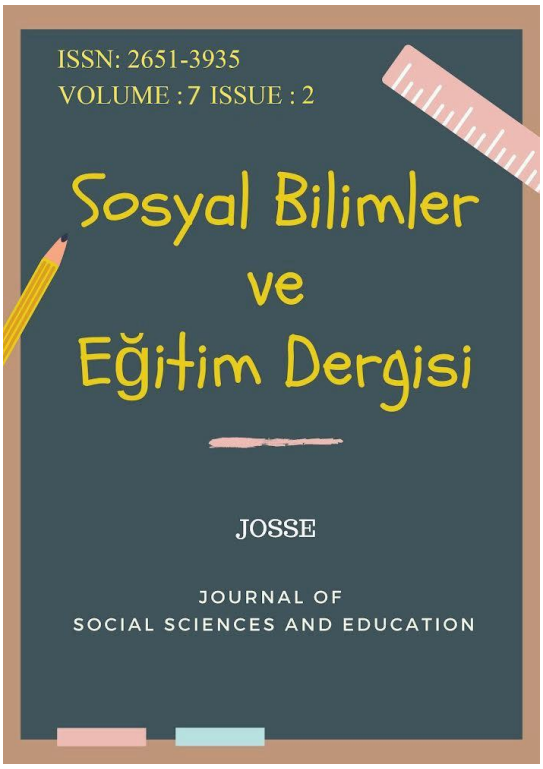
JOURNAL OF SOCIAL SCIENCES AND EDUCATION (JOSSE)



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Future of Earthquake-Based Disaster Logistics and Futuristic Approaches

Nazlıcan DİNDARİK [1]
Bartın University, Vocational School, Business Management, Dr.
ndindarik@bartin.edu.tr
Orcid ID: 0000-0003-4313-6576

Ayşe ATABEY BÖLÜK [2]
Ostim Technical University, Vocational School, Logistics, Dr.
ayse.atabey@ostimteknik.edu.tr
Orcid ID: 0000-0003-3469-5835

Article Type: Research Article
Received: 20.08.2024
Accepted: 27.10.2024
Published online: 28.10.2024

Citation: Dindarik, N., & Atabey-Bölük, A. (2024). Article title. *Journal of Social Sciences and Education, 7*(2), 257-278.

Future of Earthquake-Based Disaster Logistics and Futuristic Approaches

Nazlıcan DİNDARİK [1]

Bartın University, Vocational School, Business Management

Ayşe ATABEY BÖLÜK[2]

Ostim Technical University, Vocational School, Logistics

Abstract

Disasters that occur in the world can be caused by natural as well as human-induced factors. These disasters cause damage to cities, villages, and inhabited areas, and also result in loss of life and property. Accurately and effectively planned disaster logistics management activities are crucial during these moments when life comes to a halt. Today, it is evident that cities suffer damage or even face extinction due to deficiencies in planning, coordination, and opportunities within these practices. To mitigate the consequences of disasters and minimize damage, it is essential to always be prepared for such events and manage them well before, during, and after they occur. Disaster logistics practices should be dynamic and tailored to the specific event, suitable for addressing the situation at hand. Each disaster requires a unique set of solutions that depend on the area and geography affected. Therefore, disaster logistics must adopt and develop new approaches with a sustainable perspective. Given that earthquakes are among the disasters that occur frequently in our country, there is a critical need to create earthquake-based disaster management and action plans. Looking at disaster logistics from a futuristic perspective, it is clear that digital transformation technologies can have a significant and beneficial impact, making disaster logistics services more efficient, innovative, and solution oriented. The study conducted a literature review within the framework of qualitative research methodology, providing a detailed analysis of the role of digital transformation technologies in earthquake logistics processes. The literature review was conducted by reviewing relevant academic articles, reports, books, and scientific research. Special emphasis was placed on studies published in the last 10 years, focusing on the intersection of disaster logistics and digital transformation technologies.

Research Article

Received: 20.08.2024
Accepted: 27.10.2024
Published online:28.10.2024

Keywords: Earthquake, disaster logistics, the future of disaster logistics, futuristic approaches, digital transformation

[1] *Dr.*
ndindarik@bartin.edu.tr
Orcid ID: 0000-0003-4313-6576
[2]*Dr.*
ayse.atabey@ostimteknik.edu.tr
Orcid ID: 0000-0003-3469-5835

Introduction

Considering the effects of disasters on human life, as well as on all living things and many areas of society, it is seen that disasters are considered as extraordinary events. Disasters do not occur in a single way and are expressed in different classes. These; Flood, earthquake, tsunami, landslide takes place in many different ways. Among the aforementioned disasters, earthquakes, which endanger the lives of living things and affect human life, are among the areas that need to be examined. Earthquake; While it causes deaths and injuries, it also causes economic losses and disrupts social life. In revealing the disaster risks, the necessary preparations before, during and after the earthquake are realized with planning and coordination. In this direction, correct disaster logistics practices are needed in order to manage the process correctly.

Considering the fact that Turkey is located in an earthquake zone and has experienced severe earthquakes, the concept of disaster logistics is an important issue that should be emphasized. It is a fact that there are certain structural and administrative problems in the fight against disasters. Developing a disaster management approach to solve these problems is supported and expected. With a sustainable understanding, large-scale policies should be integrated into the system in a long-term way and disaster logistics practices should be carried out in a planned manner.

In the study, it is aimed to address the problems encountered in earthquake-based disaster logistics while determining disaster policies and to develop solutions for these problems. Among the expected developments in disaster logistics, sustainability, planning and coordination of the optimum storage areas for the disaster area, accurate estimation of alternative routes together with transportation and transportation infrastructure, determining the issue on the basis of technology, from which warehouse, in which order and by which transportation vehicle the product will be brought in the supply of demand-oriented products, Many topics can be counted, such as accessing warehouse and truck information on the system and monitoring the active process, having well-trained and ideal warehouse personnel who set speed as a criterion in warehouses.

Method

Type of Research: The research has a qualitative feature. In the light of the information given in the first chapters and the document review, a qualitative study was carried out in the last chapter.

Research Method: The study, reviews were presented using the document review method. Literature, reports and archives were searched about the future of disaster logistics and futuristic approaches. During the literature review phase, academic sources published at both national and international levels on disaster management and logistics were examined, with a particular focus on the effects of earthquakes and the logistics processes specific to this type of disaster. Based on the data obtained from these sources, potential areas for the application of digital transformation technologies in disaster logistics were identified and explored in depth.

Subject of the Study: It includes the determination of the role of possible technologies to be used in disaster logistics and the benefits that are thought to be presented to human life.

Purpose of the study: It is the examination of futuristic approaches that can be used within the scope of disaster logistics as a result of natural disasters and the development of awareness in this direction.

Importance of the Study: It is thought that it will contribute to the literature in terms of determining the factors affecting futuristic approaches in disaster logistics and disaster logistics, which have been emphasized in recent years.

1. Disaster Logistics

Disaster logistics is expressed as the use of logistics methods such as planning, coordination and resource management to deal with extraordinary situations such as natural disasters, disasters or emergencies (Barbarosoğlu et al., 2002, p. 118). Such events can occur for various reasons such as earthquakes, floods, fires, tsunamis, hurricanes, volcanic eruptions, epidemics. As Erturgut and Yılmaz (2020) stated, disaster logistics is a critical process that requires effective organization, cooperation and resource management. In this way, it is possible to reduce the damage caused by disasters and enable societies to return to normal life more quickly (Erturgut, Yılmaz, 2020, p. 106).

Disaster logistics aims to efficiently distribute resources to save lives, assist the injured and meet basic needs, by enabling emergency and rescue teams to reach affected areas quickly and effectively. During such events, the emergency needs of disaster victims such as medical care, shelter, water, food and cleaning must be met (Ersoy and Börühan 2013).

Disaster logistics requires effective cooperation and coordination between government agencies, non-governmental organizations, humanitarian organizations and other stakeholders. Disaster logistics is a complex and critical process that includes issues such as rapid response, flexibility, effective use of logistics networks and the importance of information sharing. For this reason, it is important that it is carried out by teams and experts specialized in disaster management and disaster logistics (Thompson, 2015, p. 168).

2. Problems Encountered in Disaster Logistics and Solution Suggestions

Disaster logistics includes all of the logistics activities that ensure the effective management of aid and resources during natural disasters or emergencies. During and after a disaster, many important difficulties and problems may arise. In this case, logistics is considered one of the most important areas among the activities to be done during and after the disaster, and the cost item is seen as the highest applications.

In disaster logistics, a fast, effective, effective and efficient process management is required, and it is expected that the activities to be done will be responded quickly in a way that will bring operational success towards the demands. Although it is a difficult task to ensure operational efficiency, it is essential and alternative solutions are needed for the problems encountered. It is very important to examine the problems that occur after the disaster and to understand the solutions to these problems, to minimize the wounds of the disaster and to be prepared for possible disasters. In this context, the problems encountered in disaster logistics and suggestions for solving these problems are explained in detail below.

2.1.Problems Encountered in Disaster Logistics

Disaster logistics operations require a lot of planning, coordination and coordination. Every unplanned action drags the already complex and intricate process into bigger problems and exposes it to bigger problems. From the moment of disasters, it should be acted with the awareness that everything that needs to be done is done in a race against time, and considering possible scenarios, false, incomplete and exaggerated data should be eliminated, demand forecasts should be made with data from the right sources, and search and rescue efforts should be started by distributing resources according to the size of the opportunities. It should be known that every decision made while managing the aforementioned process affects the next decision and lays the groundwork for possible problems. Logistics activities that need to be carried out after disasters occur should also be carried out in the light of this information, and logistics operation practices should be carried out by taking into account every variable in the

field. In disaster logistics, there may be unforeseen demand variations, possible damage to transportation routes, and unexpected situations depending on their location, shape and size. Along with these problems, the fact that many aid organizations act unaware of each other is among the problems faced. What needs to be done here is to act in cooperation with many different public and/or private institutions and organizations, government bodies and military units. Since disaster logistics operations are complex and chaotic structures, coordination is seen as an important building block at every step (Çınar and Mutlu, 2020, p. 54).

It is not possible to provide any predictions about where, when or how severe an earthquake-related disaster will occur. After the earthquake occurs, especially in the first stage, the extent of the damage, the accurate determination of the needs of the victims and the supply of resources are difficult. Disasters involving such an unknown cause many unknowns even after they occur, which is among the reasons that prevent the applicability of the disaster logistics process in terms of planning, effectiveness and efficiency (Sheu, 2007, p. 687).

While managing the operation in disaster logistics, issues such as demand uncertainties, resource allocation, uncertainties in the status of transportation routes, and the management of the transportation process carry uncertainties, and from this point of view, uncertainties should be taken into account during disaster preparation and planning (Galindo and Batta, 2013, p. 202).

As the first step after the disaster, damage assessment is carried out and humanitarian aid logistics activities are activated. As soon as a disaster occurs, the supply chain process is initiated and urgent needs are provided and delivered to the region. Depending on the condition of the transportation routes, the most accurate mode of transportation is selected and the needs must be dispatched to the region as quickly as possible. However, since the urgent needs are wanted to be sent to the disaster area as quickly as possible, the damage and needs analysis cannot be done very accurately in the first place (John & Ramesh, 2016, p. 63). Demands that are not predicted correctly cause disruption of aid activities in the post-disaster period and bring many problems with them. The main factors in the emergence of these problems are the deterioration in the flow of information, the unknown number of the population in need of help and accessibility (Lodree and Taskin, 2009, p. 4).

It is not easy for everyone to agree on disaster logistics operations, to meet on a common ground and to base them on a mathematical infrastructure, to make completely rational decisions, to manage activities on a process basis (Beamon and Balcik, 2008, p. 7). In this context, it is difficult to calculate costs with numerical data, since the main aim is to ensure that the disaster victims receive humanitarian aid and to alleviate the suffering to some extent.

Depending on the extent of the destruction at the disaster site, delays occur in providing, delivering and distributing the requests of those in need. Every damage that occurs in communication, distribution, transportation and energy infrastructure disrupts disaster logistics operations (Chakravarty, 2011, p. 5). Rapid delivery of aid to the region is a top priority for disaster survivors who need urgent help. All optimum planning made in ordinary logistics processes is out of order in disaster logistics, and the correct cost mentioned in the seven lines of logistics loses its validity in disaster logistics. Since time is racing, pragmatic solutions can be preferred on the basis of urgent assistance, regardless of cost. The delays increase as the road works for the extent of the destruction after the disaster take longer, which delays the delivery of aid and causes less aid to be sent during the delivery of aids (Chakravarty, 2011, p. 7).

The problems encountered in earthquake-based disaster logistics are mentioned, but when these problems are examined from a wider perspective, it is known that there are many other problems. Other problems encountered in disaster logistics are as follows (Çınar and Mutlu, 2020, p. 54., John and Ramesh, 2016, p. 63., Watson et al., 2007, p. 1., Day et al., 2012, p. 25, Balcik and Beamon, 2008, p. 102);

• Disasters cause adverse effects on logistics and organizational skills in the affected country.

• During natural disasters, power lines, communication infrastructure and communication systems may be damaged or interrupted. This makes it difficult to coordinate emergency teams and direct requests for assistance.

• Sending non-essential products causes loss of time during transportation and storage, but also causes wasted space.

• The fact that the demand for needs cannot be known with precise data causes difficulties in performance management in disaster logistics activities.

• It is difficult to maintain sufficient stocks before a disaster because it is uncertain which type of disaster will occur and when. For this reason, the problem of not having enough materials and resources to meet the urgent needs is frequently encountered in the event of a disaster.

• Congestion or closure of transportation routes after the disaster, transportation problems caused by the resulting debris cause disruptions in disaster logistics services.

• In the disaster preparedness process, there are deficiencies in the expectation of the emergency, and it causes serious problems in reaching the wrongly located emergency resources.

• Disaster victims and people who want to send aid to the city, medical support teams, firefighters and NGOs want to go to the disaster area at the same time, affecting the transportation and communication channels negatively. Disasters require complex coordination between different institutions, non-governmental organisations, governments and international aid organisations. The fact that many organizations and people want to provide assistance can create difficulties in coordination and make effective use of resources difficult.

• Disaster areas often carry security risks after the event. The destruction, disorder and confusion in the environment can threaten the safety of aid teams and add risks to logistics operations.

• Another problem encountered in disaster areas is caused by weather conditions. Severe weather conditions are often observed in disaster areas. In particular, situations such as storms, floods or tornadoes can seriously affect aid and logistics operations and put safety at risk. Similarly, conditions such as intense winter conditions, extremely hot weather, fog and rain in earthquake areas can disrupt the logistics process.

• After disasters, logistics operations are very important not only in the emergency aid phase, but also in the post-disaster reconstruction process. Repair and reconstruction efforts of the destroyed infrastructure require logistical attention and coordination.

• The emergence of epidemics in the disaster area is one of the problems that arise in the execution of the logistics operation. Problems in entry and exit to the region, difficulty in meeting individual needs are among the most important problems.

2.2.Solution Suggestions for Problems Encountered in Disaster Logistics

It is known that the response process for the size and actual location of the disaster requires different improvement and management stages at different time intervals. Logistics activities should be carried out in a planned manner in order to meet the food, shelter, medical supplies needs of the disaster victims, to evacuate the disaster victims and to do all these as soon as possible.

In addition to housing and health services after a disaster, it is of vital importance that many issues such as providing logistical support, making arrangements for transportation, taking security measures, and taking precautions against epidemic diseases are of vital importance in terms of quicker recovery of disaster survivors (Şipal, 2023, p. 821). In this respect, many problems are encountered in disaster logistics activities that will be provided for the benefit of the society after the disaster occurs and there are delays in the realization of the aforementioned services. Understanding the problems that occur in earthquake-based disaster

logistics correctly and developing solutions for them and implementing them are guiding in terms of reducing the damage that may occur in possible disasters. The need for expert disaster logistics personnel in the transportation, storage and distribution stages in the disaster area is not adequately met. Experienced ideal supply chain specialists and logisticians are faster and more effective in finding appropriate solutions to problems, based on their experience and using the knowledge gained from their past experience. For this reason, it is a fact that experienced logistics workers make more accurate decisions to solve critical situations and their numbers should be increased (Pettit and Beresford, 2009, p. 460).

Solution suggestions for the problems encountered in earthquake-based disaster logistics are listed as follows; (Kaya, 2023; Coşandal and Partigöç, 2022, p. 153; Foreword and Atalay, 2015, p. 3; TRT Haber, 2023; Özdemir, 2021, p. 42).

• Planning is the most important element for solving problems in disaster logistics. It is very important to plan ahead and be prepared for disaster situations. It is necessary to create strategic plans against possible scenarios by making disaster risk analyzes and scenario studies, and to be prepared with minimum predictable practices.

• In order to minimize the damage to the environment caused by the debris after the disaster, it is necessary to determine different routes and change the route in order to carry out the debris removal works in a fast and controlled manner and to realize alternative transportation. In order to be able to serve after the disaster, the vehicle delivery companies in the region should be determined in accordance with the risk management planning before the disaster and the determined companies should be sent to the region when the disaster occurs.

• Determining the suppliers in the region for the disaster area in national and international dimensions according to the nature of the disaster and shortening the waiting times in the disaster logistics processes are among the solutions.

• Studies are needed to strengthen coordination and communication. In terms of communication, more radio orbits should be established at points where satellite, GPS broadcasts, field radios and NGO radios are insufficient. There is a need for structuring in matters such as tower-base stations independent of buildings, strengthening the fiber infrastructure, shortening the procurement process of the wireless network. The number of mobile base stations should be increased. There is a need for alternative communication facilities such as shared use between operators. Radiolink, drone, 4G etc. communication alternatives should be developed.

• Logistic support selected from expert personnel in the disaster area is needed. The planned support for logistics and logistics personnel should be determined in advance. In

disaster situations, more than one institution and organization should intervene. Therefore, it is vital to ensure effective communication and cooperation among all stakeholders. Organizing joint trainings and doing exercises based on disaster scenarios are important in strengthening this coordination and solving problems.

• In order to facilitate transportation for international aid calls, customs, transportation and transportation problems should be prevented and coordination should be ensured.

• Since speed is one of the most important determinants in disaster logistics processes, cash aids are important in this regard. Rapid cash aid to the region is much more beneficial than the emotional and irregular aid that delays the process. This situation should be prevented as the lack of coordination created by people who want to go to the aid area irregularly causes delays.

• Awareness and preparation on a business basis is an important step in solving problems.

• Businesses and sectors in different fields should cooperate and sustainability should be the basis while doing this.

• It is very important to have regional warehouses at certain points. In this context, perishable food products should be stored in cold storage. It is important to make the chain store warehouses ready for disasters and to ensure their safety. Before a disaster, storage and stockpiling of critical materials is also important. Among these materials, emergency equipment such as food, water, medicine, blankets to meet basic needs should be kept.

• Bicycles, motor couriers and survivors can be micro-distributed in the disaster area in line with their needs. It is also important to provide loading and unloading equipment for microdistribution.

• Waste management etc. It is a necessity to get support from the logistics sector in these matters.

• Regular trainings should be given to human resources within the scope of search and rescue, burial, debris removal and emergency aid activities.

• There is a need for restructuring of AFAD and a supportive department that includes competent people in the field of logistics.

• Reporting the suggestions by academicians who are experts in their fields and sending these outputs to both Afad and NGOs is an important step in terms of cooperation.

• The fact that the Turkey disaster plan is being built together with the logistics master plan in order to make it more functional, it is predicted that acting together will positively affect the results.

3. Expected Developments in Disaster Logistics

Expected developments and preparations in terms of disaster logistics should be seen as the most important issue in cases where the existence of living things is in danger and should be carried out quickly. Considering the developments that need to be made;

- Advanced technology and automation applications,
- Data analytics and artificial intelligence applications,
- Sustainability and environmental awareness activities,
- Investments in fast communication and communication systems,
- Improved logistics and warehousing activities,
- Trained ideal warehouse personnel development,
- Ensuring the preliminary provision of ideal warehouse areas,
- Increasing human resources studies and training,
- Topics such as strengthening international cooperation and coordination can be listed (Ersoy and Börühan, 2013, p. 80; DeJohn 2005, p. 8; Aydın, 2020).

The most important development in disaster logistics is the use of applications based on advanced technology and automation. In the future, it is expected that more robotic technology and automation will be used in disaster relief and response processes. Autonomous drones and unmanned aerial vehicles can reach disaster areas quickly and perform tasks such as damage detection and aid distribution, and benefit from their use in disaster management processes both in our country and all over the world. In this direction, it is the first area that is expected to develop rapidly and effectively in disaster logistics (Adıgüzel, 2022, pp. 55-56). Data analytics and artificial intelligence applications used together with these technologies are also one of the most important areas that need to be improved in disaster logistics. Big data analysis and artificial intelligence can provide a better understanding of disaster predictions and their effects, and help to make better decisions before and after disasters, allowing resources to be distributed more effectively (Adıgüzel, 2022, p. 50).

Another area that is expected to develop in disaster logistics is sustainability and environmental awareness activities. In the future, the environmental impact of disaster logistics solutions can be taken into greater consideration. Environmental issues such as sustainable material use, energy efficiency and carbon footprint reduction may become more important in disaster response processes. It is important to prepare the society effectively and to participate in the response processes in disasters. In the future, a cultural change is expected in which society's sensitivity to disasters increases and skills to cope with disasters become widespread (Abbasi, Nilsson, 2016, p. 276, Kovács & Spens, 2007, p. 101-102).

Another area that needs to be developed and focused on is investments in fast communication and communication systems. Communication is critical in an emergency. It is expected that stronger communication infrastructures and emergency communication systems will be developed in the future in order to get the fastest solutions in disaster situations. In this way, it is possible to strengthen the communication between the disaster areas and the center and to ensure coordination quickly (Çınar and Mutlu, 2020, p. 53).

Improved logistics and storage activities are also one of the areas that need to be developed in disaster logistics. It is envisaged to develop more effective storage and distribution systems for disaster logistics. In order to react quickly to disasters, it is of great importance to store important materials and make them easily accessible when needed. After disasters occur, materials and goods that need to be delivered to those in need quickly and in a planned way are possible with the right storage activities. In this direction, it is important to make plans in the pre-disaster process and to develop studies on this subject, without waiting for the times when disasters occur (Önsüz & Atalay, 2015, p. 3).

Trained ideal warehouse personnel development is important for disaster logistics. Although the warehouse planning mentioned above is important, it is equally important that the personnel working in the planned warehouses are trained. In the process of competing with time, inexperienced and uninformed personnel can disrupt business processes. Therefore, before disasters occur, studies in this area should be accelerated and personnel should be trained (Bostan and Yüce, 2021, p. 522).

Another area that needs to be developed in disaster logistics activity processes is the provision of ideal warehouse areas. After disasters occur, it takes time to search the warehouses and to activate the found warehouses quickly. That's why up-front provisioning is of critical importance.

Increasing human resources studies and training them is another important issue in disaster logistics. In the future, the importance of trained personnel with disaster coping skills will increase even more. The training and preparation of disaster logistics teams helps the response processes to be carried out in a more effective and coordinated manner and plays a key role in saving life (Tanyaş et al., 2013, p. 2).

Strengthening international cooperation and coordination is also one of the steps expected to develop in the future. Disasters often have a cross-border impact. A stronger global disaster response system is expected in the future, with increased cooperation and coordination between countries. This helps deliver faster and more effective aid to disaster areas.

4. Futuristic Approaches in Disaster Logistics

Today, it is expected that disaster management systems will be examined and implemented in a technology-oriented manner in order to meet the sustainable welfare level. Technological developments that spread to many areas of life day by day have become a necessity in terms of disaster logistics. It is possible to provide many benefits before and after disasters with the use of internet of things, big data, autonomous vehicles, autonomous robots, RFID and barcode systems, and drone technologies.

Although these technologies, which are expressed as smart systems, have been mentioned a lot lately, it is statistically seen that they have not found the desired level of use at present. First of all, since disaster management brings the management of a chaotic process, there is a great need for the aforementioned technologies in order to process all kinds of data correctly and turn it into output. Awareness should be created that it is an area that needs to be invested rather than awareness in order to find use only in the face of disasters and that it should be applied within this scope.

In order to talk about futuristic approaches, first of all, the data we have must be analyzed and processed correctly, and when the output is obtained, correct inferences should be made regarding the dangers from these outputs. In this context, it is important to take precautions and to integrate traditional geology with digital transformation technologies and to present it in a coordinated manner within the framework of futuristic approaches. Thus, taking the necessary steps to reduce the damage caused by earthquake-based disasters, being prepared in ways that can provide foresight, and carrying out studies within this scope make it possible to provide the necessary conditions.

It is a social duty and priority to protect the society against earthquake-based natural disasters and to minimize the risk. In this context, the use of big data among futuristic approaches to earthquake points to an important area. The use of data obtained by machine learning is a benefit that serves society. In this context, further research shows that a promising way has been built for technology-based disaster management, whose awareness is raised and whose use is expected to increase (Corbi et al., 2019, p. 1304).

By making use of all the data obtained, there are advantages of using technology, in other words futuristic approaches, in developing disaster management strategies, providing risk prediction, performing analyses, fully fulfilling the plans in the order of preparation, response and improvement, and putting all these into action. Technology-based applications have started to be preferred frequently in order to minimize the risks that may arise in solving urban logistics

problems and in the effective realization of disaster logistics (Çağlayan, et al., 2018; Yiğitcanlar, et al., 2020).

With the use of artificial intelligence, it is possible to make earthquake predictions through machine learning, to estimate building damage by using geographic information systems, and to provide predictions based on earthquake data. Thus, efficiency and accuracy increase with machine learning while predicting earthquakes (Cyprus, 2022, p. 365).

Modeling is used to classify, classify, map, evaluate and predict the future of data obtained from all earthquakes that occur with machine learning. Machine learning, which finds use in this way, is among the most used methods in the field of artificial intelligence (Ayaydın & Akçayol, 2022, p. 4).

At the same time, studies are continuing to develop robots for use in disasters, but it is not enough to develop robots alone, and all institutions and organizations are expected to work in cooperation with the government (Hoşgörmez, 2020).

Since earthquakes can damage many living things and structures at the same time, different disaster management processes are required for the size of the earthquake, the condition of the damage, the durability of the buildings, seismic factors, and geological conditions. After the disaster management strategy is determined, a more active and efficient disaster logistics and process efficiency can be achieved. However, advancing technology-oriented with a futuristic perspective saves time and brings optimization.

When we look at earthquake-based disaster logistics from a futuristic point of view, when we consider the technologies that need to be integrated to ensure success in disaster logistics and gradually find use; Transportation of aids with smart traffic management, more active and energy-efficient progress with the use of autonomous trucks, machines that interact via the internet of things will provide benefits in many areas from warehouse automation to inventory processes, cost-effective, time-saving, efficient and effective distribution with coordinated disaster logistics activities providing cost advantage in automated warehouses, obtaining disease history data for disaster victims' personal information and preventing unnecessary and incorrect treatment, logistics support to progress together with artificial intelligence, and thus the opportunity to recover more economically. At the same time, creating an emergency management unit so that more than one department can work in cooperation by activating smart logistics and smart supply chain management in order to adapt to emergencies at all times provides an effective and efficient management (Adıgüzel, 2022, p. 47).

It is known that in order to provide the right logistics service in earthquake-based disaster logistics, all kinds of information about earthquakes bring many different variables in

the management of the situation. In such a case, information such as which transport mode to use, which route to go, population information, past disease data of the disaster victims are handled and optimization is provided by artificial intelligence according to the outputs of the algorithm. Artificial intelligence has a very significant role in disaster logistics in accessing information such as choosing a hospital, which way to reach emergency patients, and the traffic situation by using smart transportation channels (Adıgüzel, 2022, p. 50).

In order to manage earthquake-based natural disasters in a planned and correct way within the scope of disaster logistics, applications that can be made to reduce losses are detailed in futuristic approaches in disaster logistics on a technology basis. It has been tried to give examples of futuristic approaches on the axis of digital transformation technologies.

Table 1

Futuristic Approaches and Usage Areas

Futuristic Approaches	Usage Areas
Autonomous Vehicles	Transporting materials to the wreck site
	Debris removal with autonomous forklifts and robot arms
	Fast supply of needs through autonomously moving cargo ships
	Supply of needs with autonomous aircraft
Drone	Delivery of emergency aid to the region
	Identification of damaged buildings
	Scanning the area and intervention in flood and landslide-like situations
	Detection eye in cases where the roads are closed
	Scanning with heat cameras in needy areas (pet-wild animal detection)
Internet of Things	Determination of disaster scenarios within the scope of settlements,
	Performing micro-zoning operations for the hazard level and risk status of the determined maps,
	Determining the risk situation structurally,
	The planned use of equipment and devices in disaster relief, to prevent loss of life and property in dangerous areas,
	Instant traffic information, route optimization and planning, determination of the appropriate route for the product group to be transported and selection of the transport mode according to these criteria,
	Real-time correction of travel plans,
	Identification and management of warehouses, rapid tracking of which materials and drugs are in which warehouse in case of disaster, notification of deficiencies to the center, follow-up of orders,
	Reducing the need for manpower in transporting disaster survivors to health institutions through the communication and communication of vehicles with each other and reaching people who are waiting to be rescued from the disaster and who are waiting to be rescued.
	Making cost estimates for possible disaster situations
Big Data	Earthquake detection and prediction based on data
	Monitoring material inventory
	Route optimization

	In the disaster management model, which is preventive and risk-reducing, data can be used for preparedness against a disaster and risk-damage reduction methods.
	To store the information about the chronic diseases of the people injured in the disaster, to store the information on whether the injured person has diabetes, heart disease, whether he has an allergy to antibiotics or drugs, and to transmit this information to the health personnel who intervened in the disaster, and in the emergency response of the injured,
	It can be used to gather information and allocate medical resources by creating medical and rescue system and population-based rescue plans.
Autonomous Robots	In determining the damage to the buildings and the damage to the infrastructure,
	In the separation of aids, property identification, analysis, counting, selection processes
Virtual Reality **Augmented Reality**	Using simulation studies in the management of future disasters
	Creating scenarios and experiencing the moment of the event and determining the forms of intervention
RFID and Barcode Technologies	Determining the treatment methods applied to the disaster victims and seeing the aided materials
	Avoiding duplicating material and preventing abuse
	Information and communication technology, especially space-assisted technology, is at the stage of warning and response in case of disaster.
	Creation of emergency plans
	Identification of temporary shelters
	RFID, tag readers provide efficient storage and retrieval of products and efficient operation of the warehouse,
	Solving transportation – health – accommodation – technical equipment problems
Geographic Information Systems	Damage assessment studies,
	Determination of evacuation corridors
	Directing the emergency response teams correctly in the field,
	Preventing traffic jams by closing the road to traffic in natural disasters,
	Reaching shelters, emergency facilities or supply facilities,
	Creation of decision support systems.

Source: (Adıgüzel, 2022, p. 52; Hoşgörmez, 2020; Şen and Esmer, 2017, p. 235; Aydın, 2020)

Discussion and Results

As the world becomes more interconnected and at the same time facing the challenges of changing climate, population growth and urbanization, the need for innovative and forward-looking approaches to disaster logistics is more important than ever. This situation of need necessitates the adoption of futuristic approaches, especially in disasters, and the support of societies in disaster situations. The relationship between the future of disaster logistics and futuristic approaches is highly emphasized as it directly affects the society's ability to effectively respond to and manage disasters, emergencies and humanitarian crises.

In this study, the concept of disaster and the phenomenon of earthquakes, which always cause great destruction, were investigated. In the continuation of the study, the probable

futuristic approaches to be used are explained by detailing the problems encountered in disaster logistics and their solution suggestions. Finally, possible developments for disaster logistics have been evaluated and the usage areas of futuristic approaches both today and in the future are detailed.

Disasters, whether natural or man-made, occur more frequently and more intensely. Climate change is contributing to more frequent and extreme weather events such as hurricanes, wildfires, floods and droughts. Futuristic approaches to disaster logistics can help prepare and respond to these events more efficiently and effectively. At the same time, the world is witnessing rapid advances in technologies such as artificial intelligence, robotics, drones, blockchain, and the Internet of Things (IoT), and integrating these technologies into disaster logistics improves real-time data collection, communication, resource allocation and coordination, making it faster and faster. enable targeted interventions.

Futuristic approaches to disaster logistics emphasize data analytics and predictive modelling. By utilizing big data and artificial intelligence, emergency response teams can make more informed decisions and allocate resources based on real-time information. Thus, disaster response is more optimized and its impact on affected communities is minimized. Future-oriented disaster logistics are designed with flexibility and adaptability in mind. As disasters become more complex and unpredictable, it is critical to have logistics systems that can adapt to changing conditions and recover quickly from disruptions.

Disasters often disrupt supply chains, leading to shortages of critical resources such as food, water, medical supplies and shelter. A futuristic approach to disaster logistics should include robust supply chain management systems that can rapidly reroute essential materials and deliver them to affected areas.

Using innovative methods such as futuristic approaches, drone delivery and blockchain-based transparent delivery systems can revolutionize humanitarian aid delivery. This can increase the efficiency and accountability of aid distribution and ensure that aid reaches those who need it most, and its use in all disaster areas in the future is heavily acted upon.

Although the current approaches in disaster logistics are largely based on traditional methods, rapidly changing global conditions, climate crisis, increasing population density, and urbanization are driving the need for more innovative and advanced technological solutions. In this context, the integration of digital transformation technologies into disaster logistics facilitates the establishment of effective and rapid intervention processes.

Another notable point in the discussion is the critical role that technology plays not only during disasters but also in the preparation before and the recovery processes after them. The

study emphasizes that the use of big data, artificial intelligence, the Internet of Things, and drone technology in disaster logistics enhances the speed of logistics processes, cost-effectiveness, and the development of decision-making mechanisms. In particular, big data and artificial intelligence hold significant importance in identifying the needs of the affected area and determining intervention priorities. This enables accurate and rapid decision-making in disaster management, potentially minimizing the negative impacts on human life.

Several challenges and limitations must also be considered to fully utilize the mentioned technologies. The first of these challenges is that sufficient levels of infrastructure, training, and financial resources are necessary for the effective use of technology. Many countries, particularly developing ones, do not have complete access to these advanced technologies. This indicates that increased international cooperation and funding are needed to make technology more effective in disaster logistics.

Secondly, the adoption of futuristic approaches in disaster logistics requires not only technological integration but also societal awareness and government policies to support these approaches. To accelerate post-disaster intervention processes and enhance community resilience, collaboration among governments, non-governmental organizations, and the private sector is essential. In this process, the lack of coordination and insufficient resources can adversely affect post-disaster intervention efforts.

Finally, futuristic approaches to disaster logistics must be sustainable. No matter how advanced technology is, the human factor and awareness-raising efforts regarding disaster situations remain crucial. Therefore, not only technological solutions but also the training and capacity building of humanitarian aid teams should be considered as critical components.

When considered within the context of the discussion, the future of disaster logistics should be strengthened through innovative technology-based approaches. However, in this process, merely advancing technology will not be sufficient; societies, governments, and international organizations must also develop policies to enhance access to and utilization of these technologies. In this context, the study indicates that digital transformation technologies will play a critical role in the future of disaster logistics and emphasizes the need for increased global cooperation to integrate these technologies more effectively.

As a result, the relationship between the future of disaster logistics and futuristic approaches is vital for building a more resilient and cohesive society. By adopting innovation, technology and data-driven decision-making processes, we can better respond to emergencies, minimize the impact of disasters, and ultimately save lives and resources. To meet the challenges posed by an uncertain and rapidly changing world, governments, organizations and

individuals need to adopt forward-thinking strategies and work together. While technological innovations for the future of disaster logistics offer significant opportunities, strong steps must be taken at both the infrastructural and institutional levels to effectively utilize these opportunities.

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