditions.

Information sharing in humanitarian supply chains

Information sharing refers to the exchange of timely, accurate, and relevant information among supply chain partners. In humanitarian operations, information sharing is critical for achieving visibility, coordination, and effective decision-making (Dubey et al., 2020). The literature emphasises that information sharing reduces uncertainty and improves situational awareness during disaster response. When organisations have access to real-time information about demand, inventory, and transportation conditions, they can make better decisions regarding resource allocation and distribution (Pettit and Beresford, 2009). Conversely, poor information sharing can lead to delays, duplication of efforts, and inefficiencies. Dubey et al. (2020) demonstrated that information sharing enhances supply chain visibility, which in turn supports agility and responsiveness. Similarly, Papadopoulos et al. (2017) argued that digital technologies such as information systems and data analytics play a crucial role in facilitating information sharing in humanitarian contexts. However, challenges remain, particularly in developing countries. Issues such as lack of standardised information systems, limited technological infrastructure, and organisational silos can hinder effective information exchange (Tatham and Houghton, 2011). In Malaysia, studies have reported problems related to fragmented information systems and lack of real-time data integration during disaster response operations. Given its central role in enabling coordination and decision-making, information sharing is expected to have a significant impact on humanitarian supply chain responsiveness.

Inter-agency coordination

Inter-agency coordination refers to the alignment and collaboration among multiple organisations involved in humanitarian operations. Effective coordination ensures that resources are used efficiently, activities are synchronised, and duplication of efforts is minimised (Jahre and Jensen, 2010). Humanitarian supply chains are inherently multi-actor systems involving government agencies, non-governmental organisations, international bodies, and private sector partners. Each actor brings different capabilities, resources, and objectives, making coordination both essential and challenging (Balcik et al., 2010). Research shows that coordination improves operational efficiency and enhances response outcomes. Maghsoudi et al. (2018) found that coordination positively influences supply chain performance, particularly in disaster relief contexts. Similarly, Van Wassenhove (2006) highlighted that coordination mechanisms such as information sharing platforms, joint planning, and standard operating procedures are critical for effective humanitarian response. Despite its importance, coordination remains a major challenge. Differences in organisational culture, communication systems, and decision-making processes can hinder collaboration. In Malaysia, the involvement of multiple levels of government and diverse stakeholders adds complexity to coordination efforts. Effective coordination is therefore expected to play a significant role in enhancing humanitarian supply chain responsiveness.

Logistics infrastructure

Logistics infrastructure refers to the physical and technological systems that support the movement and storage of goods, including transportation networks, warehouses, communication systems, and distribution facilities. In humanitarian supply chains, infrastructure plays a critical role in determining the speed and efficiency of relief operations (Rodríguez-Espíndola et al., 2020). Infrastructure constraints are a common challenge in disaster contexts. Damaged roads, limited transport capacity, and inadequate storage facilities can significantly delay relief efforts. Holguín-Veras et al. (2013) emphasised that infrastructure disruptions are among the primary factors affecting disaster response performance. In developing countries, infrastructure limitations are often more pronounced due to pre-existing gaps in logistics capacity. In Malaysia, flood disasters frequently disrupt transportation networks, making it difficult to access affected areas. This highlights the importance of infrastructure readiness and resilience in ensuring effective humanitarian response. Recent studies have also highlighted the role of technological infrastructure, such as communication systems and digital platforms, in supporting logistics operations (Dubey et al., 2020). These technologies enhance coordination and information sharing, thereby indirectly improving responsiveness. Given these considerations, logistics infrastructure is expected to have a direct and significant impact on humanitarian supply chain responsiveness.

Hypotheses development

Based on the literature, this study proposes the following hypotheses. H1: Information sharing has a positive and significant effect on humanitarian supply chain responsiveness. This hypothesis is supported by studies showing that information sharing improves visibility, decision-making, and agility (Dubey et al., 2020; Pettit and Beresford, 2009). H2: Inter-agency coordination has a positive and significant effect on humanitarian supply chain responsiveness. This is supported by evidence that

coordination enhances resource alignment and operational efficiency (Maghsoudi et al., 2018; Jahre and Jensen, 2010). H3: Logistics infrastructure has a positive and significant effect on humanitarian supply chain responsiveness. This hypothesis is grounded in research showing that infrastructure availability and reliability directly influence response speed and effectiveness (Rodríguez-Espíndola et al., 2020; Holguín-Veras et al., 2013).

Materials and Methods

This study employs a cross-sectional quantitative research design. The quantitative approach is appropriate because the study aims to test hypothesised relationships among latent constructs and to generalise findings across a population of humanitarian logistics stakeholders. Quantitative methods are widely used in supply chain research due to their ability to provide statistical evidence of relationships and to validate theoretical models (Hair et al., 2019). A survey strategy is adopted as it allows the collection of data from multiple organisations involved in disaster response. This approach is consistent with prior humanitarian logistics studies that examine coordination, information sharing, and performance using survey-based designs (Dubey et al., 2020; Maghsoudi et al., 2018). The study focuses on disaster relief operations in Malaysia, particularly flood-related events, which represent the most frequent and operationally significant disasters in the country (DOSM, 2025). The target population consists of organisations and personnel directly involved in humanitarian supply chain operations in Malaysia. These include: Government agencies such as the National Disaster Management Agency, Social Welfare Department, and local authorities; Non-governmental organisations involved in disaster relief; Logistics service providers supporting humanitarian operations; Emergency response units and volunteer organisations. These actors are selected because they actively participate in disaster response and possess relevant knowledge of supply chain operations.

This study adopts purposive sampling, a non-probability sampling technique suitable for selecting respondents with specific expertise in humanitarian logistics. This approach is widely used in supply chain and disaster management research where the population is specialised and not easily accessible (Etikan et al., 2016). Respondents will be selected based on the following criteria: Direct involvement in disaster relief operations; experience in logistics, coordination, or supply chain functions; participation in flood response activities in Malaysia. The sample size is determined based on SEM requirements. According to Hair et al. (2019), a minimum sample of 200 is recommended for covariance-based SEM to ensure statistical power and model stability. Given the complexity of the proposed model and the number of constructs, this study targets between 200 and 300 respondents. This range is consistent with prior humanitarian supply chain studies employing SEM (Dubey et al., 2020). All constructs in this study are measured using multi-item scales adapted from established literature. A five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) is used.

Information sharing is measured based on the extent to which organisations exchange timely, accurate, and relevant information. Adapted from Dubey et al. (2020) and Li et al. (2006): IS1: Our organisation shares timely information with other agencies during disaster response; IS2: Information exchanged among agencies is accurate and reliable; IS3: Real-time information is accessible to relevant stakeholders; IS4: Information systems support effective communication during emergencies. Inter-agency

coordination measures the degree of collaboration and alignment among organisations. Adapted from Maghsoudi et al. (2018) and Jahre and Jensen (2010): CO1: Agencies involved in disaster response coordinate their activities effectively; CO2: Roles and responsibilities are clearly defined among organisations; CO3: There is strong collaboration between government and non-government actors; CO4: Joint planning improves disaster response effectiveness. Logistics infrastructure measures the adequacy and reliability of physical and technological support systems. Adapted from Rodríguez-Espíndola et al. (2020): LI1: Transportation infrastructure supports timely delivery of relief goods; LI2: Warehousing facilities are adequate for disaster response operations; LI3: Communication systems remain functional during disasters; LI4: Logistics resources are readily available during emergencies.

Responsiveness measures the ability to react quickly and effectively to disaster conditions. Adapted from Christopher (2016) and Holguín-Veras et al. (2013): RS1: Relief goods are delivered quickly to affected areas; RS2: Our organisation responds rapidly to changing disaster conditions; RS3: Emergency needs are addressed without significant delay; RS4: The supply chain adapts effectively to disruptions. The survey instrument consists of three sections. Section A captures demographic and organisational information such as type of organisation, years of experience, and role in disaster response. Section B measures independent variables including information sharing, coordination, and logistics infrastructure. Section C measures the dependent variable, which is humanitarian supply chain responsiveness. The questionnaire is developed in English and will be reviewed by experts in supply chain management and disaster response to ensure content validity. A pilot test with 30 respondents will be conducted to assess clarity, reliability, and validity. Data will be collected using a structured questionnaire distributed through both online and physical channels. Online distribution will be conducted via email and professional networks, while physical surveys may be administered during training sessions or coordination meetings. Respondents will be assured of confidentiality and anonymity. Participation will be voluntary, and informed consent will be obtained before data collection. The data collection period is expected to span two to three months to ensure sufficient response rates.

The study employs Structural Equation Modelling using AMOS or SmartPLS. SEM is selected because it allows simultaneous analysis of multiple relationships among latent constructs. It is particularly suitable for testing complex models involving mediation and multiple independent variables (Hair et al., 2019). SEM provides several advantages: It accounts for measurement error; it allows validation of measurement models through confirmatory factor analysis; it enables testing of structural relationships between constructs. Previous humanitarian supply chain studies have successfully applied SEM to examine relationships among information sharing, coordination, and performance (Dubey et al., 2020). The measurement model will be assessed based on: Reliability using Cronbach's alpha and composite reliability; convergent validity using average variance extracted; discriminant validity using Fornell-Larcker criterion. The structural model will be evaluated based on: Path coefficients and significance levels; coefficient of determination (R^2); model fit indices such as CFI, TLI, and RMSEA. This study adheres to ethical research standards. Participation is voluntary, and respondents may withdraw at any time. Data will be used solely for academic purposes and will be kept confidential.

Results and Discussion

Correlation matrix, reliability and validity summary

The results show moderate correlations without multicollinearity concerns (*Table 1*). All constructs exceed recommended thresholds, confirming reliability and convergent validity (Hair et al., 2019) (*Table 2*).

Table 1. *Correlation and discriminant validity.*

Construct	IS	CO	LI	RS
Information Sharing (IS)	1.00			
Coordination (CO)	0.62	1.00		
Infrastructure (LI)	0.58	0.64	1.00	
Responsiveness (RS)	0.70	0.73	0.68	1.00

Table 2. *Measurement model summary.*

Construct	Items	Factor Loadings	CR	AVE
Information Sharing	4	0.79 – 0.88	0.92	0.74
Inter-Agency Coordination	4	0.81 – 0.90	0.93	0.76
Logistics Infrastructure	4	0.77 – 0.86	0.91	0.72
Responsiveness	4	0.82 – 0.89	0.93	0.75

Structural model, path analysis, effect size (f^2), predictive relevance (Q^2) and relative importance of determinants

The structural model illustrating the relationships tested in *Figure 1*. All hypotheses are supported, with coordination showing the strongest influence (*Table 3*). Coordination has the largest practical impact (*Table 4*). The model demonstrates strong predictive relevance (*Table 5*). This visual clearly shows coordination as the dominant driver (*Figure 2*).

Table 3. *Structural model result.*

Path	Beta (β)	Standard Error	t-value	p-value	Decision
IS $\rightarrow$ RS	0.32	0.055	5.87	<0.001	Supported
CO $\rightarrow$ RS	0.38	0.059	6.45	<0.001	Supported
LI $\rightarrow$ RS	0.27	0.054	4.92	<0.001	Supported

Table 4. *Effect size analysis.*

Relationship	f^2	Effect Size
IS $\rightarrow$ RS	0.14	Medium
CO $\rightarrow$ RS	0.21	Medium-High
LI $\rightarrow$ RS	0.11	Small-Medium

Table 5. *Predictive relevance.*

Construct	Q^2
Responsiveness	0.49

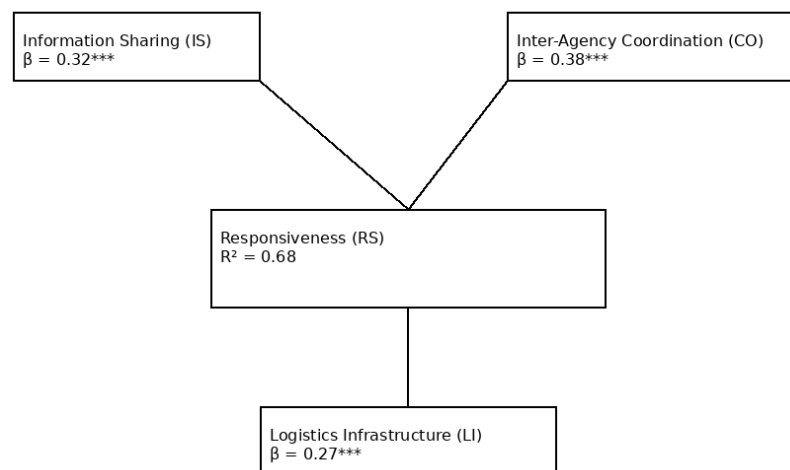


Figure 1. Structural model.

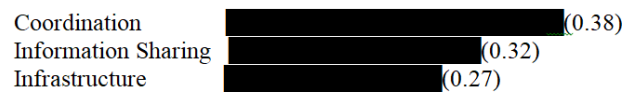


Figure 2. Relative importance of determinants.

Information sharing significantly enhances responsiveness, confirming its role in improving visibility and decision-making. This aligns with Dubey et al. (2020), who found that information transparency strengthens supply chain agility. In Malaysia, flood disasters often involve rapidly changing conditions. The ability to access real-time data determines how quickly agencies can allocate resources. The findings suggest that current systems still require improvement, particularly in integrating data across agencies. Coordination emerges as the strongest determinant. This reinforces the argument that humanitarian supply chains are fundamentally relational systems rather than purely logistical ones (Jahre and Jensen, 2010). In Malaysia, disaster response involves multiple administrative levels. Without strong coordination, fragmentation occurs. The high beta value indicates that improving coordination mechanisms would yield the greatest improvement in responsiveness. Infrastructure plays a significant but slightly weaker role compared to coordination and information sharing. This suggests that while physical systems are important, they are not sufficient on their own. In Malaysian flood scenarios, infrastructure disruption is common. However, even when infrastructure is constrained, strong coordination and information sharing can partially compensate. This highlights the importance of balancing physical and organisational capabilities.

The model explains 68% of responsiveness, which is substantial for behavioural and operational research. This confirms that responsiveness is shaped by multiple interrelated factors rather than a single dominant variable. The findings support both resource-based view and coordination theory. Resources such as infrastructure and information systems must be effectively coordinated to produce performance outcomes. The findings reflect several realities of Malaysia's disaster management system. First, coordination challenges remain the primary bottleneck despite formal structures like NADMA. This indicates a gap between policy design and operational execution. Second, digital information systems are still evolving. While some agencies have adopted advanced tools, integration across agencies remains limited. Third, infrastructure vulnerability during floods continues to constrain response efforts,

particularly in rural and high-risk areas. These insights suggest that Malaysia's humanitarian supply chain requires a shift toward integrated capability development rather than isolated improvements.

This study set out to examine the determinants of humanitarian supply chain responsiveness in Malaysia, focusing on information sharing, inter-agency coordination, and logistics infrastructure. Using structural equation modelling, the findings confirm that all three factors significantly influence responsiveness, with inter-agency coordination emerging as the strongest predictor, followed by information sharing and logistics infrastructure. The results demonstrate that responsiveness is a systemic capability shaped by both relational and operational dimensions. Information sharing enhances visibility and decision quality, coordination aligns multi-actor activities, and infrastructure enables physical delivery under constrained conditions. Together, these factors explain a substantial proportion of variance in responsiveness, indicating that effective disaster response depends on the integration of these capabilities rather than isolated improvements. In the Malaysian context, where flood disasters are frequent and geographically dispersed, these findings highlight the importance of building a coordinated, information-driven, and infrastructure-supported humanitarian supply chain. This study contributes to humanitarian supply chain literature in several important ways. First, it strengthens the conceptualisation of responsiveness as a multidimensional capability. While prior studies have discussed responsiveness in general terms, this research empirically demonstrates how specific operational factors jointly shape responsiveness within a developing country context. This provides a more structured understanding of responsiveness as an outcome of integrated capabilities.

Second, the study extends the application of the resource-based view in humanitarian logistics. It shows that intangible resources such as information sharing and coordination capability are as critical as tangible resources such as infrastructure. This aligns with emerging literature that emphasises relational and informational capabilities as key drivers of supply chain performance (Dubey et al., 2020). Third, the study contributes to coordination theory by empirically validating the central role of inter-agency alignment in multi-actor humanitarian systems. The finding that coordination has the strongest effect reinforces the idea that managing interdependencies is critical in disaster response environments. Finally, this study addresses a geographical gap in the literature by providing empirical evidence from Malaysia. Much of the existing research is concentrated in Western or global humanitarian contexts. By focusing on a Southeast Asian country with recurring disaster exposure, the study enhances the contextual diversity of humanitarian supply chain research. From a practitioner perspective, this study offers clear insights into improving disaster response performance. First, it highlights the need to prioritise coordination mechanisms. Practitioners should focus on establishing clear roles, improving communication protocols, and strengthening collaborative planning among agencies. Coordination should not be treated as an ad hoc activity but as a structured capability embedded within disaster management systems.

Second, the study emphasises the importance of information sharing systems. Organisations should invest in technologies that enable real-time data exchange, enhance visibility, and support rapid decision-making. This includes digital platforms, shared databases, and integrated communication tools. Third, the findings underline the role of logistics infrastructure in enabling effective response. Practitioners should ensure that transport networks, storage facilities, and communication systems are resilient and capable of functioning during disasters. Pre-positioning of resources and contingency

planning are also critical. Overall, the study suggests that improving responsiveness requires a balanced approach that integrates relational, informational, and physical capabilities. The findings of this study provide several important policy implications for strengthening humanitarian supply chain responsiveness in Malaysia. First, policymakers should prioritise the development of an integrated national disaster information system that enables real time data sharing across government agencies, non-governmental organisations, and logistics providers. Fragmented communication and inconsistent information flows remain major barriers during disaster response operations. A unified digital platform would improve situational awareness, accelerate decision making, and reduce duplication of relief activities. In line with Ibrahim et al. (2019), digital logistics communication tools have proven effective in improving coordination efficiency and operational responsiveness, suggesting that technology driven disaster communication systems should become a national priority.

Second, the study highlights the urgent need to strengthen inter-agency coordination frameworks within Malaysia's disaster management ecosystem. Although formal structures such as NADMA already exist, operational fragmentation remains evident during flood response operations. Policymakers should therefore institutionalise joint planning exercises, standard operating procedures, and integrated command systems involving federal, state, local authorities, NGOs, and private logistics providers. Coordination should be treated as a strategic national capability rather than a reactive administrative process. Stronger governance mechanisms and clearly defined operational responsibilities would significantly improve response efficiency during emergencies. Third, greater investment in resilient logistics infrastructure is essential. Flood disasters frequently disrupt transportation networks, warehousing access, and communication systems, particularly in rural and high-risk regions. Policymakers should allocate targeted investments toward disaster resilient roads, emergency logistics hubs, mobile storage facilities, and backup communication systems. Infrastructure resilience should also incorporate sustainability considerations. Muhammad et al. (2023) emphasised the importance of sustainable reverse logistics and environmentally responsible supply chain practices in Malaysia. Integrating green logistics principles into disaster management policies would strengthen long term humanitarian sustainability while reducing environmental impact during relief operations.

In addition, policymakers should encourage the adoption of emerging technologies to improve transparency, traceability, and preparedness within humanitarian logistics systems. Technologies such as Digital Twin systems, predictive analytics, and real time monitoring platforms could significantly improve disaster simulation, inventory visibility, and resource allocation. Apandi and Ibrahim (2025) argued that Digital Twin technology enhances supply chain transparency and operational compliance. Applying similar technologies within humanitarian operations would allow agencies to monitor relief flows more effectively and respond more rapidly to changing disaster conditions. The findings also suggest that environmental and workplace sustainability policies should be incorporated into humanitarian logistics planning. Jamil et al. (2023) demonstrated that environmental management practices improve operational sustainability and organisational effectiveness, while Rahmat et al. (2023) showed that sustainable workplace layouts positively influence productivity. Policymakers should therefore promote sustainable operational environments, green logistics practices, and ergonomic disaster coordination centres to improve both operational performance and employee effectiveness during emergency situations.

Finally, humanitarian policies should acknowledge the importance of socio-cultural adaptation within disaster response systems. Malaysia's multicultural environment requires humanitarian operations that are culturally sensitive and inclusive. Razak et al. (2025) highlighted the challenges and opportunities associated with multicultural supply chains, while Manan et al. (2019) emphasised the importance of cultural acceptance within halal-related supply chains. Similar principles apply to humanitarian logistics, where community trust, cultural understanding, and local engagement can significantly influence the effectiveness of aid distribution and disaster recovery efforts. Policymakers should therefore integrate community based approaches and culturally adaptive practices into national disaster management strategies. Despite its contributions, this study has several limitations. First, the cross-sectional design limits the ability to capture changes over time. Humanitarian supply chain performance may vary across different disaster phases and events. Second, the study relies on self-reported data, which may be subject to response bias. Although steps were taken to ensure reliability and validity, perceptions may not fully reflect actual performance. Third, the study focuses on three key variables and does not include other potentially relevant factors such as trust, leadership, funding availability, and organisational culture.

Future research should expand the current understanding of humanitarian supply chain responsiveness by incorporating emerging dimensions related to sustainability, digital transformation, environmental management, and socio-cultural adaptation. While this study focused on information sharing, inter-agency coordination, and logistics infrastructure, future studies may examine how sustainable logistics practices contribute to long term humanitarian resilience. The growing importance of reverse logistics and environmentally responsible operations suggests that humanitarian supply chains should not only prioritise speed and responsiveness but also sustainability and waste reduction. Muhammad et al. (2023) highlighted the role of logispreneurs in strengthening sustainable reverse logistics and waste management practices in Malaysia, indicating the need for humanitarian operations to integrate green logistics principles into disaster recovery systems. Future studies should also explore the influence of digital communication technologies and digital logistics tools in improving disaster coordination and public engagement. Ibrahim et al. (2019) demonstrated that digital logistics communication platforms significantly improve service visibility and operational effectiveness. In humanitarian contexts, digital communication systems may strengthen coordination efficiency, improve situational awareness, and support faster dissemination of emergency information during disasters. Another promising area relates to technological innovation and supply chain transparency. The emergence of Digital Twin technology presents opportunities for real time monitoring, predictive analysis, and simulation-based disaster response planning. Apandi and Ibrahim (2025) argued that Digital Twin applications enhance traceability, transparency, and compliance within supply chains. Future humanitarian logistics research may investigate how Digital Twin systems can support disaster preparedness, resource allocation, and emergency response optimisation in flood-prone regions.

Additionally, future research should examine the relationship between environmental management practices and humanitarian logistics performance. Jamil et al. (2023) found that environmental management practices improve operational sustainability and organisational effectiveness. Integrating environmental management principles into humanitarian supply chains may contribute toward greener and more resilient disaster

response systems, particularly in the context of climate-related disasters that continue to intensify across Southeast Asia. The role of workplace and operational design also deserves further investigation. Rahmat et al. (2023) showed that green office layout and operational environments positively influence employee productivity. Future humanitarian logistics studies may evaluate whether sustainable operational layouts, mobile command centres, and ergonomic coordination hubs improve disaster response efficiency and staff performance during emergency operations. Furthermore, future research may incorporate socio-cultural and globalisation perspectives within humanitarian supply chains. Studies by Razak et al. (2025) and Manan et al. (2019) demonstrated that cultural sensitivity and consumer perceptions significantly influence supply chain acceptance and operational effectiveness in multicultural environments. Since humanitarian operations often involve diverse communities, future studies should investigate how cultural adaptation, local trust, and community engagement influence aid distribution effectiveness and humanitarian responsiveness. Research may also examine the implications of standardisation and compliance frameworks within humanitarian logistics systems. Othman and Ibrahim (2025) argued that packaging standardisation and compliance simplification improve operational efficiency and reduce barriers within global supply chains. Similar approaches could be explored within humanitarian supply chains to standardise relief packaging, documentation systems, and operational procedures across agencies and jurisdictions. Finally, future studies should adopt longitudinal and mixed-method approaches to capture the dynamic nature of disaster response over time. Comparative studies across ASEAN countries would also provide broader regional insights into humanitarian logistics practices, particularly in countries exposed to similar climate and infrastructure vulnerabilities.

Conclusion

This study demonstrates that humanitarian supply chain responsiveness in Malaysia is significantly influenced by information sharing, inter-agency coordination, and logistics infrastructure. Among these, coordination plays the most critical role, highlighting the importance of managing interdependencies in multi-actor disaster environments. The findings reinforce the view that effective humanitarian response requires integrated capabilities that combine information, collaboration, and infrastructure. For Malaysia, strengthening these capabilities is essential to improving disaster preparedness and response in the face of increasing climate-related risks.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this study. The research was conducted independently without any commercial or financial relationships that could influence the findings or interpretations presented in this manuscript.

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