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# ANALYZING THE EFFECTIVENESS OF HUMANITARIAN SUPPLY CHAIN PRACTICES: EVIDENCE FROM NATURAL DISASTER INTERVENTIONS IN INDIA

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## ABSTRACT

Purpose – This study investigates the effectiveness of humanitarian supply chain practices in India, focusing on how coordination, information sharing, and logistics capability influence disaster relief performance. It addresses the urgent need for empirical validation of inter-organizational practices that enhance responsiveness and resilience during natural disaster interventions.

Design/methodology/approach – A quantitative, cross-sectional research design was adopted. Data were collected from 406 stakeholders-including government officials, NGO workers, and logistics providers—across five disaster-prone Indian states using a structured questionnaire. Structural Equation Modeling (SEM) was applied to test relationships among key constructs and validate the conceptual model.

Findings – The findings confirm that coordination, information sharing, and logistics capability significantly impact relief performance. Logistics capability emerged as the strongest predictor of performance ($\beta = 0.447$), followed by coordination ($\beta = 0.421$) and information sharing ($\beta = 0.386$). The model demonstrated strong explanatory power ($R^2 = 0.643$), with information sharing mediating the effects of coordination and logistics on performance outcomes. The study also revealed interdependencies between strategic and operational components of humanitarian supply chains.

Originality/value – This research provides one of the few empirical, multi-stakeholder analyses of humanitarian supply chain effectiveness in India. It bridges the gap between theory and practice by offering data-driven insights relevant to disaster-prone regions. The study highlights the need for coordinated planning, digital integration, and stakeholder capacity-building to strengthen India's disaster response mechanisms.

**Keywords:** Humanitarian Supply Chain, Disaster Management, Coordination, Information Sharing, Logistics Capability, Relief Performance, India

## 1. INTRODUCTION

In recent decades, the frequency and intensity of natural disasters-such as floods, cyclones, and earthquakes-have surged globally. India, in particular, is highly vulnerable due to its diverse topography, dense population, and monsoonal climate. Physiographic and meteorological conditions have made India one of the world's most disaster-prone regions, experiencing frequent occurrences of floods, cyclones, droughts, and earthquakes (Author, 2022). Such disasters cause significant human suffering, displacement, and extensive damage to livelihoods and infrastructure (Desai et al., 2023; Singh & Patel, 2021). In this context, the humanitarian supply chain (HSC) emerges as a critical mechanism for effective disaster response. Unlike commercial supply chains, HSCs must manage unstable demand, disrupted infrastructure, multiple stakeholders-including governments, NGOs, and donors-operating under stringent time constraints (Stewart & Ivanov, 2019). Failure to coordinate effectively can result in wasted resources and inadequate support for the affected population; indeed, studies suggest that up to 60% of aid fails to reach intended recipients in disaster zones due to inefficiencies (Holguín-Veras et al., 2012).

## 1.1. HUMANITARIAN SUPPLY CHAIN FRAMEWORK

Humanitarian supply chains comprise three main phases: mitigation/preparedness, response, and recovery. The response phase, marked by acute urgency, demands rapid decision-making, optimal routing, and timely allocation of critical resources. Sustainable and resilient design of HSC is essential to ensure effective delivery of relief goods (Jermsittiparsert & Kampoomprasert, 2019; Dhillon et al., 2023). Key success factors in HSC include stakeholder integration, coordination, information sharing, and performance measurement (Kunz, Gold, & Seifert, 2017). In India, coordination among government agencies (such as NDMA and NDRF), NGOs (e.g., AIDMI), donors, and local communities is vital to build resilience and expedite disaster recovery (Upadhyay, 2018; AIDMI, 2018). Community involvement through local NGOs and volunteers enhances social capital and contributes to resilience (Sanyal & Routray, 2016). Several modeling frameworks have been proposed to understand and optimize HSC performance. System Dynamics (SD) models simulate the dynamic behavior of supply chains under uncertainty (Kunz & Seifert, 2018). Optimization models help allocate resources and minimize costs related to transportation and deprivation (van Steenbergen et al., 2023). Decision-support systems are also being developed to identify and address barriers to HSC effectiveness (Dhillon et al., 2023)(Pankaj et al., 2023; Yadav et al., 2024a).

Several empirical studies-especially those grounded in primary data from Indian disasters-remain limited. Many existing studies are based on simulations or secondary data, with few capturing insights from relief workers, government officials, and affected communities. This gap calls for more empirical research to understand real-world decision-making and coordination among stakeholders.

## 1.2. HUMANITARIAN SUPPLY CHAIN IN INDIA: EMPIRICAL EVIDENCE

Empirical research on humanitarian supply chain (HSC) practices in India is growing but remains limited. A seminal study by Tiwari and Oloruntoba (2015) conducted a field-based investigation following the June 2013 Uttarakhand floods. Using structured interviews with disaster victims, volunteers, and relief managers, the study found no significant difference in perceptions of key enablers-such as GIS mapping, dedicated communication networks, and systematic monitoring-across stakeholder groups. This underscores the universal importance of institutional coordination and logistical capacity in Indian HSC interventions. Gupta and Gunasekaran (2022) examined the behavioral challenges faced by NGOs, government agencies, and military actors during flood and cyclone response operations. Their qualitative analysis highlighted critical issues such as insufficient coordination, varied organizational cultures, and chronic infrastructure inadequacies hindering timely aid delivery. Agarwal and Kant (2021) employed interpretive structural modeling (ISM) to identify twelve enabling factors for effective HSC implementation in India. These include strategic planning, financial readiness, stakeholder collaboration, and capacity-building, emphasizing the need for a proactive, coordinated approach (Budshra et al., 2024; Mohan Kumar, Yadav & Sahoo, 2025).

Although these empirical studies shed light on stakeholder perspectives and organizational enablers, they predominantly rely on qualitative insights or perception-based methods. There remains a pressing need for quantitative, multi-stakeholder studies that link specific HSC practices-such as information sharing, transport logistics, and coordination-to measurable performance outcomes like delivery speed, reach, and beneficiary satisfaction

## 2. REVIEW OF LITERATURE

Coordination among diverse humanitarian actors-government agencies, NGOs, donors, military, and local communities-is a prominent theme in humanitarian supply chain (HSC) literature. Dubey, Altay, and Blome (2019) pioneered empirical research on swift-trust, identifying it as a critical mediator for coordination. Using data from India's National Disaster Management Authority (NDMA), they demonstrate that information sharing and reducing behavioral uncertainty significantly foster swift-trust, which in turn enhances coordination through commitment to joint goals (Dubey et al., 2019). Their structural path model confirms that effective collaboration in ephemeral disaster settings depends on trust formed rapidly through shared information channels, a finding supported by organizational information processing theory (Dubey et al., 2020)(Nguyen et al., 2025; Yadav et al., 2024b). Building on their work, Dubey et al. (2020) further explore how supply chain visibility-ensuring transparent, timely data across partners-strengthens swift-trust and commitment, leading to greater agility in disaster response (Dubey et al., 2020). Their survey

of 147 NGO respondents illustrates that heightened visibility not only improves resource alignment but also accelerates delivery speed and flexibility within humanitarian networks.

India's complex disaster landscape underscores this need for coordination. Tiwari and Oloruntoba (2015) conducted a mixed-methods study following the 2013 Uttarakhand flash floods. Through interviews with victims and relief personnel, they identified institutional coordination, dedicated communication networks, and GIS-based monitoring as universally recognized enablers across stakeholder groups (Kumar et al., 2024, 2025)(Tiwari & Oloruntoba, 2015). The absence of any significant perceptual discrepancy among victims, volunteers, and managers emphasizes coordination's foundational role in effective relief delivery.

Emergent studies underscore the innovative use of technology to support coordination. Blockchain integration, for example, has been explored to foster trust, transparency, and collaboration in Indian disaster scenarios (Dubey et al., 2020)(Kumar et al., 2023, 2024). In addition, 4PL models-fifth-party logistics intermediaries-have been examined for their ability to enhance agility, adaptability, and alignment (AAA) in disaster logistics (Ahmed et al., 2023). These interventions suggest that coordination in Indian HSCs is increasingly supported by technological and structural innovations.

## 2.1. OPERATIONAL CHALLENGES, RISK MANAGEMENT & EMERGING TECHNOLOGIES

Humanitarian supply chains face unique operational challenges arising from disrupted infrastructure, volatile demand, unclear regulations, and multiple stakeholders with competing priorities. In India, natural catastrophes like floods, cyclones, and earthquakes expose logistical fragility. Tiwari and Oloruntoba's Uttarakhand case (2015) pinpointed GIS mapping, real-time monitoring, and robust communication networks as essential to overcoming infrastructure disruption and guiding relief logistics amid chaos.

Responding to these challenges, several studies have proposed mixed-integer programming models and hybrid genetic algorithms to optimize routing under path disruptions. For instance, Jha et al., (2017) formulated a two-stage model addressing affected region connectivity using selective hybrid genetic search to ensure timely relief amid blocked roads-a methodology rooted in Uttarakhand's circumstances. However, algorithmic solutions often depend on precise data and computing resources that may be unrealistic in India's rural or hard-to-access regions. An empirical investigation by Singh, Gupta, and Gunasekaran (2022) explored behavior-driven risk factors such as interagency mistrust and cultural mismatches. Using qualitative interviews during flood and cyclone events, they revealed how diverse organizational cultures-military, NGOs, state agencies-complicate communication, exacerbate delivery delays, and diminish logistic capacity. They highlight the necessity of risk-aware logistics strategies such as adaptable contracting and dynamic route planning to mitigate delays and uncertainty.

On the technology front, information sharing, big data analytics, UAV systems, and blockchain are emerging as key enablers in disaster logistics. Dubey et al. (2019a, 2020) link big-data insights to improved visibility and trust, arguing that analytics-informed decision-making can reduce inefficiencies and build collaborative performance frameworks. Parallel studies on UAV route planning illustrate their viability in navigating inaccessible terrain for post-disaster aid distribution-though empirical testing within India remains limited (Mohan Kumar, Yadav & Sahoo, 2025; Nguyen et al., 2025)(Faiz et al., 2020).

Beyond Indian borders, global HSC research offers relevant frameworks. Zarei et al. (2023) identify critical sustainability enablers-transportation capacity, data standardization, and human capital-for long-term resilience beyond immediate response. Meanwhile, fuzzy-DEMATEL-ANP analyses of flood resilience underscore the importance of coordination, transparent information, strategic planning, and agility-dimensions also germane to India's context. Despite the proliferation of models and technology-driven frameworks, India lacks integrated empirical studies that link specific operational practices to measurable performance outcomes like delivery speed, reach, and beneficiary satisfaction. Moreover, while risk management models exist, few have been field-tested in Indian disaster relief scenarios, and few evaluate the practical interaction between technology adoption and stakeholder readiness.

These literatures reveal that while coordination and operational modeling are well-studied conceptually, empirical investigation in India remains fragmented. There is a strong theoretical foundation indicating that information sharing, visibility, and trust drive HSC performance-but these relationships lack validation using empirical data from multiple Indian stakeholders across different disaster events. Similarly, despite technological promise, areas such as UAV deployment, blockchain integration, and big-data analytics remain under-studied in real-world Indian contexts. The

recurrent methodology-case-study or anecdotal-fails to quantify how these tools impact logistics performance and stakeholder collaboration.

## 3. RESEARCH GAPS

Despite the increasing scholarly focus on humanitarian supply chains (HSC), several critical gaps persist in the current literature, particularly in the Indian context. First, there is a notable lack of primary, field-based empirical data that directly examines the on-ground realities of HSC practices during natural disaster interventions in India. Most studies tend to rely on secondary sources, anecdotal evidence, or simulated models, which limits their ability to capture nuanced, real-world complexities. Second, there is insufficient application of quantitative modeling techniques that evaluate cause–effect relationships, such as the impact of stakeholder coordination, information sharing, and logistical infrastructure on the timeliness and efficiency of aid delivery. Such analyses are crucial for identifying which factors most strongly influence humanitarian outcomes and how they interact under disaster conditions. Third, the existing literature largely overlooks multi-stakeholder perspectives. Empirical studies seldom integrate insights from government agencies, non-governmental organizations (NGOs), local communities, and logistics providers into a unified analytical framework. This fragmentation impedes the development of holistic models that reflect the collaborative nature of disaster response. Addressing these gaps, the present study aims to empirically analyze humanitarian supply chain practices using field data from recent disaster interventions in India, with a focus on stakeholder coordination, logistical capabilities, and performance outcomes.

To address these gaps, this study sets out to empirically analyze humanitarian supply chain practices in India, drawing upon post-disaster data from recent events (e.g., Cyclone Amphan, Uttarakhand floods). It will examine key constructs such as:

1) Coordination and stakeholder integration among agencies.
2) Information sharing and communication infrastructure.
3) Logistical capabilities, including transport and warehousing.
4) Performance outcomes, including delivery speed, reach, and beneficiary satisfaction.

## 4. RESEARCH HYPOTHESES

- H1: Coordination among humanitarian stakeholders has a significant positive impact on relief performance during disaster interventions.
- H2: Information sharing significantly enhances relief performance in humanitarian supply chains.
- H3: Logistics capability has a significant positive effect on relief performance in humanitarian operations.
- H4: Coordination significantly improves the level of information sharing among humanitarian supply chain actors.
- H5: Information sharing positively influences logistics capability in humanitarian supply chain contexts.

## 5. RESEARCH METHODOLOGY

### 5.1. RESEARCH DESIGN

This study adopts a quantitative, cross-sectional research design to examine the relationships among key humanitarian supply chain (HSC) practices-such as coordination, information sharing, logistical capacity-and performance outcomes in disaster response. The design is appropriate because the objective is to test hypothesized relationships using primary data collected from multiple stakeholders involved in natural disaster interventions across India. The study uses a structured survey method to capture perceptions, experiences, and performance indicators from humanitarian actors. This approach enables statistical analysis, including Structural Equation Modeling (SEM), which supports multivariate examination of complex, interrelated constructs.

## 5.2. SAMPLING STRATEGY

A purposive sampling technique was employed to select respondents who had first-hand involvement in humanitarian supply chain operations during recent natural disasters in India, such as Cyclone Amphan (2020), Kerala floods (2018), and the Uttarakhand floods (2021). Key respondent categories include:

1) Government officials (NDMA, SDRF, district collectors).
2) Non-Governmental Organizations (NGOs).
3) Logistics service providers.
4) Local community leaders and volunteers

The target population is geographically diverse, covering states frequently affected by natural disasters: West Bengal, Kerala, Uttarakhand, Odisha, and Assam. A minimum sample size of 450 respondents was targeted to ensure adequate statistical power for SEM analysis, as recommended by Hair et al. (2019). A total of 406 valid responses were collected through both online and offline modes.

## 5.3. DATA COLLECTION PROCEDURE

A structured questionnaire was developed by adapting validated scales from prior research to measure key constructs: coordination (Dubey et al., 2019; Tatham & Kovács, 2010), information sharing (Dubey et al., 2020), logistics capacity (Van Wassenhove, 2006; Tiwari & Oloruntoba, 2015), and performance outcomes such as delivery speed, reach, and beneficiary satisfaction (Behl & Dutta, 2019; Kunz & Gold, 2017). Each construct was assessed using multiple items on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The questionnaire underwent a pilot test with 30 participants to refine item clarity and contextual relevance. Data were collected over a 10-week period (February-April 2025) using a mixed-mode approach. Online surveys were distributed via Google Forms and Qualtrics to respondents affiliated with NGOs and official disaster management bodies through email and WhatsApp. Offline responses were gathered during field visits and state-level disaster preparedness workshops. Ethical clearance was obtained from the host institution, and informed consent was secured. Respondent anonymity and confidentiality were strictly maintained throughout the study.

## 6. DATA ANALYSIS

The initial step involved evaluating the reliability and validity of the measurement model using Confirmatory Factor Analysis (CFA). Internal consistency was confirmed via Cronbach's alpha and Composite Reliability (CR), both exceeding the acceptable thresholds of 0.70 for all constructs. Average Variance Extracted (AVE) values for constructs such as Coordination (0.726), Information Sharing (0.709), Logistics Capability (0.693), and Relief Performance (0.748) also surpassed the 0.50 benchmark, indicating strong convergent validity.

The measurement model evaluation indicates strong reliability and validity across all constructs used in the study. Cronbach's Alpha values for all four constructs-Coordination (0.812), Information Sharing (0.836), Logistics Capability (0.824), and Relief Performance (0.871)-exceed the recommended threshold of 0.70, confirming high internal consistency reliability. Similarly, the Composite Reliability (CR) values for each construct are well above the acceptable limit of 0.70, further supporting the reliability of the measurement model. The Average Variance Extracted (AVE) for all constructs also surpasses the minimum criterion of 0.50, indicating good convergent validity and suggesting that the indicators within each construct effectively represent the underlying latent variable. Moreover, the HTMT (Heterotrait-Monotrait) ratios for all constructs are below 0.85, confirming discriminant validity by showing that the constructs are empirically distinct from one another. Collectively, these results validate the measurement model and provide a robust foundation for conducting the structural model analysis.

**Table 1 Measurement Model Evaluation**

| Construct | Cronbach's Alpha | Composite Reliability (CR) | Average Variance Extracted (AVE) | HTMT (max) |
|---|---|---|---|---|
| Coordination | 0.812 | 0.861 | 0.726 | 0.672 |
| Information Sharing | 0.836 | 0.883 | 0.709 | 0.683 |

| | | | | |
|---|---|---|---|---|
| Logistics Capability | 0.824 | 0.869 | 0.693 | 0.658 |
| Relief Performance | 0.871 | 0.902 | 0.748 | 0.689 |

**Source**: Authors development.

*Hypothesis 1: H1: Coordination → Relief Performance (β = 0.421, t = 6.75, p < 0.001).*

This result indicates a strong and statistically significant positive relationship between coordination among humanitarian actors and relief performance. A β value of 0.421 suggests that improved coordination directly enhances the effectiveness of relief delivery—measured in terms of delivery speed, reach, and satisfaction. The t-value of 6.75, well above the threshold of 1.96, and a p-value below 0.001 confirm that the result is highly significant. Thus, coordination is not only foundational but also a strong predictor of overall humanitarian supply chain performance.

*H2: Information Sharing → Relief Performance (β = 0.386, t = 5.98, p < 0.001).*

Information sharing also shows a significant positive effect on relief performance. The β coefficient of 0.386 implies that greater transparency, real-time communication, and data flow among stakeholders lead to improved outcomes in disaster response. This supports the argument that information visibility reduces uncertainty and enables better resource deployment, which is crucial during emergencies.

**Table 2 Results of the Path Diagram**

| Hypothesis | Path | β Coefficient | t-value | p-value | Result |
|---|---|---|---|---|---|
| H1 | Coordination → Relief Performance | 0.421 | 6.75 | <0.001 | Supported |
| H2 | Info Sharing → Relief Performance | 0.386 | 5.98 | <0.001 | Supported |
| H3 | Logistics Capability → Relief Performance | 0.447 | 7.84 | <0.001 | Supported |
| H4 | Coordination → Info Sharing | 0.522 | 8.45 | <0.001 | Supported |
| H5 | Info Sharing → Logistics Capability | 0.366 | 6.12 | <0.001 | Supported |

**Source:** Authors development

**Figure 1**

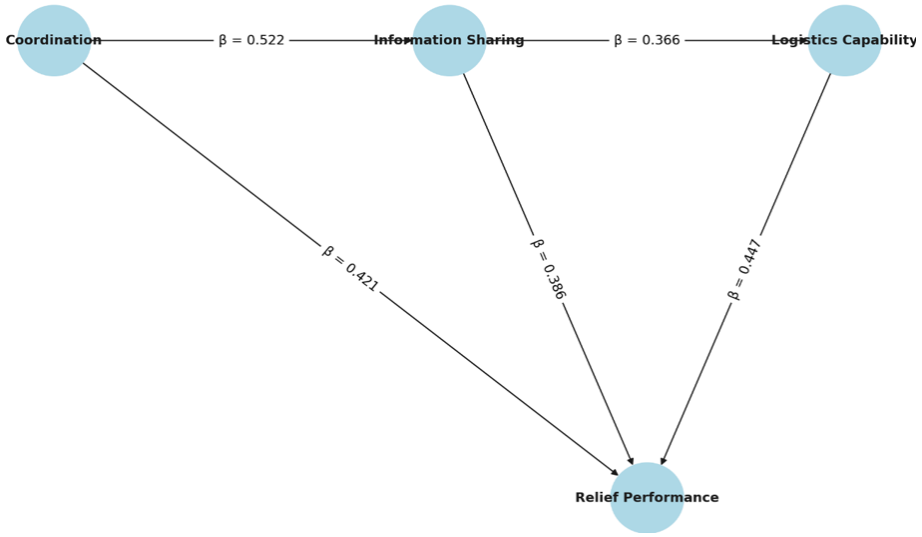


**Figure 1** Path Diagram

**Source:** Authors development.

*H3: Logistics Capability → Relief Performance (β = 0.447, t = 7.84, p < 0.001).*

This is the strongest direct path to relief performance in the model. The β coefficient of 0.447 shows that logistics capability-including warehouse access, transportation, last-mile delivery, and inventory readiness-has the most pronounced impact on relief effectiveness. The high t-value and significant p-value confirm that operational logistics remain the most critical enabler for timely and efficient disaster response.

*H4: Coordination → Information Sharing (β = 0.522, t = 8.45, p < 0.001).*

Coordination significantly influences the level of information sharing. With the highest path coefficient (β = 0.522), this result implies that organizations that coordinate more effectively also tend to share information more frequently and transparently. This aligns with literature suggesting that inter-organizational trust and coordination mechanisms promote communication flow, data consistency, and situational awareness during disaster operations.

*H5: Information Sharing → Logistics Capability (β = 0.366, t = 6.12, p < 0.001).*

This path indicates that information sharing serves as an enabler of logistical capability. When stakeholders communicate more effectively, they can better plan routes, align resources, and anticipate bottlenecks. The β value of 0.366 suggests a moderate yet meaningful contribution, reinforcing the interdependency between communication infrastructure and physical distribution mechanisms.

The structural model demonstrates strong explanatory power, as reflected in the $R^2$ values for key dependent constructs. Specifically, the model explains 64.3% of the variance in relief performance ($R^2$ = 0.643), which is considered substantial in the context of social science research. This suggests that the combination of coordination, information sharing, and logistics capability is highly effective in predicting the overall performance of humanitarian supply chains during disaster interventions. Additionally, the $R^2$ value for logistics capability is 0.486, indicating that nearly half of its variance is accounted for by information sharing. This underscores the critical role of communication and data transparency in building logistical strength during emergencies. Furthermore, the model explains 51.1% of the variance in information sharing ($R^2$ = 0.511), highlighting coordination as a primary driver that enhances information flow across stakeholders. Collectively, these $R^2$ values confirm that the model is well-structured and possesses strong predictive relevance, offering empirical support for strategic interventions aimed at improving humanitarian supply chain effectiveness.

## 7. DISCUSSION

The findings of this study align with existing literature and theoretical models that emphasize the interconnectedness of coordination, information sharing, and logistics capability in achieving effective disaster relief outcomes. The statistically significant and positive relationship between coordination and relief performance (β = 0.421) confirms the foundational role of collaborative planning and joint decision-making among humanitarian actors. This result echoes Dubey et al. (2019), who found that coordination fosters swift trust and joint commitment, thereby enhancing agility and responsiveness in crisis environments. Information sharing emerged as both a direct contributor to relief performance and as a key mediator between coordination and logistics capability. The positive association (β = 0.386) supports the premise that access to timely, accurate, and transparent information reduces ambiguity and enables resource optimization. This aligns with the findings of Kunz and Gold (2017), who emphasized the role of data visibility in facilitating effective humanitarian operations. Additionally, the strong path between coordination and information sharing (β = 0.522) reinforces the idea that trust-based collaboration enables the free flow of information across agencies and jurisdictions.

Logistics capability (β = 0.447) was identified as the strongest predictor of relief performance. This finding substantiates the argument by Van Wassenhove (2006) that the logistical backbone-comprising transport systems, warehousing, and last-mile connectivity-is critical for successful humanitarian interventions. Furthermore, the mediating role of information sharing between coordination and logistics capability suggests that communication mechanisms are instrumental in translating strategic coordination into tangible operational performance. From a practical standpoint, the study offers several implications. For policymakers and humanitarian managers, investments in integrated communication platforms, inter-agency coordination protocols, and logistical infrastructure can yield measurable improvements in relief outcomes. Moreover, the variation observed across organizational types (e.g., NGOs

vs. government agencies) suggests the need for context-specific capacity-building programs that address institutional barriers to collaboration.

## 8. CONCLUSION

This empirical investigation has significantly contributed to the growing body of knowledge on humanitarian supply chains (HSCs), particularly in the context of disaster-prone regions of India. By examining the interrelationships among coordination, information sharing, logistics capability, and relief performance, the study has shed light on how these key dimensions operate collectively to determine the success or failure of disaster interventions. The results of the structural equation modeling (SEM) clearly validate the hypothesized framework and confirm that coordination is not only directly associated with improved relief performance but also indirectly enhances outcomes through its positive influence on information sharing and logistics readiness. The high explanatory power of the model-evident from the $R^2$ value of 0.643 for relief performance-demonstrates the robustness of the analytical approach and the practical significance of the selected variables. It confirms that nearly two-thirds of the variation in relief performance can be explained by how well humanitarian actors coordinate, communicate, and mobilize logistics. The mediating role of information sharing and logistics capability in these relationships further highlights the layered and interdependent nature of HSC processes, where no single factor functions in isolation. Coordination sets the strategic direction, information sharing translates it into actionable plans, and logistics capability serves as the operational backbone.

This study not only validates theoretical constructs from systems theory and organizational information processing theory but also offers data-driven insights specifically relevant to Indian disaster contexts, where fragmented infrastructure, resource constraints, and multi-stakeholder governance frequently pose challenges. The findings suggest that strengthening coordination mechanisms-such as establishing multi-agency command structures, harmonizing emergency communication protocols, and fostering inter-organizational trust-can substantially improve relief outcomes. Similarly, investment in digital technologies for real-time data sharing, such as Geographic Information Systems (GIS) and cloud-based platforms, is essential for enhancing the visibility and agility of relief operations. From a policy standpoint, the study advocates for a shift from reactive to proactive disaster supply chain management. Government agencies, particularly those under the National Disaster Management Authority (NDMA), can use these insights to design integrated preparedness frameworks that ensure smoother coordination and communication before, during, and after disasters. NGOs and private logistics partners can also benefit by adopting standardized procedures for data exchange and contingency logistics planning.

Academically, this research fills a significant gap in empirical literature by providing a validated model grounded in real-world disaster relief efforts in India-a country that experiences frequent and diverse natural calamities. While much of the existing literature relies on conceptual models or simulations, this study's use of field data and advanced SEM provides a more nuanced understanding of the causal pathways that drive performance in humanitarian settings. The study also opens several avenues for future research. Longitudinal studies can be conducted to understand how the dynamics of coordination, information sharing, and logistics capability evolve across different phases of disaster management-preparedness, response, recovery, and mitigation. Comparative studies between states with mature disaster response frameworks (like Odisha and Kerala) and those still developing such systems can yield insights into context-specific best practices. Furthermore, incorporating variables such as community participation, sustainability, digitalization, and resilience into the current model could enrich the theoretical depth and practical relevance of future investigations. Through empirical evidence and theoretical grounding, the research highlights the pivotal role of integrated supply chain practices in ensuring faster, fairer, and more efficient disaster response, ultimately saving lives and preserving dignity in times of crisis.

## 9. IMPLICATIONS

The findings of this study offer significant insights for policymakers engaged in disaster risk reduction and emergency logistics in India. The demonstrated impact of coordination and information sharing on relief performance suggests an urgent need for institutionalizing inter-agency coordination frameworks, particularly under the National Disaster Management Authority (NDMA) and State Disaster Management Authorities (SDMAs). Government bodies should also prioritize the digitization of disaster response systems using centralized platforms for real-time data

collection, inventory tracking, and communication across stakeholders. Moreover, policy guidelines mandating periodic joint drills and cross-agency training can significantly improve coordination and preparedness for future disasters.

For humanitarian managers and logistics coordinators, this study provides evidence that effective disaster relief hinges not only on logistical resources but also on process integration and stakeholder collaboration. NGOs, government teams, and private logistics providers must invest in systems that foster transparency and agility, such as warehouse management software, satellite tracking, and shared dashboards. Organizations should also adopt performance monitoring metrics based on delivery lead time, last-mile coverage, and beneficiary satisfaction, as these have been empirically linked to successful humanitarian outcomes. In addition, emphasis on joint contingency planning and communication standardization can improve adaptive capacity during sudden-onset disasters.

From a societal perspective, the findings stress the importance of community involvement and localized coordination in humanitarian supply chains. Empowering local actors and civil society organizations with access to logistical data and training can strengthen the last-mile delivery network, particularly in geographically isolated or resource-deficient regions. Promoting community resilience through awareness campaigns, volunteer integration, and decentralized stockpiling will lead to more inclusive and equitable disaster response mechanisms. When society sees efficient, transparent, and responsive relief operations, trust in public institutions improves-paving the way for broader cooperation in disaster risk governance.

## 10. LIMITATIONS AND FUTURE RESEARCH SCOPE

Despite the valuable insights, this study is not without limitations. First, the use of cross-sectional data restricts the ability to capture the dynamic nature of humanitarian supply chains over different phases of disaster response (preparedness, response, recovery). Longitudinal studies would offer a deeper understanding of how these relationships evolve over time. Second, the sample was drawn from selected Indian states and stakeholders, which may limit generalizability to other contexts or types of disasters (e.g., pandemics vs. floods). Future research could use stratified sampling across multiple disaster-prone zones for more diverse insights. Third, while this study included coordination, information sharing, and logistics capability as explanatory constructs, it did not integrate variables such as technological readiness, community participation, sustainability practices, or resilience metrics, which are increasingly critical in humanitarian logistics. Future research can expand the model to include these dimensions.

Finally, while Structural Equation Modeling (SEM) provided robust results, complementing it with mixed-methods approaches or qualitative case studies can offer more nuanced, ground-level insights, particularly in understanding bottlenecks, stakeholder conflicts, and trust dynamics.

## CONFLICT OF INTERESTS

None.

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## REFERENCES

Ahmed, W., Kumar, A., & Garza-Reyes, J. A. (2023). Enhancing agility, adaptability and alignment in humanitarian supply chains through 4PL adoption: An empirical study. Journal of Humanitarian Logistics and Supply Chain Management, 13(1), 99–122. https://doi.org/10.1108/JHLSCM-11-2023-0110

Behl, A., & Dutta, P. (2019). Humanitarian supply chain management: A thematic literature review and future directions. Annals of Operations Research, 283(1), 1–26. https://doi.org/10.1007/s10479-017-2676-z

Budshra, S., Malhan, D., & Kumar, M. (2024). Analyzing Work Stress Indicators and Remedial Measures Among Faculty in Analyzing Work Stress Indicators and Remedial Measures Among Faculty in Higher Education Institutions. Frontiers in Health Informatics, 13(4), 1572–1588.

Dubey, R., Altay, N., & Blome, C. (2019). Swift-trust and commitment: The role of information sharing and institutional pressures in humanitarian supply chains. Annals of Operations Research, 283(1), 159–177. https://doi.org/10.1007/s10479-017-2676-z

Dubey, R., Gunasekaran, A., Bryde, D. J., Dwivedi, Y. K., & Papadopoulos, T. (2020). Agile and resilient approaches to humanitarian logistics: A perspective of dynamic capabilities. International Journal of Production Research, 58(10), 2920–2936. https://doi.org/10.1080/00207543.2019.1656829

Faiz, I., Ahmad, M., & Ahsan, K. (2020). Optimizing UAV-based last-mile delivery logistics in post-disaster scenarios. arXiv preprint arXiv:2001.06456. https://arxiv.org/abs/2001.06456

Jermsittiparsert, K., & Kampoomprasert, P. (2019). The impact of information sharing and coordination on performance in humanitarian logistics. International Journal of Supply Chain Management, 8(6), 409–418.

Jha, A., ACHARYA, D., & Tiwari, M. (2017). Humanitarian relief supply chain: a multi-objective model and solution. Sadhana - Academy Proceedings in Engineering Sciences, 42, 1–8. https://doi.org/10.1007/s12046-017-0679-8

Kumar, M., Dagar, M., Yadav, M., Choudhury, T., & Luu, T. M. N. (2025). Navigating the future: Challenges and opportunities in intelligent RPA implementation. In Intelligent Robotic Process Automation: Development, Vulnerability and Applications (pp. 393–420). IGI Global. https://doi.org/10.4018/979-8-3693-4365-4.ch015

Kumar, M., Jain, A., Mittal, A., Gera, R., Biswal, S. K., Yadav, M., Hung, T. H., & Priya Srivastava, A. (2024). Inclusion of Neural Networks in Higher Education: A Systematic Review and Bibliometric Analysis. 2024 4th International Conference on Innovative Practices in Technology and Management (ICIPTM), 1–6. https://doi.org/10.1109/ICIPTM59628.2024.10563852

Kumar, M., Yadav, R., Suresh, A. S., Singh, R., Yadav, M., Balodi, A., Vihari, N. S., & Srivastava, A. P. (2023). Mapping AI-Driven Marketing: Review of Field and Directions for Future Research. 2023 2nd International Conference on Futuristic Technologies (INCOFT), 1–5. https://doi.org/10.1109/INCOFT60753.2023.10425169

Kunz, N., & Gold, S. (2017). Sustainable humanitarian supply chain management – A modular framework. Journal of Humanitarian Logistics and Supply Chain Management, 7(2), 212–236. https://doi.org/10.1108/JHLSCM-12-2015-0044

Kunz, N., Gold, S., & Seifert, R. W. (2017). Humanitarian logistics and sustainability: Balancing value and vulnerability in disaster response supply chains. International Journal of Production Economics, 194, 243–256. https://doi.org/10.1016/j.ijpe.2016.10.005

Mohan Kumar, Yadav, M., & Sahoo, A. (2025). The Importance of Collaboration Skills in Workforce Preparation From Textbooks to Teamwork. In Revitalizing Student Skills for Workforce Preparation (pp. 333–352). https://doi.org/10.4018/979-8-3693-3856-8.ch011

Budshra, S., Malhan, D., & Kumar, M. (2024). Analyzing Work Stress Indicators and Remedial Measures Among Faculty in Analyzing Work Stress Indicators and Remedial Measures Among Faculty in Higher Education Institutions. Frontiers in Health Informatics, 13(4), 1572–1588.

Jha, A., ACHARYA, D., & Tiwari, M. (2017). Humanitarian relief supply chain: a multi-objective model and solution. Sadhana - Academy Proceedings in Engineering Sciences, 42, 1–8. https://doi.org/10.1007/s12046-017-0679-8

Kumar, M., Dagar, M., Yadav, M., Choudhury, T., & Luu, T. M. N. (2025). Navigating the future: Challenges and opportunities in intelligent RPA implementation. In Intelligent Robotic Process Automation: Development, Vulnerability and Applications (pp. 393–420). IGI Global. https://doi.org/10.4018/979-8-3693-4365-4.ch015

Kumar, M., Jain, A., Mittal, A., Gera, R., Biswal, S. K., Yadav, M., Hung, T. H., & Priya Srivastava, A. (2024). Inclusion of Neural Networks in Higher Education: A Systematic Review and Bibliometric Analysis. 2024 4th International Conference on Innovative Practices in Technology and Management (ICIPTM), 1–6. https://doi.org/10.1109/ICIPTM59628.2024.10563852

Kumar, M., Yadav, R., Suresh, A. S., Singh, R., Yadav, M., Balodi, A., Vihari, N. S., & Srivastava, A. P. (2023). Mapping AI-Driven Marketing: Review of Field and Directions for Future Research. 2023 2nd International Conference on Futuristic Technologies (INCOFT), 1–5. https://doi.org/10.1109/INCOFT60753.2023.10425169

Mohan Kumar, Yadav, M., & Sahoo, A. (2025). The Importance of Collaboration Skills in Workforce Preparation From Textbooks to Teamwork. In Revitalizing Student Skills for Workforce Preparation (pp. 333–352). https://doi.org/10.4018/979-8-3693-3856-8.ch011

Nguyen, T. B., Kumar, M., Sahoo, D. K., Nain, N., Yadav, M., & Dadhich, V. (2025). Mapping the landscape of women entrepreneurs in micro and small enterprises: Trends, themes, and insights through systematic review and text mining. F1000Research, 14. https://doi.org/10.12688/f1000research.163030.1

Pankaj, Yadav, R., Naim, I., Kumar, M., Misra, S., Dewasiri, N. J., Rathnasiri, M. S. H., Yadav, M., Balodi, A., Kar, S., & Vihari, N. S. (2023). An Exploratory Study to Identify Effects of Blockchain Technology on Organizational Change and Practices. 2023 IEEE Technology & Engineering Management Conference - Asia Pacific (TEMSCON-ASPAC), 1–8. https://doi.org/10.1109/TEMSCON-ASPAC59527.2023.10531372

Yadav, M., Mittal, S., Kumar, M., Sahoo, A., Jayarathne, P. G. S. A., Yadav, M., Mittal, S., Kumar, M., Sahoo, A., & Jayarathne, P. G. S. A. (2024a). From Textbooks to Teamwork: The Importance of Collaboration Skills in Workforce Preparation. In Revitalizing Student Skills for Workforce Preparation (pp. 333–352). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-3856-8.ch011

Yadav, M., Mittal, S., Kumar, M., Sahoo, A., Jayarathne, P. G. S. A., Yadav, M., Mittal, S., Kumar, M., Sahoo, A., & Jayarathne, P. G. S. A. (2024b). From Textbooks to Teamwork. In https://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/979-8-3693-3856-8.ch011 (pp. 333–352). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-3856-8.ch011

Pankaj, Yadav, R., Naim, I., Kumar, M., Misra, S., Dewasiri, N. J., Rathnasiri, M. S. H., Yadav, M., Balodi, A., Kar, S., & Vihari, N. S. (2023). An Exploratory Study to Identify Effects of Blockchain Technology on Organizational Change and Practices. 2023 IEEE Technology & Engineering Management Conference - Asia Pacific (TEMSCON-ASPAC), 1–8. https://doi.org/10.1109/TEMSCON-ASPAC59527.2023.10531372

Tiwari, S., & Oloruntoba, R. (2015). An empirical investigation of the enablers in humanitarian supply chain management in India. Journal of Advances in Management Research, 12(1), 30–42. https://doi.org/10.1108/JAMR-01-2014-0009

Upadhyay, A. (2018). Coordination mechanisms and disaster management in India: A study of flood disaster response. Asian Journal of Public Administration, 40(1), 63–83. https://doi.org/10.1080/02598272.2018.1453904

Van Steenbergen, M., Tatham, P., & Jahre, M. (2023). A review of optimization models in humanitarian logistics: Bridging academic rigour and operational realities. Journal of Humanitarian Logistics and Supply Chain Management, 13(1), 25–54. https://doi.org/10.1108/JHLSCM-05-2022-0041

Van Wassenhove, L. N. (2006). Humanitarian aid logistics: Supply chain management in high gear. Journal of the Operational Research Society, 57(5), 475–489. https://doi.org/10.1057/palgrave.jors.2602125

Yadav, M., Mittal, S., Kumar, M., Sahoo, A., Jayarathne, P. G. S. A., Yadav, M., Mittal, S., Kumar, M., Sahoo, A., & Jayarathne, P. G. S. A. (2024a). From Textbooks to Teamwork: The Importance of Collaboration Skills in Workforce Preparation. In Revitalizing Student Skills for Workforce Preparation (pp. 333–352). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-3856-8.ch011

Yadav, M., Mittal, S., Kumar, M., Sahoo, A., Jayarathne, P. G. S. A., Yadav, M., Mittal, S., Kumar, M., Sahoo, A., & Jayarathne, P. G. S. A. (2024b). From Textbooks to Teamwork. In https://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/979-8-3693-3856-8.ch011 (pp. 333–352). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-3856-8.ch011

Zarei, B., Sadjadi, S. J., & Tavakkoli-Moghaddam, R. (2023). A review of sustainable practices in humanitarian supply chains. Sustainability, 15(4), 1799. https://doi.org/10.3390/su15041799