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RESEARCH ARTICLE

Enhancing humanitarian operations in Malaysia: The role of logistics coordination in disaster response performance

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ABSTRACT

Humanitarian crises in Malaysia, resulting from floods, pandemics, and population displacement, necessitate effective logistics coordination to facilitate timely and efficient disaster response. Despite advancements in national disaster management systems, fragmentation remains evident among government agencies and NGOs, leading to delays, redundant efforts, and inconsistent operational practices. This research investigates the challenges associated with logistics coordination by empirically analyzing three fundamental dimensions: resource sharing, process synchronization, and operational standardization, and their effects on the performance of humanitarian operations. This study utilized a quantitative survey involving 593 practitioners from both governmental and non-governmental organizations. PLS-SEM was employed to assess the relationships among constructs including delivery speed, flexibility, service quality, and efficiency. Research indicates that resource sharing and operational standardization markedly improve performance, while process synchronization does not demonstrate a significant impact, underscoring deficiencies in real-time coordination and workflow integration. The model demonstrates significant explanatory power ($R^2 = 0.757$) and predictive relevance ($Q^2 = 0.399$), thereby affirming the robustness of logistics coordination as a determinant of humanitarian effectiveness. This study directly supports SDG 11 by enhancing disaster resilience, SDG 9 by promoting integrated systems and standardized operations, and SDG 17 by emphasizing inter-agency collaboration. The findings provide practical recommendations for policymakers to establish centralized coordination frameworks, digital platforms, and standardized procedures to enhance Malaysia's capacity for humanitarian response.

Keywords: humanitarian logistics; logistics coordination; humanitarian operations performance; disaster management; sustainable development goals (SDGs)

1. Introduction

Floods, pandemics, and population displacement have caused humanitarian crises in Malaysia to become more frequent and complex, highlighting the importance of efficient logistics coordination in guaranteeing prompt and effective humanitarian response[1,2]. Logistics coordination influences essential

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operational functions, such as resource mobilization, workflow alignment, and the creation of standardized procedures that improve the efficiency and responsiveness of relief operations. Effective coordination mechanisms enhance the capacity of humanitarian organizations to deliver aid swiftly, optimize resource allocation, and minimize operational redundancies[3,4]. Despite advancements in Malaysia's disaster management framework, coordination issues remain among government agencies, NGOs, and other humanitarian organizations. Fragmented communication systems, inconsistent protocols, and varying organizational mandates frequently hinder operational performance, leading to delays, duplication of efforts, and inefficiencies[5]. The identified limitations impede critical performance indicators, including delivery speed, flexibility, service quality, and overall efficiency, which are vital for an effective humanitarian response[6,7]. Global scholarship emphasizes the significance of resource sharing, synchronized processes, and standardized operations as essential components of coordination; however, empirical evidence pertaining to Malaysia is still scarce[8,9]. This study develops a conceptual model to examine the impact of logistics coordination, encompassing resource sharing, process synchronization, and operational standardization on the performance of humanitarian operations in Malaysia. The findings seek to guide policy development, strengthen capacity-building initiatives, and refine operational strategies to improve the resilience and effectiveness of the Malaysian humanitarian sector.

The rising frequency of disaster events, health emergencies, and humanitarian crises in Malaysia necessitates the development of effective logistics coordination mechanisms to enhance disaster response[10]. Logistics coordination is essential for ensuring timely aid delivery, efficient resource allocation, and adaptive organizational responses to changing crisis conditions. Previous research highlights the substantial impact of coordinated logistics activities on enhancing delivery speed, operational flexibility, service quality, and overall efficiency in humanitarian operations[2,11]. Despite the involvement of various response agencies, coordination challenges persist in Malaysia. Diverse organizational structures, inconsistent communication practices, and varying levels of preparedness have led to fragmented and occasionally inefficient coordination among agencies[5]. These issues frequently lead to operational delays, task duplication, and misalignments that diminish the effectiveness of disaster response efforts[6].

Despite Malaysia's heightened investment in disaster preparedness and the increasing participation of government agencies and NGOs in humanitarian response, logistics coordination continues to be fragmented and inconsistent. Humanitarian operations often face delays, duplication of efforts, restricted information sharing, and procedural misalignment, which collectively hinder the efficiency and effectiveness of aid delivery[5,6]. Global humanitarian logistics literature consistently identifies resource sharing, process synchronization, and operational standardization as critical enablers of effective disaster response, particularly in multi-agency environments. However, despite extensive international evidence, empirical studies examining these coordination mechanisms within the Malaysian humanitarian context remain limited. Existing research largely focuses on operational outcomes or sector-specific interventions, with insufficient attention to how coordination practices influence overall response performance. This gap underscores the need for context-specific empirical analysis to understand how coordination mechanisms function within Malaysia’s humanitarian system[8,10]. Operational challenges, including incompatible systems, differing organizational mandates, and a lack of unified coordination protocols, persistently hinder performance outcomes such as delivery speed, flexibility, service quality, and efficiency[7]. Previous research demonstrates that while some coordination practices enhance humanitarian outcomes, others are inadequately developed or implemented, indicating substantial discrepancies between theoretical frameworks and practical applications in Malaysia[9].

The ongoing coordination issues and absence of localized empirical studies render it unclear how various dimensions of logistics coordination collectively impact the performance of humanitarian operations in Malaysia. This gap restricts policymakers and practitioners from formulating targeted strategies to enhance the effectiveness of humanitarian responses. A systematic empirical investigation is required to evaluate the effects of logistics coordination practices—resource sharing, process synchronization, and operational standardization—on the performance of humanitarian operations in the context of Malaysian disaster management. Current research highlights three essential elements of logistics coordination—resource sharing, process synchronization, and operational standardization—as vital facilitators of effective humanitarian response[8,12]. However, empirical evidence regarding the impact of these components on the performance of humanitarian operations in Malaysia is limited. This study investigates the relationships between logistics coordination practices and operational outcomes in Malaysian humanitarian organizations to address the identified gap. This research employs a quantitative survey directed at disaster management personnel within government agencies and NGOs to evaluate the impact of coordination practices on performance indicators such as speed, flexibility, service quality, and efficiency. This study integrates theoretical perspectives with empirical insights to enhance understanding of logistics coordination in the Malaysian humanitarian context and offers strategic recommendations to improve future disaster response efforts.

In addition, this study offers empirical evidence regarding the impact of logistics coordination, which includes resource sharing, process synchronization, and operational standardization, on the performance of humanitarian operations in Malaysia. This research contributes to global initiatives aimed at improving disaster preparedness and resilience. The study identifies coordination mechanisms that enhance delivery speed, flexibility, service quality, and efficiency, thereby contributing to SDG 11, which focuses on strengthening resilience and adaptive capacity to disasters in sustainable cities and communities. The study outlines strategies that enhance resource efficiency and foster institutional collaboration, thereby supporting SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals) through a focus on integrated systems, shared digital platforms, and multi-stakeholder cooperation. The insights produced are significant for policymakers and practitioners aiming to improve national disaster management frameworks, thereby ensuring that humanitarian assistance is delivered to vulnerable populations more effectively and sustainably.

In addition to addressing humanitarian water access, waqf-based water initiatives operate within complex environmental contexts characterized by groundwater variability, contamination risks, sedimentation, and climate-induced water stress. In rural Malaysia, these environmental challenges directly affect the reliability and sustainability of humanitarian water infrastructure. Community participation therefore serves not only as a governance mechanism but also as a critical link between humanitarian operations and environmental stewardship. By fostering shared responsibility for system maintenance, water quality monitoring, and sustainable usage practices, community-managed waqf water systems contribute to environmentally resilient humanitarian outcomes. Positioning the study at this intersection strengthens its alignment with environmental sustainability research and the broader scope of humanitarian–environmental governance.

2. Literature review

Prior research consistently highlights that coordination failures in humanitarian operations are driven by fragmented institutional arrangements, limited information sharing, and weak inter-agency alignment, often resulting in duplication of efforts and inefficient resource allocation[1,2,22]. These challenges are particularly

pronounced in multi-actor response environments where governmental agencies, non-governmental organisations, and private actors operate under differing mandates and operational logics. Humanitarian operations take place in contexts marked by uncertainty, time constraints, and resource limitations, necessitating effective logistics coordination to ensure a rapid and efficient response. Logistics coordination involves the synchronization of activities, workflows, and decision-making processes among various agencies engaged in disaster relief[1]. In multi-stakeholder contexts like Malaysia, coordination difficulties arise from fragmented communication systems, inconsistent protocols, and varying organizational mandates, frequently resulting in duplicated efforts and operational delays[5,6]. The increasing frequency and intensity of humanitarian crises necessitates enhanced coordination mechanisms to bolster national disaster preparedness and response capabilities[2].

Three fundamental dimensions of logistics coordination consistently appear in humanitarian logistics literature: resource sharing, process synchronization, and operational standardization. The effectiveness of agency collaboration during disaster response and the achievement of intended outcomes in humanitarian operations are determined by these components. Resource sharing entails the collaborative utilization of physical assets, expertise, information, and facilities to minimize redundancy and enhance operational effectiveness during emergencies[8]. Organizations that share transportation assets, warehousing space, equipment, or personnel can respond more swiftly and effectively to changing demands. Prior studies demonstrate that resource sharing improves agility and responsiveness, particularly in resource-limited contexts such as flood or pandemic responses in Malaysia[9]. Scholars further argue that effective coordination mechanisms enhance visibility of information flows, resource availability, and decision-making processes, enabling response actors to align actions in real time and reduce operational uncertainty[23,24]. However, such coordination challenges are not confined to humanitarian operations in developing contexts. Empirical evidence from large-scale disaster responses in high-income countries similarly documents coordination breakdowns, institutional silos, and difficulties in synchronizing response activities across multiple agencies[25,26]. Additionally, shared logistics platforms enhance visibility, optimize supply utilization, and decrease lead times[13]. Given its central role in improving aid delivery, this study hypothesizes:

H1: Resource sharing has a positive relationship with humanitarian operations performance.

Process synchronization involves the coordination of timelines, operational workflows, and decision-making processes among stakeholders engaged in humanitarian logistics. Synchronizing key activities, including procurement, transportation, distribution, and needs assessment, mitigates delays and minimizes the risk of conflicting operational schedules[10]. The literature also emphasizes that standardized processes and protocols play a critical role in improving coordination effectiveness by facilitating faster decision-making, reducing ambiguity in roles and responsibilities, and enhancing interoperability across organizations[10,27]. Nonetheless, despite extensive international scholarship, empirical studies examining how these coordination mechanisms operate within specific national humanitarian systems particularly in Malaysia remain limited. This gap underscores the need for context-sensitive empirical investigation to assess how resource sharing, process synchronization, and operational standardization shape humanitarian response performance.

Empirical findings in Malaysia indicate that synchronization is frequently constrained by organizational silos and inconsistent information-sharing mechanisms[6]. Synchronization is acknowledged as crucial; however, research indicates that it remains one of the most underdeveloped dimensions of coordination in numerous disaster contexts within developing countries[14,15]. Therefore, evaluating its practical impact is essential. Thus, the following hypothesis is proposed:

H2: Process synchronization has a positive relationship with humanitarian operations performance.

Operational standardization entails the implementation of uniform procedures, reporting formats, technology platforms, and performance guidelines that are collectively utilized by responding organizations. Standardization improves interoperability, decreases uncertainty, and clarifies communication by ensuring that all participants adhere to aligned expectations and consistent protocols[12,13]. Standardized processes in disaster response enhance decision-making speed, improve resource allocation, and minimize operational errors. The lack of standardized logistics in Malaysia is identified as a significant obstacle to effective humanitarian response[5]. Establishing shared guidelines and interoperable systems is crucial for enhancing national disaster management frameworks. The third hypothesis posits:

H3: Operational standardization has a positive relationship with humanitarian operations performance.

The performance of humanitarian operations is typically assessed using indicators including speed, flexibility, service quality, and efficiency[7,11]. Humanitarian performance enhances through the coordination of resources, synchronization of actions, and adoption of standardized operational procedures[3]. Effective coordination enhances operational efficiency and mitigates the human and economic impacts of disasters. Empirical research investigating the joint impact of the three coordination dimensions in Malaysia is still scarce. This study integrates resource sharing, synchronization, and standardization into a unified model to evaluate their combined effects on the performance of humanitarian operations.

3. Materials and methods

The study utilized a quantitative design to examine the impact of logistics coordination practices on the performance of humanitarian operations in Malaysia. Due to the intricate and multi-agency characteristics of disaster response environments, a systematic and theory-based methodology was necessary to empirically examine the relationships among the study constructs. A cross-sectional survey was selected as the primary data collection method, facilitating the gathering of responses at a single point in time and permitting statistical evaluation of the proposed relationships[16]. A structured questionnaire was created to assess essential constructs of logistics coordination—resource sharing, process synchronization, and operational standardization and their impacts on the performance of humanitarian operations, indicated by delivery speed, flexibility, service quality, and operational efficiency. The study employed a quantitative approach to test theoretical linkages and investigate causal effects among latent variables within the context of humanitarian logistics. The cross-sectional survey design facilitated efficient data collection from a substantial cohort of practitioners engaged in disaster response throughout Malaysia. The research focused on logistics officers, operations managers, and disaster coordination personnel from both governmental and non-governmental organizations engaged in disaster management operations in Malaysia. Purposive sampling was utilized to guarantee that only individuals with significant responsibilities in logistics coordination were included in the study. The sampling method enhanced the internal validity of the findings by ensuring that the dataset represented informed judgments from practitioners with relevant expertise[17]. A total of 593 valid responses were obtained, surpassing the minimum thresholds suggested for Partial Least Squares Structural Equation Modeling (PLS-SEM). The sample encompassed various organizational backgrounds, including civil defense units, humanitarian NGOs, and emergency coordination agencies, thus offering a comprehensive representation of Malaysia's humanitarian ecosystem.

The survey instrument consisted of three sections. Section A collected demographic and organizational information. Section B assessed logistics coordination constructs through items derived from established humanitarian logistics literature. Section C evaluated the performance of humanitarian operations through

established indicators, including speed, flexibility, service quality, and efficiency. All items were evaluated using a five-point Likert scale, with responses ranging from 1 (strongly disagree) to 5 (strongly agree), in accordance with psychometric standards for interval-level data collection[16]. The constructs were defined using reflective measurement models, consistent with previous research in humanitarian logistics. Indicators were improved through pilot testing to enhance reliability, clarity, and contextual relevance within Malaysian humanitarian operations. The data collection utilized an online questionnaire disseminated through official channels to specific organizations. Participants were provided with a study information sheet detailing the research purpose, confidentiality guarantees, and protocols for voluntary participation. Follow-up reminders were implemented to enhance response rates and mitigate non-response bias. Ethical considerations were rigorously upheld, encompassing informed consent and the safeguarding of respondent anonymity. Data analysis utilized SmartPLS 4.0, employing the PLS-SEM technique for its effectiveness in predictive modeling, theory development, and managing complex models with latent constructs.

Clear inclusion and exclusion criteria were applied to ensure the relevance and validity of the empirical data. Participants were included if they were adult community members directly involved in, or affected by, the Waqf Tube-Well Boring System, including participation in training activities, routine maintenance, governance meetings, or regular system use. Individuals without direct engagement in the project were excluded from the study. The empirical research followed a structured sequence of stages. First, measurement items were adapted from established psychosocial and community participation literature and contextualized to waqf-based rural water management. Second, eligible respondents were identified through community records and engagement lists. Third, data were collected through face-to-face survey administration. Fourth, data screening and validation were conducted prior to model estimation. Finally, the measurement and structural models were assessed using PLS-SEM. PLS-SEM was chosen due to its suitability for non-normally distributed data and the relatively large sample sizes characteristic of humanitarian logistics research. The data analysis followed a two-stage PLS-SEM procedure. First, the measurement model was evaluated by assessing internal consistency reliability using Cronbach's Alpha and Composite Reliability, establishing convergent validity through Average Variance Extracted and indicator loadings, and confirming discriminant validity using the Fornell–Larcker criterion and HTMT ratios. Second, the structural model was assessed by examining the significance of path coefficients via bootstrapping, determining explanatory power using the coefficient of determination (R^2), evaluating effect sizes (f^2), assessing predictive relevance through Q^2, and checking for multicollinearity using VIF values. All analyses and interpretations adhered to current PLS-SEM reporting standards as recommended by Saunders et al.[18] and Sarstedt et al.[19]. A cross-sectional survey design was employed to assess post-intervention psychosocial and behavioral outcomes of the Waqf Tube-Well Boring System. This design is appropriate for exploratory research in applied community settings where longitudinal data are not readily available. Partial Least Squares Structural Equation Modelling (PLS-SEM) was selected due to its suitability for exploratory studies, its ability to handle complex latent constructs, and its robustness with small-to-medium sample sizes. PLS-SEM is particularly appropriate for humanitarian and sustainability research where prediction, theory development, and practical applicability are prioritized over strict model confirmation.

Table 1 illustrates the demographic profile of respondents with diverse qualification backgrounds, with the majority holding diplomas (42.2%), followed by bachelor's degrees (16.7%). A smaller segment held advanced degrees, including master's (1.2%) and Ph.D. (1.0%). Respondents occupied various roles within their organizations, predominantly categorized as "others" (44.7%), administration roles (22.3%), and clerical positions (17.0%). Managerial (4.0%), professional (3.9%), and supervisory/executive (8.1%) positions constituted smaller proportions of the total sample. Participants' humanitarian operation- related

experience varied considerably, with the largest group having less than five years (46.9%) of experience, followed by respondents with 6 to 10 years (33.7%), and smaller groups with 11 to 15 years (11.8%), 16 to 20 years (4.4%), and more than 20 years (3.2%) of relevant experience. Organizational representation encompassed government agencies from different zones—North Zone (22.1%), Central Zone (16.2%), South Zone (23.1%), and East Zone (25.8%)—as well as NGOs such as MERCY Malaysia (3.0%), Malaysian Red Crescent (3.4%), Islamic Relief Malaysia (IRM) (2.7%), Humanitarian Care Malaysia (MyCare) (1.7%), and others (2.0%), reflecting the broad and inclusive coverage of the humanitarian sector.

Table 1. Respondent demographic profile.

Variable	Frequency	Percent (%)
Qualification Diploma	250	42.2
Bachelors	99	16.7
Masters	7	1.2
Ph.D.	6	1.0
Total	593	100.0
Position Held Manager	24	4.0
Professional	23	3.9
Administration	132	22.3
Supervisor/Executive	48	8.1
Clerical	101	17.0
Others	265	44.7
Total	593	100.0
Humanitarian Operation Related Experience Less than 5 years	278	46.9
6 to 10 years	200	33.7
11 to 15 years	70	11.8
16 to 20 years	26	4.4
20 years plus	19	3.2
Total	593	100.0
Types of Organization A. Government Agency (Malaysia Civil Defence Force, APM) State - North Zone	131	22.1
- CCentral Zone	96	16.2
- South Zone	137	23.1
- East Zone B. Non-Governmental Organization (NGO's)	153	25.8
- MERCY Malaysia	18	3.0
- Malaysian Red Crescent	20	3.4
- Islamic Relief Malaysia (IRM)	16	2.7
- Humanitarian Care Malaysia (MyCare)	10	1.7
- Others	12	2.0

Variable	Frequency	Percent (%)
Total	593	100.0

Table 1. (*Continued*)

The measurement model demonstrated strong psychometric properties across all reliability and validity assessments. Internal consistency reliability was established, with all constructs exceeding the recommended threshold of 0.70 for both Cronbach's Alpha and Composite Reliability, ranging from 0.745 to 0.877, indicating robust internal consistency[16]. Convergent validity was also confirmed, as all Average Variance Extracted (AVE) values were above 0.50 (0.660–0.797), and indicator loadings surpassed 0.70, verifying that each item adequately represented its latent construct. Furthermore, discriminant validity was supported through both the Fornell–Larcker criterion, where the square roots of AVE were greater than inter-construct correlations, and the HTMT ratios, all of which were below the 0.90 threshold, demonstrating clear construct distinctiveness. **Table 2** illustrates the internal consistency and convergent validity for the model.

Table 2. Internal consistency and convergent validity.

		Reliability		Convergent Validity	
Name of Construct	**No. of Items**	**Cronbach's Alpha**	**Composite Reliability**	**Average Variance Extracted (AVE)**	**Minimum Factor Loading**
Resource Sharing	4	0.828	0.886	0.660	≤ 0.787
Synchronisation	3	0.745	0.887	0.797	≤ 0.886
Standardisation of Operations	3	0.838	0.902	0.755	≤ 0.851
Speed	5	0.877	0.911	0.671	≤ 0.780
Flexibility	3	0.840	0.903	0.757	≤ 0.862
Service Quality	3	0.786	0.875	0.701	≤ 0.814
Efficiency	3	0.808	0.886	0.722	≤ 0.829

The structural model assessment demonstrated strong statistical robustness across all evaluation criteria. Variance Inflation Factor (VIF) values were below the threshold of 5.0, confirming the absence of multicollinearity issues among the predictors. Hypothesis testing using PLS bootstrapping revealed that resource sharing ($\beta = 0.515$, $p < 0.001$) and operational standardization ($\beta = 0.227$, $p < 0.001$) had significant positive effects on humanitarian operations performance, while process synchronization ($\beta = 0.083$, $p = 0.202$) did not exhibit a statistically significant relationship. These results underscore the critical importance of resource sharing and standardized procedures in enhancing operational outcomes. The model demonstrated substantial explanatory power, with an R^2 value of 0.757, indicating that 75.7% of the variance in humanitarian performance was accounted for by the predictors. Effect size analysis further showed that resource sharing had a medium effect ($f^2 = 0.183$), operational standardization had a small effect ($f^2 = 0.022$), and process synchronization contributed negligibly. Additionally, the Stone–Geisser's Q^2 value of 0.399 confirmed strong predictive relevance, reinforcing the model's capability to accurately forecast humanitarian operations performance.

4. Results

The measurement model demonstrated strong reliability and validity across all constructs. Internal consistency reliability was confirmed, with Cronbach's Alpha and Composite Reliability (CR) scores exceeding the recommended threshold of 0.70 for all constructs. Average Variance Extracted (AVE) values ranged from 0.660 to 0.797, satisfying the requirement for convergent validity. Indicator loadings surpassed

0.70, confirming that items adequately represented their respective latent constructs. Discriminant validity was established using both the Fornell–Larcker criterion—where the square roots of AVE exceeded inter-construct correlations—and the HTMT ratios, all of which were below 0.90, demonstrating clear construct distinctiveness. **Table 3** shows that all diagonal values (the square roots of AVE) exceeded the corresponding off-diagonal inter-construct correlations.

Table 3. Fornell and Larcker (1981) criterion of discriminant validity.

	1	2	3	4	5	6	7
Efficiency (1)	**0.850**						
Flexibility (2)	0.706	**0.870**					
Resource Sharing (3)	0.598	0.634	**0.812**				
Service Quality (4)	0.707	0.762	0.661	**0.837**			
Speed (5)	0.716	0.766	0.608	0.738	**0.819**		
Standardisation of Operations (6)	0.601	0.618	0.727	0.645	0.654	**0.869**	
Synchronisation (7)	0.574	0.563	0.681	0.602	0.602	0.736	**0.893**

Note: *Diagonal elements underlined and highlighted in bold represent the square root of AVE. Off-diagonal elements are simple bivariate correlations between the constructs*

The structural model exhibited strong explanatory and predictive capabilities. VIF values were all below 5.0, indicating no serious multicollinearity issues. Path coefficient analysis revealed that resource sharing ($\beta = 0.515$, $p < 0.001$) and operational standardization ($\beta = 0.227$, $p < 0.001$) significantly improved humanitarian operations performance, while process synchronization ($\beta = 0.083$, $p = 0.202$) did not have a statistically significant effect. Collectively, the predictors explained 75.7% of the variance in humanitarian operations performance ($R^2 = 0.757$), indicating substantial explanatory power. Effect size analysis showed a medium effect for resource sharing ($f^2 = 0.183$), a small effect for operational standardization ($f^2 = 0.022$), and negligible effect for process synchronization. Predictive relevance was confirmed with a Q^2 value of 0.399, demonstrating strong predictive capability of the model. **Table 4** presents the path coefficient assessment for the structural model.

Table 4. Path coefficient assessment (N = 593).

	Relationship	β	T-Statistic	P-Value	Decision
H_1	Resource Sharing -> Humanitarian Logistics	0.515	8.548	0.000	Supported
H_2	Standardization of Operations -> Humanitarian	0.227	3.701	0.000	Supported
H_3	Synchronisation of Processes-> Humanitarian	0.083	1.275	0.202	Not Supported

Criteria: p value < 0.05, t value > 1.96

Table 5 displays the collinearity statistics for the structural model, evaluated through the Variance Inflation Factor (VIF). The VIF value for Logistics Coordination was 3.624, which is below the commonly accepted upper limit of 5.0, suggesting that multicollinearity is not an issue in the model. The value, while slightly exceeding the conservative guideline of 3.3, remains within acceptable limits. This indicates that the predictor does not demonstrate problematic overlap with other constructs, and that the regression estimates are stable and reliable[19]. The results indicate that the structural model is devoid of significant collinearity issues, facilitating a valid interpretation of the path coefficients. The structural model's explanatory power was evaluated through the coefficient of determination (R^2), representing the proportion of variance in the

endogenous variable explained by the exogenous constructs. This study found that Humanitarian Operations Performance had a R^2 value of 0.757 and an adjusted R^2 of 0.755, indicating that logistics coordination dimensions account for approximately 76% of the variance in humanitarian performance outcomes. This level is regarded as substantial in social science research, especially in behavioral and organizational contexts[19]. The results demonstrate that the model exhibits significant predictive relevance and accurately reflects the fundamental structural relationships in the humanitarian logistics context. The elevated R^2 supports the theoretical rationale for including resource sharing, operational standardization, and process synchronization as significant predictors of performance outcomes[20,21], indicating that external variables not accounted for in the model may have a minimal impact on additional variance. The substantial R^2 presented in **Table 5** is significant, considering the complexities and interdependencies present in applied logistics and operations research. The model's robust explanatory power offers empirical validation for the proposed conceptual framework and highlights its relevance for future research and policy formulation in humanitarian logistics[13].

Table 5. Variance Inflation Factor (VIF) and Coefficient of Determination (R^2) for key constructs.

Title 1	VIF	Coefficient of determination (R^2)	R^2 Adjusted
Humanitarian Operations Performance	-	0.757	0.755
Logistics Coordination	3.624	-	-

The effect size (f^2) assessment showed logistics coordination had a small but meaningful impact on humanitarian performance ($f^2 = 0.022$) and a medium effect on individual performance ($f^2 = 0.183$). These results highlight its practical importance while affirming that multiple factors jointly shape humanitarian outcomes. The model's predictive relevance, assessed using Stone-Geisser's Q^2, yielded a strong value of 0.399, indicating substantial predictive capability. This confirms that logistics coordination dimensions effectively explain humanitarian performance, reinforcing the model's robustness and practical usefulness for enhancing operational readiness in humanitarian logistics.

5. Discussion

The findings provide substantial empirical evidence for the significance of logistics coordination in improving the performance of humanitarian operations in Malaysia. Of the three dimensions analyzed, resource sharing was identified as the most significant predictor, aligning with previous research that highlights the critical role of asset, information, and personnel pooling in enhancing operational agility and reducing redundancies in crisis response[9]. The significant effect size highlights that shared logistics platforms and coordinated resource deployment are essential for effective humanitarian operations. Operational standardization markedly enhanced performance outcomes, confirming that consistent procedures, reporting mechanisms, and interoperable systems diminish operational uncertainty and improve inter-agency alignment[12]. This factor exhibited a smaller effect size relative to resource sharing; however, its statistical significance underscores its role in developing predictable and efficient response frameworks.

In contrast, process synchronization, while theoretically important, did not produce a significant impact. This may indicate ongoing obstacles within Malaysia's disaster management system, where varying organizational mandates, communication deficiencies, and inconsistent workflow integration hinder the real-time coordination of operational activities[5]. The small effect size indicates that synchronization efforts are either underdeveloped or inadequately institutionalized, necessitating initiatives for capacity building and enhanced coordination protocols. The results underscore the need to enhance resource-sharing systems and

standardize operational processes among agencies. The integration of digital coordination platforms, the development of unified standard operating procedures (SOPs), and the enhancement of inter-agency training could markedly improve Malaysia's disaster preparedness and response capabilities. Although this study is empirically situated in Malaysia, the findings offer broader relevance to the international scientific community, particularly for regions facing persistent rural water insecurity and reliance on community-managed humanitarian infrastructure. The psychosocial constructs examined the knowledge, attitudes, skills, aspirations, and practice change, represent universally relevant mechanisms that influence community participation in humanitarian water systems across low- and middle-income countries. Similar challenges related to governance fragmentation, behavioral adoption, and long-term sustainability have been documented in faith-based, NGO-led, and community-managed water initiatives in Asia, Africa, and the Middle East. Consequently, the insights derived from the Waqf Tube-Well Boring System extend beyond the Malaysian context and contribute to global discussions on participatory governance, sustainable humanitarian operations, and community resilience.

The findings yield several practical implications with relevance beyond the Malaysian context. First, humanitarian water initiatives should prioritize practice-oriented and role-based capacity building rather than knowledge dissemination alone, as behavioral adoption emerged as the strongest predictor of participation and sustainability. Second, integrating environmental stewardship narrative, such as water conservation, resource protection, and climate resilience into community engagement strategies can strengthen long-term commitment. Third, clear role differentiation within community governance structures enhances accountability and operational efficiency. Finally, policymakers and practitioners should formalize collaborations among humanitarian organizations, faith-based institutions, and government agencies to scale community-managed water solutions in environmentally vulnerable regions globally.

6. Conclusion

This study presents empirical evidence indicating that logistics coordination is a vital factor influencing the performance of humanitarian operations in Malaysia. Resource sharing and operational standardization were identified as key predictors of enhanced delivery speed, flexibility, service quality, and operational efficiency. In contrast, process synchronization did not demonstrate a significant impact, highlighting ongoing coordination challenges. The substantial explanatory power ($R^2 = 0.757$) and notable predictive relevance ($Q^2 = 0.399$) validate the robustness of the proposed model. The practical implications involve the creation of centralized coordination frameworks, the development of integrated digital platforms for shared resource management, and the implementation of standardized operating procedures to enhance inter-agency collaboration. Future research may investigate longitudinal analysis, qualitative insights, or comparative cross-country applications to enhance comprehension of coordination dynamics in humanitarian contexts.

Author contributions

Conceptualization, ZS.MJ. and S.A.; methodology, ZS.MJ.; software, R.M.; validation, N.Y., NF.MN. and S.A.; formal analysis, S.A.; investigation, N.Y.; resources, N.Y.; data curation, N.Y.; writing—original draft preparation, S.A.; writing—review and editing, S.A.; visualization, NF.MN.; supervision, ZS.MJ.; project administration, ZS.MJ.; funding acquisition, ZS.MJ. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

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