

Chapter 6

Redesigning Humanitarian Logistics with Intelligent Systems: From Chaos to Coordination

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ABSTRACT

Sudden and destructive disasters such as earthquakes create complex and uncertain logistical needs that challenge traditional humanitarian response systems. This chapter explores how smart technologies such as artificial intelligence (AI), predictive analytics, cloud computing, Internet of Things (IoT), drone systems, and Geographic Information Systems (GIS) can enhance earthquake-based humanitarian logistics by improving speed, coordination, and decision-making. A thematic literature review, a technology–value matrix, and five real-world-inspired scenarios are used to evaluate these technologies’ effectiveness across logistics functions. Additionally, an Integrated Smart Technology Ecosystem model is introduced to demonstrate how these tools can work collectively. The study highlights that successful implementation depends not only on technical capability but also on ethical governance, data quality, interoperability, and institutional readiness. Strategic recommendations are offered for humanitarian actors, emphasizing holistic planning and future research directions.

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1. INTRODUCTION

The accelerating frequency, severity, and complexity of disasters driven by environmental degradation, socio-political instability, and global technological interdependencies—have drastically reshaped the landscape of humanitarian crises. Earthquakes, floods, pandemics, wars, forced migrations, and the escalating climate emergency not only increase the number of people requiring urgent assistance but also expose the structural limitations of conventional response systems. Humanitarian logistics, in particular, has become increasingly challenged by unpredictable demand patterns, infrastructure disruptions, information asymmetries, and multi-actor coordination gaps.

In such environments, the capacity of logistics systems to function rapidly, flexibly, efficiently, and sustainably is no longer a luxury but a matter of survival. Yet, the majority of existing humanitarian logistics infrastructures continue to rely on fragmented coordination mechanisms, operate with limited real-time data, and lack anticipatory planning capabilities. As a result, decision-making remains reactive and often delayed, leading to critical inefficiencies in the distribution of aid, allocation of resources, and overall situational awareness.

Traditionally, humanitarian logistics has been organized around manual operations and static contingency plans. However, over the past two decades, major global disasters such as the 2004 Indian Ocean tsunami, the 2010 Haiti earthquake, and more recently the 2023 Türkiye–Syria earthquake have served as catalysts for digital innovation in humanitarian operations. These events have underscored the urgent need for transformation toward proactive, data-informed, and digitally integrated response systems.

At the forefront of this transformation are smart technologies including Artificial Intelligence (AI), predictive analytics, Internet of Things (IoT), cloud computing, Geographic Information Systems (GIS), and autonomous platforms such as drones and robotic agents. These tools collectively offer unprecedented opportunities to enhance the agility, scalability, and responsiveness of humanitarian supply chains. They facilitate dynamic decision-making, disaster forecasting, real-time monitoring, route optimization, needs assessment, and improved access to vulnerable and hard-to-reach populations.

In the case of high-impact, time-critical disasters such as earthquakes, where minutes can determine the difference between life and death, technology-driven logistics solutions become essential. The ability to capture and process data in real time, to anticipate cascading failures, and to coordinate multi-stakeholder actions rapidly is vital to achieving life-saving outcomes. Smart systems thus represent a critical enabler of situational awareness, operational coherence, and resource effectiveness in humanitarian contexts.

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