THE ROLE OF DIGITAL SOLUTIONS IN MANAGING HUMANITARIAN LOGISTICS OPERATIONS

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Abstract

With the increase of natural and man-made disasters worldwide such as earthquakes, tsunamis, pandemics, wars etc. the role of adequate management of humanitarian logistics is becoming more and more prominent on the disaster relief agenda. One of the main aims of the humanitarian logistics operations is to eliminate the negative effects of the disaster and to do so numerous actors must be involved in the process (governments, NGOs, military, civil societies and humanitarian organizations). The implementation of disaster relief actions and coordination of various and often conflicting goals of the mentioned actors is facilitated by the usage of smart, digital solutions which are becoming an irreplaceable tool for the realization of humanitarian logistics activities. The analysis within this paper considers the usage, role and benefits of chosen digital solutions for the facilitation of humanitarian logistics operations. The results of the analysis based on the secondary data sources show threefold conclusions regarding the adequate implementation of the analyzed digital solutions in aiding the humanitarian logistics operations. First of all, the ability of humanitarian logistics to respond in an efficient manner to natural disasters is influenced by the adequate selection of an appropriate digital solution and by the level of individual training to use the precise solution. Second, the community facing a disaster can use the full potential of chosen digital solutions only if it has the capabilities to support its demands and the capacities for this type of interaction. Finally, the usage of adequate digital solutions in disaster stricken areas definitively shows positive results in practice when it comes to annihilating fatal outcomes and harsh situations for the environment.

Key words: digital solutions, IT, humanitarian logistics, disaster stricken areas, disaster relief solutions.

1. INTRODUCTION

The intensiveness of crisis situation occurence worldwide has determined the rapid development of the field of humanitarian logistics. The aim of humanitarian logistics is to efficiently respond to all challenges posed by the crisis situation and to help facilitate it as fast as possible (Ye et al., 2020). Due to re-occuring crisis situations the need for humanitarian aid is becoming greater and greater so this can be considered an industry on the rise (Vega & Roussat, 2014). For example, the aid in food supplies accounts for billions of dollars, which has consequences on both the food and transport industry (Van Wassenhove, 2006). The specifics of humanitarian logistics operations is that they face quite unique and non-repetitive situations which can not be directly linked to any other happening or disaster, so a country can never be fully prepared to cope with the consequences of these negative events. Differing from classic, business logistics, humanitarian logistics has many unknown elements such as time, place and level of catastrophy for the local inhabitants and their belongings (Ranke, 2016). Definitely, infrastructure and IT equipment avaliable at the moment of the catastrophe represent one of the most important inputs within the humanitarian logistics process (Tatham & Rietjens, 2015).

Following the contemporary technology advances within the XXI century, humanitarian logistics has different IT/digital equipment solutions at its disposal in order to save the lives of people and alleviate their suffering due to a disaster situation. IT equipment solutions offer a wide scope of services within the operations of humanitarian logistics. First of all, within extraordinary conditions IT solutions enable security and communication services, vocal and internet connection which is needed to secure continuous service offering in saving lives (Sigala et al., 2020). Second, digital solutions have to improve coordination among humanitarian organizations, as well as the operative and security surroundings for staff and the right time approach to information of utmost importance. Given information refer to a very wide scope of relevant logistics data, such as: supplier efficiency, response timeliness, managing information and the quality of donated goods. Stated aspects can be crucial for the preparation of future operations and plans. The approach path to endangered areas after the catastrophe can be destroyed, as well as telephone, cable and optic infrastructure. The standard path and supply dynamics are thus jeopardized while the circumstances are such that they demand a quick reaction in order to reduce negative consequences and save lives (Sheller, 2012).

Thus, the third role of digital IT solutions is a reliable communication between different sectors which intervene in activities of offering aid, and connecting different places where those activities take place. The needed coordination of information flow functioning, money flow and material flow, as well as connecting different operative centers (fieldwork, distribution centers, seaports, roads, both central and lateral warehouses) where activities take place. Finally, different types of digital systems satisfy different needs and have diversified possibilities within humanitarian logistics activities. The improved navigation systems and big data analysis enable the discovery of the crisis source and the definition of the action plan in accordance with the available resources. On the other hand, wireless digital equipment enables the transfer of voice, text, picture and video, through public mobile services, wireless internet, television, radio and satellite systems. In extraordinary circumstances wireless networks for special purposes are also

of utmost importance and are used by the security sector. Usually, there is no unique solution, but rather several kinds of compatible electronic equipment are used (Masudin et al., 2021).

Apart from the introduction and conclusion, this paper is divided into three parts. The first part focuses on the main types of digital solutions in humanitarian logistics operations and their importance and benefits. The second part addresses the specific risks of using digital solutions for these purposes, while the last, third part deals with a Unicef case study analysis showing the precise benefits of using digital solutions in the practice of humanitarian logistics operations. A detailed analysis follows.

2. DIGITAL SOLUTIONS IN HUMANITARIAN LOGISTICS OPERATIONS- MAIN TYPES AND IMPORTANCE

Digital solutions can be defined as technology-based tools, systems, or applications that leverage digital or electronic components to address specific challenges, meet objectives, or provide solutions in various domains. These solutions often utilize computer software, hardware, data, and the internet to enhance efficiency, effectiveness, and convenience in a wide range of applications (Coppens et al., 2018). Digital solutions have several characteristics (Pant & Baroudi, 2008). First of all, they are technology-based, meaning that they rely on technology, including software, hardware, and data, to provide a solution to a problem or improve a process (Bharadwaj et al., 2013). Second, digital solutions tend to be versatile, referring to their application which can be applied across diverse industries and domains, such as healthcare, logistics, finance, education, and more (Westerman et al., 2014). Next, the main orientation of digital technologies is problem-solving, since they are designed to address specific challenges, improve existing processes, or create new opportunities. This is enabled by them being data-driven, which means they often involve the collection, analysis, and utilization of data to inform decision-making and enhance performance (Berman & Kim, 2020). Finally, digital solutions enable connectivity, demonstrating that many digital solutions are connected to the internet or other networks, allowing for real-time communication and collaboration (Yoo et al., 2010).

Digital solutions in humanitarian logistics enhance the speed, accuracy, transparency, and overall effectiveness of relief operations. They enable humanitarian organizations to respond more efficiently to crises, reach more beneficiaries, and better fulfill their mission of saving lives and alleviating suffering in times of need (Vargo & Seville, 2011). Table 1 contains the main digital solutions used in managing humanitarian logistics, along with the explanation of their role.

Table 1. Main digital solutions in humanitarian logistics and their role

Type of digital solution	Role in the humanitarian logistics process
Supply Chain Management Systems	These systems help organizations manage the flow of goods and information in their supply chain. They can track inventory levels, monitor demand, and optimize the allocation of resources.
Geographic Information Systems (GIS)	GIS technology is used to map and analyze geographic data. In humanitarian logistics, GIS

	can be used to assess the impact of natural disasters, plan routes for relief convoys, and identify the locations of affected populations.
Warehouse Management Systems (WMS)	WMS software helps organizations manage and optimize warehouse operations. It tracks inventory, manages space efficiently, and streamlines the movement of goods within warehouses.
Fleet Management Software	This software helps in the management of vehicles, their routes, maintenance schedules, and fuel consumption. It is crucial for optimizing the movement of relief goods and personnel.
Real-time Tracking and Monitoring	IoT (Internet of Things) devices and sensors can be used to monitor the condition and location of relief shipments in real-time. This information can help organizations make informed decisions and respond quickly to any issues.
Mobile Applications	Mobile apps can be used by field workers to collect data, track deliveries, and communicate with the central logistics hub. They can also enable cash transfers and provide beneficiaries with information.
Big Data and Analytics	Big data analytics can be used to make sense of the vast amounts of data generated in humanitarian operations. It can provide insights into the needs of affected populations and help with resource allocation.
Drones	Drones can be used for aerial surveys, monitoring disaster-affected areas, and even for delivering critical supplies to hard-to-reach locations.
Blockchain	Blockchain technology can enhance the transparency and security of transactions and data in humanitarian logistics. It can be used for supply chain traceability and to ensure that aid reaches the intended recipients.
Artificial Intelligence (AI)	AI can help optimize routing, forecast demand, and even predict the impact of disasters. Machine learning models can be trained to make more accurate predictions and recommendations.
Communication and Information Management Systems	Tools that enable effective communication among humanitarian actors, such as coordination between agencies, sharing information about needs, and tracking the status of relief efforts.
Remote Sensing and Satellite Imagery	These technologies are used for disaster risk assessment, damage assessment, and monitoring of affected areas.

Weather Forecasting and Early Warning Systems	Access to accurate weather forecasts and early warning systems can help humanitarian organizations prepare for and respond to natural disasters more effectively.

Source: Oxford research group (2019).

Digital solutions are crucial for humanitarian logistics for several reasons. Digital tools and technologies help streamline logistics operations, reducing manual and time-consuming processes. This leads to more efficient handling and distribution of relief supplies, which is essential in emergencies when time is of the essence (Altay & Pal, 2014). Digital solutions provide real-time data and insights into the supply chain, which is invaluable for logistics planning and execution. This visibility helps humanitarian organizations make data-driven decisions and respond effectively to changing circumstances. This leads to enhanced visibility (Sundarakani et al., 2010). With the help of data analytics and forecasting, humanitarian organizations can better allocate resources, including personnel and supplies, to areas with the greatest need. This prevents wastage and ensures that aid reaches those who need it most. Digital solutions enable the tracking and monitoring of relief supplies from origin to destination. This transparency is crucial for accountability and preventing the diversion of aid. It also helps build trust with donors and the affected communities (United Nations, 2020).

When a disaster strikes, digital solutions allow for rapid assessment of the situation, enabling a faster and more targeted response. This is essential for saving lives and mitigating the impact of disasters. Humanitarian logistics generate vast amounts of data, which can be harnessed through digital tools to make informed decisions (Queiroz & Telles, 2019). Whether it's predicting demand, identifying trends, or assessing the effectiveness of relief efforts, data-driven decision-making is key to success. Digital solutions facilitate better communication and coordination among humanitarian agencies, government bodies, and local partners. This improves the overall response by avoiding duplication of efforts and ensuring a cohesive approach. Blockchain and other digital technologies can enhance the security and accountability of financial transactions and the distribution of aid. This is crucial in environments where corruption and misappropriation are concerns (Yan & Lee, 2018). Digital tools and remote sensing technologies allow for monitoring and evaluation of relief programs, even in hard-to-reach or conflict-affected areas. This helps organizations adjust their strategies based on real-time feedback. Digital solutions can help reduce the environmental impact of humanitarian logistics. Optimized routing, resource allocation, and reduced paper-based processes can contribute to sustainability goals. Finally, digital solutions also play a role in long-term resilience building. They can assist in risk assessment, early warning systems, and the development of disaster preparedness and response plans.

3. SPECIFIC RISKS OF USING DIGITAL SOLUTIONS IN HUMANITARIAN LOGISTICS OPERATIONS

As it has been shown, the usage of digital solutions brings many benefits into the process of managing humanitarian logistics. However, these technologies also come with several risks and

challenges. Some of the key risks associated with the use of digital solutions in this context include:

a) *Cybersecurity Threats*: Digital solutions are vulnerable to cyber-attacks, including data breaches, hacking, and ransomware. These attacks can compromise sensitive information, disrupt operations, and erode trust in humanitarian efforts (Kruse et al., 2016).

b) *Dependency on Technology*: Overreliance on digital solutions can be problematic, especially in resource-constrained or disaster-affected areas where infrastructure may be unreliable. If the technology fails, it can lead to logistical breakdowns (Chowdhury & Paul, 2019).

c) *Data Privacy Concerns*: Humanitarian organizations often deal with personal and sensitive data of affected populations. Mishandling or breaches of this data can result in privacy violations and harm to beneficiaries (Deloitte, 2017).

d) *Access and Inclusivity*: Not everyone in disaster-stricken or conflict-affected areas has equal access to digital technology. Dependence on digital solutions can lead to exclusion of vulnerable groups who lack access to devices or connectivity (Fakhruddin et al., 2017).

e) *Digital Divide*: There can be a significant digital divide, even within affected populations, which can lead to unequal access to humanitarian assistance. Those with digital literacy and access may benefit more than others (Yan & Lee, 2018).

f) *Operational Disruptions*: Technical issues or software failures can disrupt logistics operations, causing delays in aid delivery and hindering disaster response effort (Berman & Kim, 2020).

g) *Lack of Power and Connectivity*: In many disaster scenarios, power outages and a lack of network connectivity can render digital solutions ineffective. In such cases, alternative methods may be necessary (Westerman et al., 2014).

h) *Complexity and Training*: Implementing and maintaining digital solutions can be complex. Humanitarian workers may require training and technical support to use these systems effectively (Bharadwaj et al., 2013).

i) *Costs*: The initial investment and ongoing costs associated with digital solutions can be high, and some humanitarian organizations may struggle to allocate funds for these technologies (Coppens et al., 2018).

j) *Supply Chain Vulnerabilities*: The use of digital solutions can introduce vulnerabilities into the supply chain, particularly if these systems are interconnected. A cyberattack on one part of the supply chain can affect the entire operation (Coppens et al., 2018).

k) *Reliability of Data*: Data quality and accuracy are critical in humanitarian logistics. Relying on digital solutions for data collection and analysis can introduce errors if not carefully managed (Queiroz & Telles, 2019).

l) *Ethical Concerns*: The use of digital solutions in humanitarian operations may raise ethical questions about data ownership, surveillance, and consent, particularly in conflict zones (Sheller, 2012).

To mitigate these risks, humanitarian organizations need to adopt robust cybersecurity measures, consider the digital divide, provide alternative solutions for areas with limited digital infrastructure, and ensure that digital solutions are ethically and transparently used. Additionally,

comprehensive risk assessments and disaster recovery plans should be in place to address potential disruptions.

4. CASE STUDY ANALYSIS: UNICEF'S USE OF DIGITAL SOLUTIONS IN HUMANITARIAN LOGISTICS OPERATIONS

UNICEF (United Nations Children's Fund) is a well-known international organization dedicated to providing assistance and support to children and families in need around the world. They are actively involved in disaster relief efforts, including delivering emergency supplies, healthcare, and education in crisis-affected areas.

In humanitarian logistics, UNICEF faces the challenge of ensuring the efficient and timely delivery of aid to children and families affected by natural disasters, conflicts, and public health emergencies. They must overcome obstacles such as poor infrastructure, limited access to remote regions, and rapidly changing conditions.

UNICEF has embraced a range of digital solutions to improve the efficiency and effectiveness of their humanitarian logistics operations. Table 2 explains these solutions in detail.

Table 2: UNICEF digital solutions used in humanitarian logistics operations

Type of digital solution	Role in the humanitarian logistics process
Digital Data Collection	UNICEF equips field teams with mobile devices to collect real-time data on the needs of affected communities. This data includes information on population demographics, health, and nutrition status, and infrastructure damage. Mobile data collection applications and tools allow for quick and accurate data entry.
Supply Chain Management System	UNICEF employs a robust supply chain management system that integrates data from various sources, including suppliers, warehouses, and transportation providers. This system helps in optimizing the procurement, storage, and distribution of relief items. It ensures that supplies reach the right locations at the right time.
Geographic Information Systems (GIS)	GIS technology is used to create maps of disaster-affected areas, track supply routes, and assess the impact of natural disasters. This spatial data is invaluable for planning and executing logistics operations.
Real-time Monitoring	UNICEF utilizes IoT devices and sensors to track the condition and location of relief shipments. This information is monitored in real-time at their logistics

	hubs and helps them respond to any issues or changes swiftly.
Communication and Coordination	UNICEF employs digital communication tools and platforms to coordinate with partner organizations, local authorities, and communities. This enables a more collaborative and organized response.
Blockchain for Transparency	UNICEF has experimented with blockchain technology to enhance the transparency and traceability of transactions and aid distribution. Blockchain can help ensure that aid reaches the intended recipients and reduce the risk of corruption.

Source: UNICEF (2023).

The adoption of digital solutions listed in Table 2 has yielded several positive outcomes for UNICEF's humanitarian logistics operations (UNICEF, 2023):

   a) *Improved Response Time*: Real-time data collection and monitoring enable quicker response to disasters and changing conditions, helping save lives.

   b) *Better Resource Allocation*: Data-driven decision-making ensures that resources are allocated to areas with the greatest need, preventing waste and inefficiency.

   c) *Enhanced Accountability*: Digital solutions enhance transparency, reducing the risk of aid diversion and mismanagement.

   d) *Efficient Supply Chain*: The supply chain management system optimizes the flow of goods, reducing delays and improving the overall efficiency of logistics operations.

   e) *Increased Community Engagement:* Digital communication tools allow for better engagement with affected communities, involving them in the decision-making process and tailoring aid to their specific needs.

   f) *Data-Driven Insights:* The vast amount of data collected provides UNICEF with valuable insights for future preparedness and response strategies.

In conclusion, UNICEF's use of digital solutions in humanitarian logistics has transformed their ability to provide assistance during crises. These solutions have improved their response times, resource allocation, and transparency, ultimately helping them fulfill their mission of safeguarding the well-being of children and their families in times of need.

5. CONCLUSION

The analysis within the paper has shown that the importance of using digital technologies in humanitarian logistics operations is paramount. These technologies significantly enhance the efficiency, transparency, and effectiveness of humanitarian efforts in several ways. Firstly, they provide real-time data and insights into the supply chain, which is invaluable for logistics planning and execution. This visibility helps organizations make data-driven decisions and respond effectively to rapidly changing conditions on the ground. Secondly, digital technologies optimize the allocation of resources, ensuring that vital aid reaches the areas with the greatest need. This prevents resource wastage and improves the overall impact of humanitarian interventions.

Furthermore, these technologies are instrumental in improving response times during crises. By streamlining data collection, analysis, and communication, they enable organizations to act swiftly and save lives in the critical early stages of a disaster. Additionally, digital solutions enhance accountability by providing transparent tracking of aid from origin to destination. This accountability is crucial for maintaining trust with donors and the affected communities. Moreover, these technologies improve coordination and communication among humanitarian actors, reducing duplication of efforts and ensuring a more cohesive and efficient approach to relief efforts. Digital solutions also allow for better risk assessment and preparedness planning, helping organizations anticipate and mitigate the effects of disasters, ultimately increasing resilience.

The future of research in this field will center on harnessing the potential of digital technologies to improve the effectiveness, efficiency, and sustainability of humanitarian logistics while addressing the unique challenges and ethical considerations that come with their use in crisis-affected contexts.

In conclusion, digital technologies are indispensable in humanitarian logistics, enabling better decision-making, efficient resource allocation, rapid response, and enhanced transparency, all of which are essential in providing timely and effective aid to those in need during emergencies.

6. LITERATURE

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