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STRATEGIC APPROACHES TO CRITICAL INVENTORY MANAGEMENT FOR DISASTER RESPONSE: GOVERNMENTAL AND NON-GOVERNMENTAL PERSPECTIVES FROM PAKISTAN

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Abstract: Efficient inventory management plays a vital role in humanitarian operations, particularly in disaster-prone regions where the timely delivery of essential supplies can save lives. This study defines critical inventory management as the systematic process of identifying, pre-positioning, and delivering essential relief items including food, water, medical kits, and shelter materials required for effective emergency response. Using a multiple case study approach, this research examines the inventory management practices of two key actors: the Provincial Disaster Management Authority (PDMA), the primary governmental disaster response agency in Khyber Pakhtunkhwa, Pakistan, and a prominent local non-governmental organisation (LNGO). Semi-structured interviews with senior leaders from both organisations reveal significant differences in operational frameworks, resource allocation, and adaptive capacities. The findings indicate that PDMA adopts a proactive, resilience-focused strategy characterised by pre-emptive planning and pre-stocked supplies. In contrast, the LNGO employs a more flexible approach, relying on rapid procurement and adaptability to evolving needs. The study highlights how organisational mandates and contextual factors critically shape inventory management strategies. It concludes that integrating systematic governmental preparedness with NGO flexibility could significantly enhance disaster response effectiveness. Theoretical and policy implications are discussed, underscoring the importance of collaborative, context-sensitive approaches to humanitarian inventory management.

Keywords: Critical Inventory Management, Humanitarian Aid, Disaster Response, Provincial Disaster Management Authority (PDMA), Multiple Case Study, Emergency Preparedness

1. Introduction

Effective inventory management is fundamental to successful humanitarian response, especially in disaster-prone nations like Pakistan. Despite the recent expansion of research on humanitarian logistics, a notable gap persists in comparative evaluations of inventory management systems utilised by governmental and non-governmental organisations (NGOs) within the same national framework. Notably, fewer studies have rigorously compared the methodologies of public disaster management agencies and local NGOs in Pakistan, despite the nation's recurring vulnerability to natural and manmade disasters. This comparison is

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particularly relevant due to the unique operating requirements, resource limitations, and coordination difficulties encountered by both agencies.

This study outlines "critical inventory" from general inventory, defining it as essential supplies that are linked with life-saving interventions and immediate disaster relief, including food, potable water, medical kits, and emergency shelter materials (Schwarz, 2024; Ellison & Cook, 2020). In contrast to general inventory, which can include a wider range of non-essential products, critical inventory is characterised by its essentiality for quick deployment and its crucial significance for the survival and well-being of impacted populations. This differentiation is essential for comprehending the priorities and limitations in the humanitarian supply chain (Van Wassenhove, 2006). This research empirically focuses on a multiple case study of the PDMA, the principal governmental body for disaster response in Khyber Pakhtunkhwa, and a prominent LNGO engaged in humanitarian efforts. Six participants were purposefully chosen for interviews, consisting of three senior leaders from each organisation, all occupying pivotal positions in inventory management and disaster logistics. The case of Pakistan presents a crucial background for our inquiry, being both theoretically and empirically relevant due to its vulnerability to frequent calamities, varied geographic obstacles, and intricate humanitarian environment. This study aims to enhance the comprehension of critical inventory management by comparing government and local NGO approaches in Pakistan, providing practical recommendations for improving humanitarian responses in similar environments.

2. Problem Statement

Pakistan frequently experiences both natural and man-made disasters, including floods, earthquakes, and internal displacement crises. In such emergencies, the prompt delivery of essential relief items such as food, clean water, shelter materials, and medical supplies is critical to saving lives. Effective inventory management plays a pivotal role in ensuring this happens. Despite a growing interest in humanitarian aid studies, there remains limited research comparing how different types of organisations manage critical inventories within the same operational environment. Government agencies, such as the Provincial Disaster Management Authority (PDMA), typically employ structured, pre-planned models, whereas local non-governmental organisations (LNGOs) tend to adopt more flexible and responsive approaches due to their grassroots orientation and resource constraints. These contrasting approaches underline the need to examine how institutional roles and operational strategies influence inventory management during disaster response in Pakistan.

Much of the existing literature focuses on inventory systems from the perspective of a single organisation, offering little insight into how governmental and non-governmental actors differ or collaborate in practice. This gap is particularly significant in regions where disasters are frequent, and coordination among actors is vital. Additional challenges, including poor infrastructure, security concerns, and evolving community needs, further complicate inventory planning and deployment. Without a comparative understanding of how PDMA and LNGOs operate, opportunities for integrated, efficient, and contextually appropriate supply chain solutions risk being overlooked. This study seeks to address this gap

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by analysing and comparing the inventory management practices of PDMA and LNGOs, with the aim of identifying strengths, limitations, and opportunities for collaboration. In doing so, it aspires to inform the development of hybrid models that can enhance disaster response efforts across Pakistan.

3. Literature Review

3.1. Critical Inventory Definition and Discussion in the Context of Humanitarian Aid Sector

Critical inventory in the humanitarian sector denotes the indispensable goods and resources necessary for effective crisis response, based on established frameworks like the Sphere Standards, which delineate minimal humanitarian supply prerequisites (Sphere Association, 2018). This inventory generally includes medical supplies, food, potable water, sanitation materials, clothes, and shelter-related items, all essential for preserving life and health in disaster or conflict situations (Schwarz, 2024). The management of essential inventory is characterised by the sector's operation under significant unpredictability and urgency (Stevens et al., 2022), necessitating compliance with standards that guarantee availability, quality, and prompt distribution. The tactics employed for inventory management can differ significantly by the kind of organisation. For example, large international NGOs like the International Federation of Red Cross and Red Crescent Societies (IFRC) typically sustain substantial prepositioned inventories, but smaller local NGOs may depend more on just-in-time procurement due to budget limitations (Frennesson et al., 2022). Recent disaster response data (e.g., International Federation of Red Cross and Red Crescent Societies [IFRC], 2022) show similar disparities, emphasising how organisational size, mandate, and resource availability affect the selection of inventory management strategies.

A key characteristic of humanitarian inventory management, in comparison with commercial techniques, is its focus on availability and accessibility rather than cost-efficiency (Richardson et al., 2016). While commercial supply chains prioritise demand forecasting and lean inventory systems to optimise profit and efficiency, humanitarian operations must prioritise preparedness for unforeseen and urgent demands, frequently compromising cost (Van Wassenhove, 2006). Humanitarian logistics face additional challenges due to political instability, infrastructure failures, and rapidly changing needs, requiring highly flexible inventory management practices supported by advanced information systems, mobile warehousing, and real-time tracking technologies (Akhtar et al., 2012). Humanitarian inventory is generally classified into consumables (e.g., food, water, medications) and non-consumables, for example, shelter materials, and logistical support tools (Ellison & Cook, 2020). Additionally, inventory can be classified as pre-positioned stock, stored at strategic sites according to frameworks such as the Logistics Cluster model and emergency response stock, which is acquired post-disaster for adaptability and contextual relevance (Mitchell et al., 2011). The perishability of goods dictates handling strategies: perishable items require stringent storage and prompt distribution, whereas non-perishable goods permit extended storage (Ferreira et al., 2018).

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The adaptability and robustness of inventory management in humanitarian contexts are increasingly bolstered by modern technology. Instruments including Geographic Information Systems (GIS), radio-frequency identification (RFID), and real-time inventory monitoring systems improve situational awareness and reactivity (Akhtar et al., 2012). Moreover, dynamic system modelling and various analytical methodologies have been empirically utilised in humanitarian contexts, illustrating advantages in planning and resource optimisation; however, implementation is contingent upon context and can be constrained by data quality (Anjomshoae et al., 2018). The success of humanitarian inventory management relies on ongoing enhancement of pre-positioning strategies, flexible classification techniques, and the incorporation of empirical technologies, all guided by established frameworks and insights gained from practical experience (Sphere Association, 2018; Van Wassenhove, 2006).

3.2. Comparison of Inventory Management in the Humanitarian Sector and the Business Sector

The classification of organisations profoundly influences the implementation of inventory management strategies. Government agencies, including national disaster management bodies, frequently use centralised, resilience-oriented frameworks, emphasising readiness by stockpiling and prepositioning essential supplies in high-risk areas. Conversely, NGOs often utilise flexibility and decentralisation, commonly implementing just-in-time (JIT) procurement or local sourcing to address resource limitations and swiftly adapt to changing demands (Moshtari et al., 2021; Frennesson et al., 2022). Inventory management in the business sector, aimed at profit maximisation, generally employs lean and Just-In-Time approaches to reduce holding costs and enhance efficiency (Sunil Chopra & Meindl, 2016). These systems rely on consistent demand and strong infrastructure, allowing accurate forecasting and efficient supply chains. In unstable humanitarian contexts such as Pakistan, the unpredictability of calamities, infrastructural failures, and variable demands complicate the direct implementation of economic concepts. Humanitarian organisations should prioritise availability, accessibility, and resilience rather than cost-effectiveness (Richardson et al., 2016).

Analytical evidence from Pakistan illustrates these distinctions. Government entities like PDMA and international organisations such as UNICEF engage in strategic prepositioning by accumulating vital medical and relief commodities in disaster-prone regions to guarantee prompt accessibility during disasters (United Nations International Children's Emergency Fund [UNICEF], 2024). This strategy enhances systematic resilience and reduces the likelihood of stockouts, however, it elevates storage expenses and requires meticulous inventory management. Non-governmental organisations, such as the Aga Khan Foundation (AKF) and the Aga Khan Agency for Habitat (AKAH), enhance their efforts through reactive procurement and local collaborations, allowing them to respond to swiftly evolving requirements; nevertheless, this approach may occasionally lead to supply chain disruptions during significant calamities (Aga Khan Foundation [AKF], 2024).

Although commercial principles like JIT and lean inventory can provide insights for

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humanitarian supply chains, particularly for multinational NGOs in stable situations, their applicability is constrained in severely unstable environments. Trade-offs among cost, speed, and resilience are paramount: stockpiling enhances preparation and resilience but escalates expenses, whereas JIT minimises inventory costs but jeopardises timely responses in unforeseen situations. Consequently, good humanitarian inventory management integrates corporate efficiency with the resilience and flexibility necessary for catastrophe response (Van Wassenhove, 2006).

3.3. Humanitarian Aid Operations in Pakistan

Pakistan is highly susceptible to numerous natural disasters, including earthquakes, floods, droughts, and landslides, in addition to anthropogenic crises such as armed war and significant population relocation. In the last twenty years, Pakistan has endured multiple major disasters, such as the 2005 earthquake, the 2010 floods, and ongoing warfare in tribal areas, necessitating substantial humanitarian assistance (Ferris & Kirisci, 2016). The magnitude and frequency of these catastrophic events frequently outweigh the operational capabilities of governmental agencies and local organisations, as demonstrated by recorded funding deficiencies, logistical impediments, and delays in aid distribution noted during recent emergencies (Shah, 2015; Ferris & Kirisci, 2016).

Humanitarian organisations throughout Pakistan have significant logistical obstacles, including challenging terrain, insufficient infrastructure, and intricate security conditions, which hinder the prompt provision of assistance. In these circumstances, effective inventory management is crucial and must be customised to accommodate local limitations. Humanitarian organisations consistently engage in the pre-positioning of critical supplies, such as medical kits, food, and shelter materials, in strategically located warehouses adjacent to disaster-prone areas, in accordance with national and international rules. Moreover, adaptive strategies like mobile supply units and flexible procurement frameworks have been utilised to alleviate access difficulties and decrease response times in locations that are inaccessible or afflicted by conflict (Shah, 2015).

International organisations, such the United Nations, the International Federation of Red Cross and Red Crescent Societies (IFRC), and Médecins Sans Frontières (MSF), are crucial in enhancing local initiatives by direct intervention and technical support. The 2010 floods demonstrated the efficacy of a coordinated, multi-agency response; despite extensive infrastructure failure, pre-positioned inventories and collaborative logistics platforms allowed international organisations to provide essential supplies for affected populations within days (Ferris & Kirisci, 2016). These experiences underscore the imperative of cooperative inventory management among governmental, international, and non-governmental organisations to enhance resource allocation and guarantee that life-saving goods are delivered to those most in need.

3.4. Challenges in Humanitarian Sector of Pakistan

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Despite the hard work of humanitarian organisations, Pakistan's humanitarian sector faces significant problems. One significant impediment is inadequate infrastructure, particularly in remote and rural locations, which hinders the transportation and distribution of important inventories. Following emergencies, damaged roads, bridges, and transportation networks impede relief efforts (Hussain, 2011). Security is a further significant problem, particularly in conflict-affected areas like Khyber Pakhtunkhwa and Balochistan, where persistent hostilities limit humanitarian agencies' operational coverage. Organisations must strike a compromise between strategic supply placement and the security of their employees and volunteers (Ferris & Kirisci, 2016). Furthermore, Pakistan's diversified geography complicates logistics; for example, high northern areas become inaccessible in winter due to heavy snowfall, while southern regions are frequently affected by flooding, disrupting supply chains (Shah, 2015).

Humanitarian organisations have to react to these geographic and environmental factors by storing inventory in year-round accessible locations to facilitate prompt relief delivery (Hussain, 2011). Pakistan's particular setting additionally influences specific inventory requirements, such as water purification tablets and mosquito nets during floods and winter gear in cooler places after earthquakes (Ferris & Kirisci, 2016; Shah, 2015). Cultural worries are also important, as proper clothing and familiar food can increase acceptance and effectiveness (Hussain, 2011). Another goal is to build regional resources, with local and international organisations collaborating to manage storage facilities, organise logistics, and improve government response capabilities. Through such collaboration, organisations can ensure that help arrives on time, effectively, and culturally sensitively, thus boosting Pakistan's overall preparedness capacity (Shah 2015).

4. Research Methodology

This research utilised a qualitative multiple case study methodology to investigate differences in inventory management techniques, operational difficulties, and adaptability among humanitarian groups in Pakistan (Yin, 2018). The technique was used to facilitate a comprehensive comparison of government and NGO-led disaster response strategies, directly addressing the study topics including strategy, obstacles, and organisational adaptation. Two organisations were purposefully chosen to exemplify significant typologies in the sector: the PDMA, the primary governmental entity coordinating extensive disaster response, and a prominent LNGO recognised for its adaptable field operations. This decision was supported by their roles within the wider humanitarian context of Pakistan, hence enhancing external validity and transferability.

Six participants, three from each organisation, were selected due to their critical roles in inventory management, encompassing both executive leadership (e.g., Director General, Director of External Affairs) and operational decision-makers (e.g., Senior Procurement Officer, Director of Relief Operations). This purposive sampling encompassed both strategic supervision and functional implementation viewpoints. Despite the limited sample size, it was justified by information power and data saturation (Malterud et al., 2016), as each participant possessed considerable knowledge (average of over 15 years), and initial interviews revealed

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a significant level of thematic duplication (Table 1). Semi-structured interviews were performed, each lasting 60 to 90 minutes, and were held either in person or over secure online platforms, depending upon participant availability and security considerations. Interviews were done in English or Urdu, as desired by participants, audio-recorded with consent, and transcribed verbatim for precision. An interview guide, created and tested with two outside experts, addressed inventory strategy, risk management, procurement processes, adaption, and organisational problems. The researchers with a reflexive approach minimised bias in data collection and analysis. Consistent peer debriefings with an impartial co-researcher significantly improved confirmability and reliability.

Table 1. Demographic and Experience Profile of Key Respondents

Name	Experience (Years)	Gender
Director External Affairs (LNGO)	23	Male
Director Safety and Security (LNGO)	15	Male
Senior Procurement Officer (LNGO)	15	Female
Deputy Commissioner (PDMA)	18	Male
Director General (PDMA)	13	Male
Director Relief Operations (PDMA)	15	Female

The data analysis employed the six-step theme analysis methodology established by Braun and Clarke (2006), integrating both inductive and deductive coding methodologies. Codes were produced iteratively, themes were modified, and NVivo (v.14) software was utilised to organise and organise data. Themes were examined and validated via peer review and member verification with specific participants, enhancing the credibility and reliability of the findings. The study ensured integrity by addressing credibility, dependability, confirmability, and transferability using triangulation, audit trails, and comprehensive descriptive accounts. Although female participants constituted merely 20%, this constraint was acknowledged and handled in the study. The incorporation of both executive and operational positions facilitated a more refined comprehension of the multifaceted inventory management techniques inside each organisation.

5. Data Analysis and Findings

This section presents the results of a thematic analysis based on six semi-structured interviews with leaders from two distinct types of humanitarian organisations operating in Pakistan: the Provincial Disaster Management Authority (PDMA) and a local non-governmental organisation (LNGO). The study explored how these organisations manage critical inventory, defined as life-saving items such as food, water, shelter materials, and medical supplies, during emergency situations. Braun and Clarke's six-step framework guided the analysis, employing both inductive and deductive approaches to systematically code and interpret the data. NVivo 14 software was used to organise themes and identify recurring patterns across the transcripts.

The findings revealed two contrasting paradigms of critical inventory management, closely aligned with the differing mandates and structural positions of each organisation.

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PDMA has adopted a systematic, state-led approach, emphasising proactive planning, resource stockpiling, and inter-agency coordination. Its leaders described a comprehensive preparedness framework incorporating risk-based forecasting and regionally distributed storage facilities. One PDMA respondent explained:

"Preparation is not a choice for us; it is our first line of defence. We stock ahead of time because we can't rely on last-minute buying in mountainous or flood-prone areas."

This approach reflects the organisation's legal authority and responsibility for ensuring continuity and effective disaster management in high-risk regions.

Table 2. Summarises of Thematic Findings from The Interviews

Respondents	Approach to Handling Critical Inventory	Type of Critical Inventory
Director External Affairs (LNGO)	Effectively manages inventory demands through diplomatic engagement, ensuring that emergency relief resources are distributed fairly and efficiently. Prioritizes critical supplies based on urgency and need while balancing the organisation's mission with external requests. Works closely with stakeholders to maintain relationships that support sustainable inventory management and facilitate quick responses during crises.	Helicopters for emergency transportation
Director Safety and Security (LNGO)	Ensures that security protocols are strictly followed while balancing the need for rapid aid delivery to high-risk areas. Conducts thorough risk assessments to protect personnel and inventory, minimizing potential threats. Works with law enforcement and security teams to establish safe and efficient delivery routes, ensuring that aid reaches affected populations without unnecessary delays.	Security routes, armoured vehicles
Senior Procurement Officer (LNGO)	Implements a strategic procurement approach that relies on a pre-approved supplier list and framework agreements to expedite purchases without compromising compliance. Ensures procurement processes remain transparent, well-documented, and aligned with ethical sourcing principles. Regularly evaluates supplier performance to maintain a steady flow of critical inventory while adhering to budgetary constraints.	Medical supplies, food, and water
Deputy Commissioner (PDMA)	Proactively pre-positions essential supplies ahead of disaster seasons to ensure timely distribution when emergencies arise. Balances the immediate need for relief with long-term preparedness by maintaining adequate stock levels. Develops contingency plans to address inventory shortages and coordinates with governmental and non-governmental agencies to enhance disaster response efficiency.	Stoves, tents, and blankets
Director General (PDMA)	Strategically allocates resources to ensure a balance between immediate disaster relief and long-term preparedness. Oversees inventory planning to maintain a resilient supply chain, ensuring that emergency response mechanisms remain operational. Continuously assesses evolving risks to adapt inventory strategies accordingly, promoting sustainability and efficiency in disaster management.	Relief kits, early warning systems
Director Relief Operations (PDMA)	Maintains a well-equipped emergency response team capable of rapid deployment, investing in resilience-building strategies to strengthen disaster response capabilities. Establishes partnerships with local and international stakeholders to enhance coordination and optimize inventory distribution. Continuously reviews and updates response plans to improve efficiency and reduce operational bottlenecks in emergency relief efforts.	Food, water, medical supplies, and temporary shelter

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In contrast, the LNGO's model is built around agility, rapid mobilisation, and decentralised procurement strategies. Interviews with its leaders highlighted an adaptable approach, underpinned by pre-disaster agreements with pre-qualified suppliers. The LNGO also places strong emphasis on diplomatic engagement with multiple stakeholders, particularly government officials. This reflects the cultural and legal context of Pakistan, where government authorities play a central role in coordinating disaster response efforts. As the Senior Procurement Officer of the LNGO noted:

"We are able to move rapidly without sacrificing the integrity of our procurement process due to the pre-approved supplier list and transparent framework contract".

While this model enables rapid response in dynamic environments, it also faces challenges linked to fluctuating prices, inconsistent local supply of critical inventory, and limited storage capacity. Table 2 summarises the thematic findings from the interviews, comparing the approaches of PDMA and LNGO leaders to critical inventory management.

The table highlights that PDMA leaders—including the Deputy Commissioner, Director General, and Director of Relief Operations—rely heavily on pre-disaster stockpiling and coordinated engagement with government and non-government stakeholders to ensure the availability of essential items such as tents, stoves, and early warning kits. In contrast, LNGO representatives—including the Director of External Affairs, Director of Safety and Security, and Senior Procurement Officer—describe operational environments that demand flexibility and rapid decision-making. The Director of External Affairs remarked:

"Our decisions often need to be made within hours, not days. We can't afford bureaucratic delays when lives are at stake."

This statement encapsulates the urgency-driven, locally responsive environment in which LNGOs operate.

Interviews also revealed that both organisations share concerns regarding inventory security and accessibility. While PDMA leverages institutional relationships to coordinate with local authorities and security forces, the LNGO invests in route risk assessments and partnerships with law enforcement to ensure aid reaches remote or high-risk areas. Given Pakistan's complex security environment, integrating security considerations into operational planning is essential. As the LNGO's Director of Safety and Security explained:

"Sometimes, securing a safe passage for aid delivery is more complicated than sourcing the aid itself."

This concern about balancing speed with security was echoed by all LNGO interviewees involved in this research.

Overall, the thematic analysis underscores a clear strategic divergence between the two organisations. The LNGO operates with an emphasis on flexibility, decentralised decision-

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making, and rapid deployment, enabling it to respond effectively to unpredictable and rapidly evolving disaster scenarios. Its reliance on pre-qualified suppliers, local partnerships, and transparent procurement reflects a pragmatic approach suited to volatile environments. However, this model is also vulnerable to market instability, logistical constraints, and compliance pressures that limit stockpiling and long-term planning.

Conversely, PDMA adopts a structure-centred, state-mandated approach grounded in legal authority, centralised coordination, and long-term planning. Its strategy prioritises pre-disaster forecasting, regionally dispersed stockpiles, and robust inter-agency collaboration, enabling sustained operations even when markets falter or access becomes restricted. These contrasting approaches are not merely technical but are rooted in each organisation's institutional mandate, operational scale, and level of accountability. As a state body, PDMA is answerable to public policy objectives and political oversight, with a focus on stability and risk mitigation. The LNGO, driven by its mission and donor requirements, enjoys greater operational flexibility and responsiveness to emerging needs on the ground. Together, these findings reflect the broader tension between preparedness and adaptability in humanitarian inventory management. They also highlight the potential for hybrid strategies that integrate the strengths of both models to enhance disaster response effectiveness in Pakistan.

6. Discussion

The findings of this study highlight a key insight into HA efforts in Pakistan. Effective disaster response depends not only on what aid is delivered, but also on how critical inventory is managed, prioritised, and deployed. The comparative analysis between PDMA and the LNGO reveals two distinct approaches to inventory management, each reflecting their broader organisational priorities. PDMA focuses on institutional stability, and the LNGO emphasises on operational flexibility. These contrasting models underscore the importance of aligning inventory strategies with organisational missions and contextual demands. While PDMA's structured preparedness allows for coordinated, long-term planning, the LNGO's flexible model enables swift responses in rapidly evolving emergency situations. Together, these insights suggest that a balanced integration of both approaches may enhance the overall effectiveness of disaster relief operations in Pakistan.

PDMA's approach matches with established public-sector disaster management frameworks, where central planning, pre-positioned stock, and contingency protocols form the core of disaster preparedness. PDMA's reliance on historical disaster trends and established government coordination mechanisms contributes to a resilient and well-structured disaster management approach. This aligns with arguments by Kunz et al. (2014) and Van Wassenhove (2006), who emphasise that systematic pre-disaster planning enables faster response and mitigates the effects of infrastructure disruptions. In Pakistan, where road networks can become unreliable depending on the type and location of the disaster, such a proactive strategy is particularly valuable. However, this approach may face challenges in dynamic environments where needs change rapidly or where sudden access constraints

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require flexible, real-time adjustments. Rigid planning may delay aid delivery or fail to address emerging priorities on the ground.

In contrast, the LNGO's operational approach is based on flexibility and rapid resource mobilisation. It follows a demand-driven procurement model, utilising framework agreements, pre-negotiated pricing, and supplier performance evaluations to enable swift and compliant purchasing. This aligns with the perspective of Wakolbinger and Toyasaki (2018), who stress the importance of agility and local responsiveness in effective humanitarian aid delivery. The LNGO's methods are particularly well-suited for Pakistan's complex and dynamic environment, especially in high-risk areas where disasters occur unpredictably and supply routes are often compromised by insecurity or congestion. However, this flexibility involves trade-offs. Just-in-time procurement can expose operations to market volatility, delivery disruptions, and stock shortages. Further, limited warehouse capacity and strict donor compliance requirements may hinder the ability of LNOG to pre-position its supplies, even when early warning indicators suggest urgent preparedness. Balancing speed with sustainability remains a critical challenge, especially when both access and availability change rapidly.

The study reveals that both PDMA and LNGO face constraints unique to their institutional environments. PDMA benefits from authority, reach, and policy alignment, but struggles with inflexibility. LNGO on the other hand excels at improvisation and responsiveness, but lacks the scale and predictability of governmental systems. These findings suggest that rather than positioning these models as contradictory, humanitarian operations in Pakistan would benefit from strategic integration. The idea of "complementary capabilities" is supported by existing literature, including the work of Pettit and Beresford (2009), who argue that the effective disaster responses emerge from coordinated action between public and non-state actors. This synergy is especially important in a country like Pakistan, where diverse geographic, cultural, and political factors affect aid delivery. In flood-prone southern districts, earthquake-prone mountainous regions, and conflict-affected tribal areas, no single actor can adequately cover the logistical demands of an emergency. Joint planning, pooled inventory, and integrated procurement mechanisms can improve inventory visibility, reduce redundancies, and enhance reach. For example, PDMA's warehouses could be utilised to store pre-positioned supplies procured by NGOs, while LNGO procurement officers could provide technical guidance on sourcing ethically and locally. Coordinated drills and simulation exercises may further align response strategies, improving speed and reducing friction.

Furthermore, the study underscores the importance of institutionalising collaboration. Shared platforms for data exchange, centralised dashboards for stock visibility, and integrated emergency logistics clusters can offer operational cohesion. Technologies such as cloud-based inventory systems, GIS-enabled warehouse maps, and mobile apps for last-mile delivery verification can increase transparency and speed in crisis situation. However, the adoption of technology in humanitarian operations must be tailored to local conditions, taking into account factors such as internet bandwidth, digital literacy, and data privacy concerns. Tools that perform well in one region may be ineffective or even counterproductive

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in areas with limited connectivity or low levels of tech knowledge. Ensuring inclusive access and safeguarding sensitive information are essential to building trust and maintaining operational effectiveness (Staus & Reuter, 2020).

7. Conclusion

This study aimed to fill the significant void in the literature concerning comparative methodologies in critical inventory management across governmental and non-governmental humanitarian groups in Pakistan. The research specifically aimed to investigate how the PDMA and a prominent LNGO locate, pre-position, and distribute vital relief products, as well as how their organisational contexts influence these methods. Research demonstrates that PDMA employs a proactive, resilience-focused inventory management framework, prioritising rigorous pre-disaster planning, strategic stockpiling, and effective inter-agency collaboration. This method offers stability, guarantees the accessibility of essential resources, and facilitates extensive catastrophe response. On the other hand, LNGO employs a flexible, adaptive framework characterised by agile procurement methods, swift resource allocation, and responsiveness to emerging demands. This allows the business to effectively manage uncertainty and react promptly in unstable circumstances, however it may be hindered by resource limitations and erratic supply chains.

The research emphasises that neither method, independently, adequately resolves the intricate issues of disaster response within Pakistan's difficult environment. The comparative analysis illustrates the benefits of merging PDMA’s systematic planning and resilience with LNGO’s agility and adaptability. This integration could be implemented via collaborative inventory management platforms, coordinated procurement, shared information systems, and cross-sector reaction planning. By utilising the advantages of both models, humanitarian organisations may bolster supply chain resilience, increase resource utilisation, and enhance response speed and efficacy. This study enhances the theoretical and practical comprehension of critical inventory management by demonstrating that collaborative, context-specific solutions are vital for effective humanitarian efforts. Future studies should investigate the design and sustainability of institutional structures for integration, along with the potential contributions of technology and data-sharing in facilitating a cohesive humanitarian supply chain.

8. Future Recommendations

To improve inventory management in humanitarian operations, future research and policy efforts should explore ways to strengthen systemic collaboration among governmental institutions, NGOs, and international agencies in Pakistan. Developing joint information-sharing platforms, shared warehousing strategies, and synchronised procurement models could enhance inventory visibility, reduce duplication, and optimise resource allocation. These coordinated frameworks are particularly relevant in Pakistan’s complex disaster landscape, where fragmented efforts often lead to inefficiencies. By enhancing collaboration, stakeholders can improve the speed, reach, and overall effectiveness of aid delivery.

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In parallel, the adoption of advanced technological solutions, such as real-time geospatial analytics, block chain-enabled supply chains, drone-assisted inventory audits, and cloud-based management platforms, offers significant potential to improve the accuracy and transparency of humanitarian inventory systems. However, implementing these technologies requires careful adaptation to local realities, including limited infrastructure, variable data quality, and evolving regulatory environments. Pilot initiatives and partnerships with local tech providers can help ensure both feasibility and sustainability. Additionally, integrating the resilience-focused planning of government bodies with the agile, needs-based methodologies of NGOs may yield robust hybrid models for disaster response. Practical interventions including cross-sector training, jointly developed contingency plans, and formal mechanisms for shared resource deployment should be examined to determine how such models can effectively address the diverse and unpredictable disasters and their management across Pakistan.

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