Research Article

DIGITAL TRANSFORMATION IN HUMANITARIAN LOGISTICS: IMPACT ON AGILITY, TRUST AND COLLABORATION

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Abstract

Humanitarian aid logistics is the process of managing resources, materials, people and information to ensure that aid reaches those in need quickly and effectively after a disaster. The supply chain must be flexible and adaptable to effectively coordinate post-disaster aid, ensuring that the right goods are in the right places at the right times. This study aims to examine the impact of digital transformation on agility, trust and collaboration in the humanitarian aid logistics supply chain. Digital transformation enhances supply chain efficiency by leveraging information technologies and digitalisation processes, while also fostering trust among stakeholders. Digitalisation improves information sharing during disaster response and makes supply chain processes more adaptable. Agile supply chains deliver faster and more effective services during disasters, while digital solutions enable the monitoring and understanding of the process. Furthermore, digital transformation facilitates collaboration and coordination among supply chain personnel, ensuring aid is delivered fairly and on time. The study's findings suggest that digital transformation is crucial for enhancing the effectiveness of humanitarian aid logistics supply chains and that digital technologies facilitate more efficient responses to disasters in aid operations. It presents a model to clarify the link between digital transformation and supply chain agility. It highlights the advantages of digital transformation in humanitarian aid logistics, particularly in improving key elements such as agility, trust and collaboration. The results obtained from the literature review provide strategic recommendations to humanitarian aid logistics actors on how to implement digital transformation more effectively.

Keywords: Humanitarian Logistics, Digital Transformation, Supply Chain Agility, Collaboration

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Introduction

To aid vulnerable individuals impacted by disasters, humanitarian logistics ensures the efficient and cost-effective flow, storage, planning, execution, and control of commodities, resources, people, competencies, and relevant information (Thomas & Kopczak, 2005). It is well-known that rapid organization and distribution of emergency supplies are crucial in the aftermath of disasters (L'Hermitte & Nair, 2021). Thus, it can be concluded that agility is a vital component of humanitarian relief logistics, and that quickness of response is extremely important (Dubey et al., 2016). According to Tse et al. (2016), operational efficiency is improved in agile supply chains because they are better able to respond to unexpected changes.

To improve coordination and information sharing, agile supply chains must incorporate information technology. Thanks to this digital integration, supply chain participants may trust one another more, which opens the door to further information exchange. Reducing wait times and improving material and information flow are two ways to increase agility (Khanuja & Jain, 2016).

The phrase "digital transformation" refers to the significant changes in operational procedures that have been brought about by breakthroughs in information and communication technology. These changes enhance a company's performance and operational efficiency, enabling a quicker response to changes in the external environment. Distributed networks can work together in new ways thanks to digital transformation (Vial, 2019). Humanitarian aid logistics are becoming more flexible due to digitalization, which makes it possible to respond to disasters more quickly and adjust to changing conditions.

The purpose of this study is to conduct a comprehensive analysis of how digital transformation impacts the responsiveness of supply chains in humanitarian logistics. In order to demonstrate how digital transformation increases agility in humanitarian logistics, this study aims to investigate the fundamentals of digitization and their effects on the supply chain. After a thorough review of the literature, this study will show how digital transformation can improve humanitarian logistics' agility, especially in dynamic contexts. The impact of digitization on the humanitarian supply chain will be clarified by this study.

Within the scope of the research, answers to the following questions were sought.

Q1. How does digital transformation increase agility in the humanitarian logistics supply chain?

Q2. How does digitalisation affect information sharing and collaboration in the supply chain?

Q3.What is the role of digital transformation in enhancing the capacity to respond quickly to disasters?

Q3.How do digital technologies strengthen trust and coordination between parties in humanitarian logistics?

Q4.What are the contributions of digitalisation to improving the effectiveness of the humanitarian supply chain?

The literature review in the study was conducted with a systematic approach. The Web of Science, Scopus, Google Scholar, and TRDizin databases were searched, using keywords such as "humanitarian logistics", "digital transformation", "supply chain agility", "trust", and "collaboration". Peer-reviewed studies between 2000-2023 were included, and only publications addressing digitalisation in the context of disaster/humanitarian logistics were selected.

This study aims not only to contribute to the literature with its findings but also to provide practical recommendations for humanitarian logistics stakeholders and researchers. At the end of the study, strategies and recommendations for the effective implementation of digital transformation will be elaborated.

1. Theoretical Framework

1.1. Humanitarian Aid Logistics

There is a significant increase in the number of both man-made and natural disasters every year. Due to the increase in population density and global developments, many areas are now

more vulnerable to natural disasters (Swanson & Smith, 2013). Unfortunately, the number of both natural and man-made disasters is expected to increase approximately fivefold in the next fifty years. This indicates that disaster relief operations and humanitarian logistics will become more complex and comprehensive (Kovacs & Spens, 2007).

Humanitarian logistics is a specialised branch of logistics that manages the provision of critical supplies and services in a wide range of time-competitive operations, often under challenging conditions such as uncertain supplies and demands, as well as infrastructure weaknesses (Apte, 2010). In another definition, humanitarian logistics refers to the process of planning, implementation, and control that ensures the efficient and cost-effective flow and storage of goods and services from source to consumer, thereby meeting the needs of the ultimate beneficiary (Thomas & Mizushima, 2005).

Humanitarian logistics encompasses various operations at different times and for various types of disasters. The primary objective of these logistics is to ensure the delivery of first aid supplies, food, equipment, and rescue teams to disaster areas, as well as to facilitate the safe and rapid evacuation of disaster-affected individuals and their transportation to healthcare facilities. Humanitarian logistics generally includes the phases of preparedness, emergency response and reconstruction (Kovacs & Spens, 2007).

Humanitarian logistics include planning, procurement, supply, transportation, monitoring, and storage. The goal is to get the right product to the right people at the right time. Logistics operations are very important for disaster relief because they take up a large part of the budget for these efforts. Logistics serves as a bridge between disaster preparedness, response, and distribution procedures to make sure that basic humanitarian needs are met quickly and effectively. It also keeps an eye on the flow of goods through the supply chain and gathers information that is important for figuring out how well the operation is working, like response costs and the availability of donated goods (Thomas, 2003).

1.2. Agility

In the field of humanitarian relief logistics, it is impossible to know exactly when and where a disaster will happen. The requirements also change depending on the type and date of the event. Transportation, communication, and coordination problems can also cause delays in interventions. Swanson and Smith (2013) found that these delays can have a big effect on finances. Logistics for humanitarian purposes that work save lives, ease suffering, and cut costs and response times. As a result, it is very important to carry out logistical operations quickly, fairly, and without any risk (Khan et al., 2019).

In times of disaster, meeting the basic needs of victims requires good planning and distribution of relief goods. Therefore, it is very important to find out exactly what the affected area needs (Khan et al., 2022a). After a disaster, thorough humanitarian assistance logistics are very important for people to get back to their normal lives (Swanson & Smith, 2013).

Businesses can better meet customer needs, adapt to changes in the market, cut down on inventory, and work better with their suppliers when their supply chain is more flexible. Mason et al. (2002) say that an agile supply chain lets you look at and change to real demand.

Agility is a crucial feature that prevents changes in the supply chain from causing disruptions in logistics activities, particularly in humanitarian logistics, where uncertainties are high. The key components of an agile humanitarian supply chain include volume flexibility, delivery flexibility, supply system flexibility, supply chain responsiveness and flexibility in product variety. These components enable the supply chain to rapidly adapt and increase its effectiveness in response to changing needs following donations and disasters (Yıldız, 2020).

Agility can be defined as the ability to respond quickly to changes in both volume and diversity. Since humanitarian aid logistics activities are carried out in environments where beneficiary needs change over time, become difficult to predict, and uncertainty prevails, this field has the most dynamic supply chain in the world (Kovacs & Spens, 2007). Therefore, organisations operating in humanitarian logistics need to specialise in agility. The main components

of agility are speed, flexibility, visibility and adaptability (Charles et al., 2010; Khanuja & Jain, 2016).

1.3. Collaboration

Humanitarian logistics are carried out in a complex environment of resource constraints, where information gaps and available information can be unreliable. Responding to large-scale disasters often exceeds the capacity of a single organisation or public response, so there is interaction between many different stakeholders involved in humanitarian operations. According to Kovacs & Spens (2007), the main stakeholders in humanitarian logistics include governments, militaries, logistics service providers, donors, aid agencies and non-governmental organisations.

It is well known that it is hard to command and control after a disaster. A lot of planning, organizing, and overseeing is needed for many tasks, such as getting, moving, and giving out relief supplies; collecting donations; figuring out what people need; and finding skilled workers. At every step of these processes, it is very important to make sure that all of the stakeholders are working together and coordinating well. On the other hand, failures or delays can cause more pain and even death (Tomasini & Wassenhove, 2009; Swanson & Smith, 2013). This shows how important it is to have a supply chain that is quick and flexible. To be agile, all parts of the supply chain must work together and use resources wisely (Khan et al., 2019).

Lack of trustworthy information is one of the main issues with logistics coordination (Khan et al., 2022a). In order to collaborate effectively, you must communicate your resources and strengths at the appropriate moment (Dubey et al., 2022).

The logistics of humanitarian relief involve a lot of people, but mistakes can still happen. Planning and coordinating humanitarian relief efforts requires careful consideration. Efficient development of operations, including transportation, storage, handling, distribution, and performance evaluation, is necessary to improve logistics performance. For any collaboration to succeed at this stage, logistics service providers are essential (Daud et al., 2016).

1.4. Technology Usage and Digital Transformation

Companies are developing new strategies to succeed in the competitive and unpredictable market of today. Digitalization is one of these strategies (Abourokbah et al., 2023). To satisfy the demands of stakeholders and consumers, businesses are undergoing a digital transformation. This entails integrating technology and digital skills into every aspect of their business operations. Organizational, operational, and cultural changes are made possible by this integration process, which permits adjustments to current business practices (Shalini & Devi, 2022).

Information systems are very important in determining whether humanitarian relief logistics operations are successful or not. When things go wrong, accurate data is very important for planning evacuations, tracking and meeting individual needs, and making sure everyone works together. In this case, dependable information systems make it possible to quickly send data. One of the most important things in humanitarian logistics is to make better coordination software (Kovacs & Spens, 2007).

Due to donor and stakeholder demands, as well as challenges in managing disaster relief operations' resources, efficient, safe, and equitable humanitarian logistics are essential. The demands of logistics operations can be effectively met through digital transformation, according to recent studies. Digitalization allows for the tracking of humanitarian aid logistics, beginning with the receipt of donations and resources and ending with their efficient distribution in disaster locations (Khan, et al., 2022b).

The logistics of humanitarian aid greatly depend on digital technologies. Communication is made more effective, transparent, reliable, adaptable, and traceable by technologies like cloud computing, big data analytics, blockchain, the internet of things (IoT), and artificial

intelligence (Preindl et al., 2020). With blockchain technology, transactions can only be recorded, accessed, altered, and verified by network users who have registered. This ensures that transactions take place in a secure manner and protects the original information (Khan et al., 2022b). Blockchain technology enables safe, quick, and transparent resource exchange. Additionally, it enables real-time transaction monitoring. Placzek and Switalska (2023) claim that by monitoring previous transactions and security breaches, this technology also increases transparency and security. These qualities are very beneficial to humanitarian logistics, which involves a lot of different people working together, because they enable responders with limited resources to make decisions quickly (L'Hermitte & Nair, 2021).

Another technological tool utilized in humanitarian logistics is the Internet of Things. Transportation, inventory management, and storage are just a few of the many tasks that the Internet of Things can assist with (L'Hermitte & Nair, 2021). L'Hermitte and Nair (2021) claim that RFID technology enables real-time delivery tracking, which facilitates prompt problem-solving. This facilitates planning, control, and coordination, increasing the supply chain's flexibility. When blockchain technology and the Internet of Things are combined, smart contracts are used to improve security, dependability, and transparency (Arias Aranda et al., 2019).

Cloud computing enables remote storage and processing of data through a distributed computing structure. Additionally, data analytics and artificial intelligence technologies are utilised to predict and optimise operations. Machine learning algorithms utilise historical data to aid in requirements forecasting and delivery optimisation. Various portals and applications enable the collection and sharing of information about relief activities in a given region in one place. This facilitates the fundraising process and ensures that needs are met quickly. Digital transformation ensures the security of data and supply chain in humanitarian logistics, while improving operational performance (Placzek & Switalska, 2023).

The contributions of these technologies to humanitarian aid logistics processes are summarised in Figure 1.

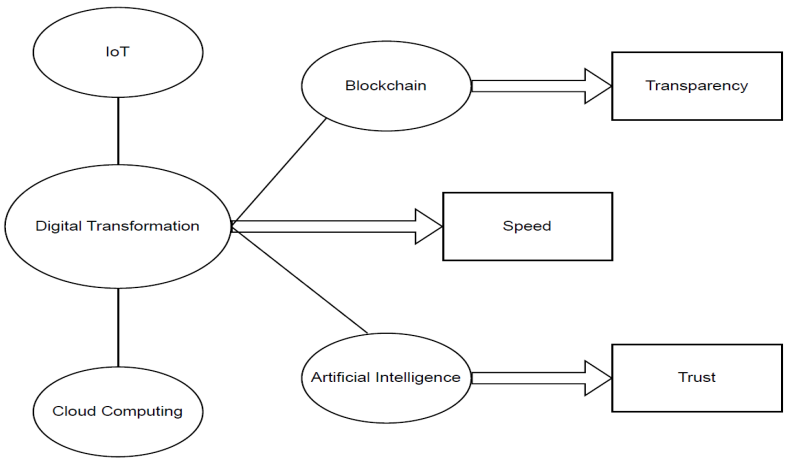

Figure 1. Impact of Digital Transformation on Logistics Processes

Figure 1 is based on research about how digital transformation technologies affect humanitarian logistics (Preindl et al., 2020; Khan et al., 2022b; L'Hermitte & Nair, 2021). Figure 1 shows how IoT, blockchain, AI, and cloud computing technologies all play a role in digital transformation and help with important parts of humanitarian logistics like trust, speed, transparency, and collaboration. These technologies speed up the flow of information in the supply chain, make it easier to track things, and create an environment of trust-based

cooperation among stakeholders. This makes it easier to manage post-disaster response processes.

Digital transformation has a lot of benefits for transportation management, route planning, vehicle tracking, fuel consumption management, and maintenance planning, to name a few. These new ideas make logistical operations more clear and easy to follow, which makes them more efficient. Digitalization makes it easier to collect and share information, which makes it easier for people to work together and lessens the chance of corruption. Vhikai et al. (2024) also found that sharing data in real time makes people more flexible and adaptable, builds trust and cooperation, and makes it easier to make decisions.

However, digital transformation also has some disadvantages. Firstly, the complexity of technologies and algorithms leads users to require technical skills. This challenge can be overcome with user-friendly applications. In addition, the various resources required for digital transformation, such as the provision of hardware and software, as well as the recruitment of specialised staff and training, incur significant costs. Donors primarily expect to meet the basic needs of those in need. Additionally, problems with the post-disaster communication infrastructure may negatively impact the effectiveness of digital technologies. Finally, big data storage operations may increase the risk of cyber-attacks (Khan, et al., 2022b; Placzek & Switalska, 2023).

1.5. Trust and Reliability

Since humanitarian supply chains are rapidly established in the aftermath of disasters, the concept of "trust" is critical to the effectiveness of these activities. Trust is a fundamental element for co-operation and coordination in logistics activities (Dubey, et al., 2022).

Trust can be defined as a belief in mutual reliability, honesty, helpfulness and fulfilment of obligations between the parties. A limited or lack of trust is common in the early stages of the change process. This leads to limited exchanges at the beginning. However, over time, as the positive results and the fulfilment of promises are realised, the commitment and trust between the parties increases (Lambe et al., 2001).

Humanitarian processes occur in high-stress environments where resources must be mobilised immediately and decisions must be made quickly. In such emergencies, there is insufficient time to identify the best resources and build trust with organisations willing to participate (L'Hermitte & Nair, 2021). In disaster relief operations, a lack of trust, poor collaboration, and delays in response time negatively affect the effectiveness of humanitarian organisations. Information sharing between parties increases supply chain visibility and strengthens trust among stakeholders involved in relief operations. Increased trust leads to improvements in co-operation, communication and agility. Hence, increased trust also increases the level of co-operation (Dubey, et al., 2022).

L'Hermitte and Nair (2021) categorise trust in terms of logistics resource users and providers as follows: Trust in terms of logistics resource users: Trust in the provider refers to the belief that the provider will fulfil its obligations, such as transport and storage. Trust in the platform: The belief that the digital platform provides reliable matches, supports efficient transactions and uses algorithms that apply predetermined rules and contract terms. Trust in the product: Belief that the emergency supplies and logistics services provided will meet the user's needs. Trust in the logistics resource provider: Trust in the user: Belief that the user will take care of logistics resources such as shelter supplies, transport and transport vehicles. Trust in the platform: The belief that the platform provides secure payments using reliable algorithms (L'Hermitte & Nair, 2021).

It has been emphasized that establishing trust on both sides depends greatly on the counterparty and the platform used to transfer resources. Because it allows donors to view the amount of money they have contributed and its progress at any point in time, digitization is a good way to increase public trust (Khan et al., 2022b).

Blockchain technology makes global supply chains safer and easier to monitor, which helps to increase consumer trust. Every step is traceable and unchangeable because blockchain records every transaction. Current systems, on the other hand, rely on fragmented information flows that make precise product tracking impossible. This eliminates risks like fraud and incorrect information transfer and makes the supply chain easier to see. Every participant in the distributed ledger has access to the data that the blockchain stores for every transaction. Every transaction is examined twice by separate computers in order to prevent counterfeiting and protect data. By making cross-border transactions safer, quicker, and less expensive, blockchain technology also increases the trustworthiness of supply chains (Kaya & Yıldız, 2024). By establishing transparent smart contracts for fund distribution, blockchain technology improves stakeholder trust, according to Saad et al. (2023).

Reliability stands out as a fundamental capability that humanitarian organisations should possess. Reliability in humanitarian logistics can be defined as the ability of the supply chain to meet the needs under specified conditions and timeframes, and the capacity to maintain the system's functionality in the face of unexpected situations. Ensuring this reliability is possible through effective real-time information exchange (Roh et al., 2022).

If humanitarian aid logistics are not reliable, supply disruptions may occur during or after a disaster, jeopardising human life and increasing social costs. Since humanitarian interventions must be carried out within 72 hours, the demand for emergency supplies increases, and the supply chain may reach its capacity. While the reliability objective of commercial supply chains is to maximise profit, the objective of humanitarian supply chains is to efficiently procure relief supplies and reduce disaster losses. Increasing rescue costs and operational resources also increase costs, so a balance between reliability and cost must be struck (Zhang et al., 2019).

Reliability in humanitarian supply chains is usually analysed in three main components: delivery reliability, transport reliability and disaster response infrastructure. Delivery reliability refers to the timely and accurate delivery of the required quantity to the intended recipients. Transport reliability encompasses components such as vehicle availability, transport capacity and transport time, which are necessary to deliver the aid at the specified time. Finally, disaster response infrastructure encompasses information and communication infrastructure, storage capacity and quality, as well as the adequacy of skilled humanitarian personnel (Sutrisno et al., 2020).

As an example of practices to increase reliability, a study conducted in Taiwan can be cited. In this study, a software was developed and made available to volunteers to share the latest information and photos related to the disaster. This technology made the relief operations in the disaster area more coordinated and ensured reliable control of the supply of materials. In humanitarian logistics, the real-time flow of information significantly enhances the reliability of the supply chain (Roh et al., 2022).

1.6. Effective Warehouse Management

Post-disaster humanitarian aid logistics is of critical importance because the first 72 hours after a disaster represent a life-saving period. Within the first 24 hours, humanitarian organisations and professional staff are positioned in the disaster area to identify the needs in the region. Within the first 36 hours, calls and requests are made by governments, international non-governmental organisations and other stakeholders. It is of great importance to prioritise and sort material donations, comparing them with existing demand. Procurement activities start with cash donations. The efficient functioning of the humanitarian aid supply chain is crucial for the rapid delivery of aid to disaster victims. However, short response readiness times can lead to inventory shortages (Swanson & Smith, 2013). Therefore, it is crucial to ensure the timely implementation of post-disaster operations, an adequate supply of materials, and effective storage strategies (Ertem et al., 2010).

Inventory management in humanitarian logistics is a challenging and uncertain task. Long-term pre-positioning is done at strategic warehouses in the days before disasters. However,

as soon as a disaster strikes, these items must be transported to the affected area. Due to factors like timing, location, and the volume of demand, humanitarian organizations find it challenging to determine what supplies to store, where to store them, and how much to store (Balcik & Beamon, 2008). This is a major barrier to the supply chain's effective operation.

Reliable delivery, dependable transportation, and disaster response infrastructure are the cornerstones of humanitarian supply chains. Aid is dependable when it is provided to the appropriate individuals at the appropriate time and in the appropriate quantity. The length of the trip, the number of passengers that a vehicle can accommodate, and the availability of vehicles all have an impact on how reliable transportation is. Disaster response infrastructure, according to Sutrisno et al. (2020), also consists of adequate storage space, a sufficient number of trained personnel, and efficient information and communication technologies. All of these factors demonstrate how crucial it is to have effective logistics and warehousing in place to ensure a successful disaster response.

A major issue in the supply chain that develops following a disaster is the time and cost required to obtain adequate relief supplies from both domestic and foreign vendors. In order for operations to begin promptly after a disaster, emergency relief supplies should be stored in key locations beforehand. However, planning ahead may result in financial difficulties (Balcik & Beamon, 2008). It can be challenging for humanitarian aid logistics to function after a crisis due to issues with transportation infrastructure, road closures, a shortage of vehicles, high fuel prices, a shortage of skilled personnel, and physical obstacles (Altay & Labon-te, 2014).

The logistics of providing humanitarian aid can greatly benefit from technological advancements. Artificial intelligence (AI), blockchain, and the Internet of Things (IoT) are examples of digital transformation tools that can assist warehouse managers in maintaining transparency and traceability. These digital technologies have a significant impact on the effectiveness of warehouse management and transaction efficiency, according to studies by Khan et al. (2022b) and Khan et al. (2023). Therefore, precise inventory control, strategically placed warehouses, an open and adaptable management structure, and the development of supply networks backed by collaboration from both domestic and foreign organizations are all critical components of humanitarian logistics. An essential tool for managing these procedures more easily, safely, and transparently is digitalization.

2. Literature Review and Establishment of Research Hypotheses

2.1. Digital Transformation and Supply Chain Agility

L'Hermitte et al. (2015) assert that supply chain agility denotes the ability to manage and react to unexpected situations. Humanitarian logistics often works in unstable and unpredictable situations, so it needs a flexible adaptation process instead of a well-planned strategy. Meeting people's immediate needs is the most important thing in this line of work. Humanitarian logistics has a hard time managing limited resources while also responding quickly. After a disaster, damage to transportation networks would make detours necessary. This could lead to logistical chaos as many aid organizations try to get to the affected area (Kunz et al., 2017). There are many problems that humanitarian supply chains have to deal with, such as quickly getting emergency relief supplies to people, finding reliable supply sources, keeping good coordination, and running logistics. To do these tasks well, you need access to real-time supply and demand data, which is hard to get during a crisis (Rasyi-di & Kusumastuti, 2020).

Agility is only possible when everyone in the supply chain can share information with each other in a useful way. Suifan et al. (2020) say that the information given must be up-to-date, correct, useful, and trustworthy. Digital transformation has made it possible to share this data whenever it is needed (Khan, et al., 2022a). Preindl et al. (2020) say that digital

technologies make supply chains much more flexible by speeding up the flow of real-time information.

Companies that go through digital transformation get benefits like better performance, sustainability, and a focus on the customer. This is because it combines information, informatics, communication, and connection technologies to make organizations stronger. Some of the benefits of digital transformation are better operational efficiency, automated business processes, lower costs, and faster response times. Artificial intelligence and big data analytics are two examples of digital technologies that make decision-making faster and better. Digital transformation can help businesses become more flexible and respond more quickly to changes in their environment. Digital technology adoption also improves other important performance measures, such as growth, innovation, competitive advantage, financial performance, and reputation. Digital transformation encourages businesses to look at their surroundings and change their main activities to improve their chances of survival. Al Jabri et al. (2024) say that digital transformation has a big effect on agility, which is the ability of organizations to respond quickly and improve their performance.

Suifan et al. (2020) discovered that the exchange of accurate and timely information substantially improves supply chain agility. Digitalization makes it much easier to share this information. Khan et al. (2022b) found that digitalization has a positive effect on important parts like accountability, transparency, trust, cooperation, and agility in their study of how digitalization affects supply chains. According to Zhou et al. (2023), digitalization makes supply chains more flexible and easier to track.

Based on these findings, a hypothesis was formulated to investigate the correlation between digital transformation and supply chain agility:

H1: Digital transformation has a significant positive effect on supply chain agility.

2.2. Digital Transformation and Trust

A company's performance can be directly improved by digital transformation if its digital knowledge is used effectively, and productivity can be increased even without knowledge exchange being necessary. Knowledge sharing between companies does not happen by chance, according to agency theory; it necessitates cooperation predicated on trust. Digital transformation encourages greater involvement in creative processes and risk-sharing by fostering trust between businesses. Kim et al. (2024) highlight the effect of the digital revolution on trust.

Prompt acquisition and distribution of resources is of the utmost importance in the humanitarian aid logistics industry, which deals with the urgent satisfaction of requirements in the aftermath of disasters. Although this need for quick responses speeds up the decision-making process, it leaves little room for thoroughly investigating potential vendors. Consequently, contracts are sometimes awarded to untrustworthy or unskilled companies that fail to meet their promises (L'Hermitte & Nair, 2021). The timely, adequate, and high-quality delivery of relief may be jeopardised as a result. At its worst, human casualties could occur as a consequence of the improper delivery of products and services to recipients in humanitarian aid logistics.

A key player in humanitarian logistics is the donor. Donors want their money to go to those who can use it the most. Any uncertainty in this area might cause people to lose faith in humanitarian organizations, which in turn reduces the quantity of money donated. Within this framework, digitalization emerges as a powerful instrument for fostering confidence among supply chain participants. According to Khan et al. (2022b).

According to Khanuja & Jain (2016), the integration of digital technology in supply chains boosts trust and satisfaction, which in turn allows for increased information exchange. According to Kab-ra & Ramesh (2016), parties are able to trust one another more when they utilize information technology. Additionally, digital technologies such as blockchain enhance

confidence among stakeholders in humanitarian logistics (Saad et al., 2023; Vhikai et al., 2024).

Based on these results, we postulate the following about the impact of digital transformation on confidence:

H2: Digital transformation positively and significantly affects trust.

2.3. Digital Transformation and Collaboration

Donors, humanitarian agencies, governments, the military, NGOs, and logistics suppliers are just a few of the many independent entities who participate in relief efforts following a disaster. The goals of the various organizations are subject to change because they are all run by separate boards of directors. But for relief efforts to be successful, cooperation and coordination are key. To meet the needs of disaster victims at lower prices, collaboration within the supply chain is essential. Organizations may waste resources, misuse them, and fail to respond quickly enough to catastrophe victims if they do not work together and coordinate their efforts (Ganguly et al., 2017).

All three of these things—information, commodities, and money—are constantly moving down the supply chain. Information technology is very important for bringing all the parties together. Information technology, which acts as the central nervous system of supply chain management, helps it sense and react better. Because of this, information technology is necessary for any supply chain to work well. Hudnurkar et al. (2014) assert that a pivotal element of effective collaboration is the dissemination of information.

With the help of digital transformation, supply chain partners may more easily gather, analyze, and share information in order to work together more efficiently. When stakeholders utilise communication tools and information management systems, they are more effective in sharing current information and collaborating. Humanitarian logistics can benefit from the increased communication efficiency brought about by technologies like cloud computing, artificial intelligence, blockchain, IoTs, and big data analytics (Vhikai et al., 2024). Better cooperation and coordination among stakeholders in humanitarian logistics is a direct result of advances in information technology and communication infrastructure, according to Altay & Labonte (2014) and Saad et al. (2023).

One of the most important ways digital transformation can help alleviate these negative aspects, improve coordination and collaboration among assistance organizations, and lower costs is by facilitating the rapid sharing of information (Khan et al., 2022a). Supply chain product and vehicle tracking made possible by new electronic tracking technology facilitates cooperation through the timely generation of accurate information (Preindl et al., 2020).

In light of the research conducted in this context, the following hypothesis was developed on how digital transformation affects collaboration:

H3: Digital transformation has a positive and significant impact on collaboration.

2.4. Trust and Collaboration

Trust is a key factor in the initial stage of co-operation, and a sound co-operation relationship is based on mutual trust and commitment between the parties. Partners with high levels of trust are willing to allocate more resources to cooperative relationships. It is stated that commitment and trust have positive effects on co-operation (Wu et al., 2012).

Trust is defined as the ability of supply chain parties to fulfil the terms of the contract. Trust helps to improve the relationships between the parties by reducing the perceived level of risk between stakeholders. The trust structure is also directly related to the duration of the relationship. Initially, "trust", which is based on the information received from trusted third parties and has a fragile structure, is strengthened over time with the increase in the level of exchange and relationship and the increase in the level of information obtained (Başkol, 2014). An increasing level of trust leads to an increase in the level of co-operation. Lack of

trust in the supply chain is one of the most important barriers to co-operation (Thomas & Skinner, 2010).

The supply chain encompasses all processes, from the point of supply to the consumer, in order to respond more quickly to customer demands and needs. In this process, multiple parties collaborate. Effective use of resources and sharing of competences for the realisation of a common goal are only possible through these collaborations (Yılmaz, 2016).

Collaboration becomes even more crucial in contexts such as humanitarian logistics, where multiple parties are involved and the timely delivery of the correct supplies to the right people is of the utmost importance. Many lives can be lost, resources can be wasted, and expenses can increase if people don't work together. Humanitarian relief operations are less effective due to a lack of confidence in humanitarian logistics, which hinders collaboration among parties (Shayganmehr et al., 2024).

In a study conducted by Yılmaz (2016), the positive effect of trust on collaboration was emphasised. Similarly, Dubey et al. (2022) found a positive relationship between trust and collaboration.

In light of these findings, the following hypothesis was developed to examine the relationship between trust and co-operation:

H4: Trust has a positive and significant effect on collaboration.

2.5. Collaboration and Agility

People must cooperate in order to increase flexibility. When a supplier and customer collaborate effectively, they exchange information, complete tasks, and plan crucial actions. Mutual alignment, cooperation, shared goals, and cooperative problem-solving are all necessary for this partnership to succeed. By collaborating more closely, businesses can better meet the needs of their customers. To create new products and improve existing ones, a lot of information must be shared. Agility performance is significantly impacted by strong supplier collaboration. This facilitates businesses' ability to be more flexible and agile when developing new products. The degree of cooperation in this situation is a key factor in determining agility performance (Narayanan et al., 2015).

The logistics of humanitarian aid are always changing and involve a lot of different people. Sharing information, getting resources, getting, moving, storing, and delivering relief goods are all important steps in this process that need to be coordinated. When people work together well, they can save time and energy by sharing information in an emergency. This makes it easier for everyone to get ready together. A flexible humanitarian supply chain is what makes it possible to quickly get life-saving supplies to people after a disaster. Collaboration is a key part of the agile supply chain (Dubey et al., 2022).

By working together with other companies in its supply chain, a company can make its own supply chain more flexible and responsive to changes in demand (DeGroote & Marx, 2013). Dubey et al. (2022) found in their study that working together makes you much more agile.

From these findings, we hypothesized the subsequent correlation between party collaboration and agility:

H5: Collaboration *has a positive and significant effect on agility.*

As a result of the literature review, the research model in Figure 2 was developed.

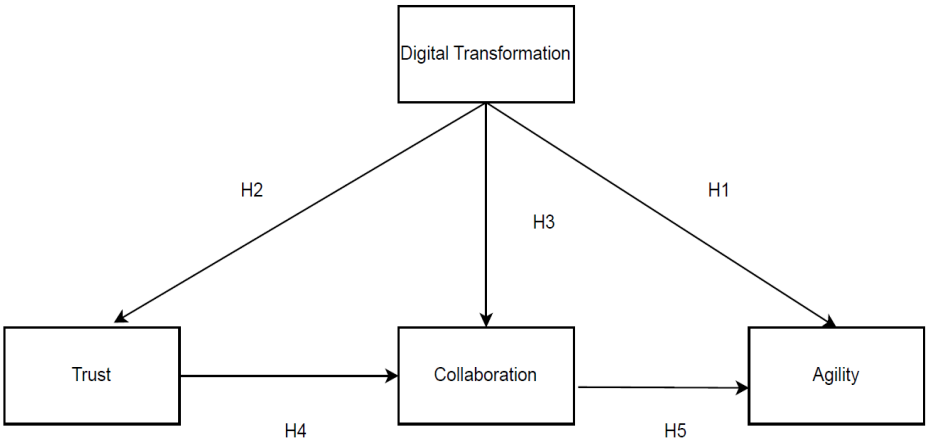

Figure 2. Developed Conceptual Model

Conclusion

The purpose of this study is to investigate how humanitarian logistics have been altered by digital transformation, with an emphasis on the interplay between factors like supply chain agility, cooperation, and trust. Significant evidence that digital transformation enhances humanitarian logistics processes and promotes cooperation and trust amongst various stakeholders is presented by the literature review and analysis. Additionally, digitization is required to increase supply chain flexibility and expedite the delivery of aid to disaster-affected individuals.

The results of the literature review, which was carried out in accordance with H1, support the idea that digital technologies increase supply chain agility. When it comes to humanitarian relief logistics, speed is crucial, particularly in the wake of a disaster. In addition to increasing supply chain flexibility, digital transformation facilitates quicker and easier supply chain process management (Preindl et al., 2020). Digital transformation improves supply chain flexibility and responsiveness, which leads to better process management, according to research.

Digital technologies contribute to the development of trust, according to H2 research. Several studies have highlighted the positive effects of digital technologies like blockchain and the Internet of Things on supply chain participants' trustworthiness, which leads to improved coordination and cooperation (Khan et al., 2022; Saad et al., 2023). Digitalization has been found to increase stakeholder transparency and transaction traceability. By monitoring the process at every stage, all parties involved in the supply chain can establish solid collaborations.

Digital transformation facilitates collaboration among supply chain participants, according to presentations on H3. When individuals collaborate, they can provide assistance in times of need, such as humanitarian logistics, in a timely and efficient manner. Digital technologies improve information sharing by streamlining communication processes, according to Hudnurkar et al. (2014). Consequently, this increases the likelihood that the collaborative planning process will succeed. Two additional advantages of digitization are that it reduces waste and improves resource utilization.

Trust and cooperation are key factors in making the supply chain more agile, according to the results of H4 and H5. Trust and collaboration, according to the literature review (Yılmaz, 2016; DeGroote & Marx, 2013), are essential components that boost the adaptability of a supply chain and play a pivotal role in the timely delivery of relief supplies following a disaster. Cooperation between stakeholders must be secure and efficient in order to create agile supply chains in humanitarian relief logistics. Every link in the supply chain must work together on this, and digital transformation is just one way to achieve it.

After reviewing the existing research on the topic, this study comes to the conclusion that supply chain digital transformation improves the connections between agility, trust, and cooperation in humanitarian logistics. Future studies and clinical procedures may be affected by these findings. One effective strategy that can assist in addressing these demands is digitalization. Digital transformation in supply chain management and logistics has numerous advantages for businesses. These advantages include reduced expenses, improved operational procedures, increased traceability and transparency, improved warehouse management, increased speed, agility, and flexibility, and increased mutual trust. Companies must therefore undergo digital transformation if they wish to remain ahead of the competition. Within this framework, this study examined how the digital transformation affects the logistics of humanitarian aid. Finding the closest suppliers and the best ways to get to the aid area, ensuring that the right aid arrives on time, determining what people in disaster areas need, and fostering trust through greater transparency and process compliance are just a few of the tasks that digital transformation technologies make more efficient. The findings demonstrate how digital transformation fosters collaboration and flexibility among supply chain participants.

A thorough review of the literature showed that, especially in the national literature, there were insufficient case studies and experimental research to support the topic. It is anticipated that the study will offer the researchers direction in this area. In order to improve their processes through continuous learning, the state, the military, humanitarian aid organizations, donors, service providers, and organizations working in the communication and technology domains will all have the opportunity to participate in the studies and learn from the findings. We can learn about the benefits and drawbacks of digitization, as well as possible remedies and actions to address them, through empirical research.

By examining how digital transformation affects supply chain agility, the first hypothesis investigated the claim that digital technologies improve this quality. The impact of digital transformation on supply chain agility has been highlighted in the literature (Pre-indl et al., 2020). According to studies, digital technologies speed up and improve the efficiency of the supply chain, allowing it to react faster. Rapid logistics operations are crucial following a disaster, and digital transformation enables them. The supply chain must be adaptable if aid is to reach the disaster area in a timely manner. Supply chain operations become agile through increased speed and flexibility brought about by digitalization.

This is also supported by the study's findings. Supply chain operations become faster, more flexible, and more efficient with digital transformation. This is crucial in situations that are temporary and urgent, such as humanitarian logistics. The results of this study support the claims made by DeGroote and Marx (2013) about the function of digital technologies in promoting agility through cooperation by showing that digitalization is a powerful instrument for improving supply chain agility.

Digitalization increases stakeholder trust in one another, according to our testing of H2, which examined the impact of digital transformation on trust. Transparency and traceability may be significantly impacted by digital transformation. Digital technologies improve supply chain trust, which in turn promotes cooperation and effective coordination (Khan et al., 2022). The study unequivocally demonstrates how digital tools—particularly blockchain—help foster trust. Because every transaction is tracked and recorded, blockchain technology fosters trust amongst those involved. The supply chain will become more dependable as a result.

However, digitization increases the transparency, traceability, and trustworthiness of data sharing. According to Saad et al. (2023), digitalization facilitates and secures information sharing. According to the study's findings, digitalization speeds up operational procedures and makes building trust easier.

Digital technologies facilitate stakeholder collaboration, according to H3, which examined the impact of digital transformation on teamwork. The literature also highlights how digitization improves cooperation by making it easier for supply chain participants to coordinate and share information. According to Vhikai et al. (2024), digital transformation improves stakeholder interaction, particularly when it comes to big data analytics, cloud computing, and the Internet of Things. According to this study, digital tools improve logistics communication, which strengthens teamwork.

According to the results, the current study supports the idea that digital technologies, particularly in the areas of communication tools and knowledge management systems, make collaboration easier. One advantage of digitalization is that it facilitates communication amongst stakeholders, which makes it simpler for people to cooperate in order to accomplish shared objectives. Du-bey et al. (2020) discussed the significance of digital transformation for fostering collaboration and trust. According to our research, digitalization speeds up the management of these procedures and improves supply chain collaboration's effectiveness.

H4 and H5 investigate the relationship between supply chain agility, collaboration, and trust. The importance of cooperation and trust in enhancing agility has been underlined in the literature (Shayganmehr et al., 2024). Adopting digital transformation strengthens these ties and increases supply chain flexibility. It becomes more evident how crucial cooperation, trust, and adaptability are during the post-disaster processes. This is how SCM is more significantly impacted by the digital revolution.

The results of the study show that digitalization has a major effect on the development of frameworks for cooperation and trust that are necessary for building agile supply chains. This study found that digitization strengthens the relationship between agility and collaboration, which is consistent with the findings of Dubey et al. (2022).

The study's conclusions about how digital transformation affects cooperation, trust, and agility in humanitarian logistics highlight how crucial digital technology is to enhancing supply chain operations' efficacy. The results show that digital transformation improves supply chain agility by streamlining operational procedures and encouraging cooperation and trust among stakeholders. The findings demonstrate the potential benefits of digitalization for short-lived and dynamic systems, such as humanitarian logistics. Future studies in this field will greatly benefit from this data.

For digital transformation to be successful in humanitarian logistics, more funding is required for digital infrastructure, and local suppliers must be replaced. Digital transformation will increase the efficiency of logistics processes, despite the initial high cost. Therefore, creating digital training courses and infrastructure support packages is crucial. Additionally, everyone involved needs to increase their digital literacy and learn how to use technology in an emergency.

In humanitarian logistics, honesty, open communication, and trust are crucial. Digital tools, particularly blockchain and the Internet of Things, can help make information sharing easier to understand and more visible. Nonetheless, data security policies must be created and stakeholders must receive security training. Digitalization can improve communication and collaboration between local suppliers and donors.

Just as crucial as establishing strategic collaboration agreements at the national and international levels to promote cooperation is identifying and resolving the issues impeding digital transformation. During disasters, digital platforms based on shared goals can help people work together more quickly and respond better.

The supply chain's flexibility determines how quickly and efficiently you can use your resources after a disaster. Accordingly, digital technologies must facilitate flexible supply chain strategies, and digital infrastructure must be adaptable. Digital tools can aid in the more effective and efficient management of supply chain operations in disaster areas.

Rapid and accurate information sharing is essential for humanitarian logistics to function and enable prompt and efficient disaster responses (Altay & Labonte, 2014). Examining how knowledge sharing affects transparency, accountability, and confidence in this context is crucial. Relief organizations and donors seek a transparent method of providing funds as well as evidence that the assistance is having an impact (Khan et al., 2019). Therefore, it is crucial to look into how the efficiency of logistics systems and stakeholder trust are improved by the free flow of information. Researchers need to look more closely at how digitization might improve transparency and accountability. Future humanitarian operations would

benefit greatly from more research on the effects of digital tools like blockchain and the Internet of Things on supply chain traceability and transparency.

Humanitarian aid logistics must be flexible in order to distribute relief supplies in a timely and accurate manner (Baharmand et al., 2019). But remember that obtaining accurate and timely information is the most crucial factor that contributes to flexibility. The supply chain benefits greatly from IT's ability to increase flexibility and speed up decision-making (Jermsitti-parsert & Pithuk, 2019). Future studies should focus on a more thorough examination of the flexibility offered by information technology. More information about how digital transformation improves resilience among supply chain stakeholders and is crucial for quick responses to trouble spots is needed to address the shortcomings. Furthermore, it is possible to investigate how uncertainties and a lack of information lead to disruptions in logistics activities (Zhou et al., 2023).

When it comes to humanitarian logistics, the funders are the most crucial link in the supply chain. They should anticipate that their gifts will be handled quickly, honestly, and carefully. Further studies in this area should look at how digitization can improve donor relationships by fostering trust and increasing contributions. By involving contributors at every step of the assistance process, digital transformation can increase transparency and accountability. The potential use of digital tools to strengthen donor relationships requires further investigation by researchers. One important question that may be answered by further research in this area is how successful digitization could boost donor confidence.

Promoting the use of local suppliers is crucial as hu-manitarian logistics undergoes a digital transformation. Everyone, including businesses, nonprofits, and the government, should have access to digital logistics systems. These systems will facilitate resource sharing, inventory management, and disaster preparedness. To effectively utilize digital resources, field employees should receive frequent training on technology usage and digital literacy. Strong cybersecurity safeguards and data protection guidelines should be implemented for digital systems utilized in the humanitarian supply chain.

In an emergency, the ability to make prompt and accurate logistical decisions is crucial for humanitarian assistance. Obtaining and disseminating pertinent information promptly is crucial for precise and prompt decision-making. Decision support system digitization may speed up and improve the efficiency of this procedure. The effects of the digital revolution on emergency management can now be further explored in future studies. Research can con-centrate on discovering improved methods for incorporating data analytics and machine learning into decision support systems, facilitating more effective assistance delivery.

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