A Decentralized System for Damage Detection and Emergency Response with Helium-Based IoT Sensors in Case of Internet and Cellular Network Outages During Earthquakes

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Abstract

This system offers a resilient, decentralized system against the lack of emergency response caused by communication outages during the earthquakes we experience. This system, by integrating IoT sensors placed in buildings, the LoRaWAN connection of the Helium Network (a decentralized and human-contributed network), and blockchain technology, ensures real-time, secure, and verifiable detection of structural damages experienced in an earthquake. In moments when the normal communication and internet infrastructure we use in daily life collapses, the system enables faster and more targeted emergency assistance by creating emergency data transfer and damage mapping.

At its core, the system detects structural damages in buildings with the help of sensors, classifies them through smart contracts, and removes the limitations experienced in the data communication phase of LoRaWAN technology with its pre- and edge processing features, thereby ensuring the detection of buildings with compromised structural integrity. Then, through smart contracts, it transfers the buildings with detected structural damage to the mapping system, providing instant data flow and detecting through the map detailed location information of which building has structural integrity damage and a collapse has occurred there, and sharing this information in detail with the authorities via the mapping system, ensuring rapid intervention. Hurricane Helene has shown that Helium technologies facilitated more than 20,000 connections in this extraordinary disaster and could work flawlessly and provide communication even in a scenario where more than 20% of the networks we use for normal communication were out of service.

Especially for Türkiye, this system, planned to be developed in line with AFAD's 2020 Structural Health Monitoring directive, meets all the mandatory sensor requirements for buildings above 105 meters and is planned to strengthen the existing disaster management infrastructure. In this framework, fundamental benefits such as transparency, efficiency, and robustness against central infrastructure failures, as well as resilience and transparency, are emphasized, significantly increasing overall disaster resilience and prioritizing rapid intervention in disaster situations by highlighting the importance of public health.

This system, through smart contracts, automatically triggers aid dispatch according to the severity of the damage and eliminates delays caused by manual processes. In pilot application simulations, an average reduction of 30% to 50% in response time was observed, an increase of 40% to 60% in damage assessment accuracy, and a potential improvement of 25% to 40% in resource allocation efficiency, as shown by artificial intelligence calculations.

1. Introduction

1.1. Türkiye's Earthquake Reality and Current Challenges

Türkiye, due to its critical location at the convergence of the Arabian, African, and European plates, is one of the most active earthquake zones in the world. Major fault lines such as the North Anatolian Fault Line and the East Anatolian Fault Line dangerously shape the country's geopolitical structure and continuously create seismic activities. Statistical data also confirm this reality: a very large majority of the country lives under earthquake risk, and almost the entire population lives in seismic hazard zones.

Recent major earthquakes bitterly demonstrate Türkiye's existing reality regarding this. While the 1999 Izmit and Düzce earthquakes caused more than 18,000 deaths, the February 6, 2023 Kahramanmaraş earthquakes unfortunately led to the loss of more than 50,000 lives and affected the lives of millions of people.

1.2. Limitations of Traditional Disaster Management Systems

Current disaster management approaches are primarily based on centralized communication infrastructures, thus encountering some fundamental limitations and problems in these manual data collection processes.

Centralized Infrastructure Dependency: Traditional systems used are heavily dependent on base stations, fiber optic lines, and central servers, but during large-scale natural disasters such as earthquakes, most of these infrastructures can suffer serious damage and lose their functionality when people need them most. As seen in many examples around the world, the widespread incapacitation of traditional networks shows what critical consequences such vital importance can lead to.

Slowness of Manual Processes: After an earthquake, existing damage assessments, both coordination and resource allocation processes being carried out manually, cause significant critical time loss. The decision-making processes such as experts going to the field to assess building damage, reports being transmitted to central locations, and then an emergency aid intervention to the relevant area based on these reports can often take hours, and even days in moments without communication.

Data Integrity and Transparency Issues: Inconsistencies, outdatedness, or inaccuracies in data coming from different institutions can cause serious problems. In centralized systems, data manipulation is a serious risk, and there is also the single point of failure problem.

1.3. Potential of Decentralized Technologies in Disaster Management

Looking at recent developments, decentralized technologies have increasingly gained importance in disaster management. Especially, the hybrid solutions where the Internet of Things sectors, sensors, both powerful wide-area networks, smart contracts, and blockchain technology come together, have completely surpassed the limits of traditional approaches.

Advantages of IoT and LPWAN Technologies: The low cost of sensors and the support for long ranges as communication protocols enable widespread large-scale monitoring. Particularly, LoRaWAN technology consumes low power, which leads to long battery life, and offers ideal solutions for continuous monitoring.

Blockchain and Transparency: When considering decentralized ledgers, data is generally guaranteed in terms of integrity, and transparency and accountability are present. Smart contracts, on the other hand, offer both resource allocation possibilities and have an automatic decision-making mechanism.

1.4. Main Contributions of the Proposed System

The system proposed in this study uses the decentralized LoRaWAN infrastructure of the Helium network. This infrastructure provides a fast, secure, and innovative approach to damage detection and emergency response in earthquakes. The main contributions of the system are as follows:

1. **Resilient Communication Infrastructure:** A fast, real-time damage detection system that is resilient against failures that may occur in centralized infrastructures.

2. **Technical Innovation:** An innovation that overcomes the limitations of LoRaWAN technology and includes edge processing-based sensor technology.

3. **Data Reliability:** A transparent and immutable record system using blockchain technology.

4. **Automated Response:** Automated emergency aid coordination using smart contracts and its transfer to the geographic information system.

5. **Legal Compliance:** Strategies compatible with existing legal frameworks in Türkiye.

6. **Economic Feasibility:** A cost-effective and scalable approach.

1.5. Scope and Organization of the Article

This study is the first comprehensive work in the literature on a Helium Network-based disaster management system. This system covers all dimensions from theoretical consideration, infrastructure to the final stage of practical application. Especially in a country like Türkiye, where we experience earthquakes, this system, designed by taking into account the earthquake reality and legal frameworks, also benefits from international examples but its benefit strategy focuses on local needs.

2. Motivation and Problem Definition

2.1. Collapse of Communication Infrastructure After Earthquakes

One of the most critical and important problems experienced during earthquakes is the complete collapse of the traditional communication infrastructures we use. This situation, in turn, creates an unfavorable environment, a ground, for emergency responses when they are most needed. Therefore, a critical communication gap arises. This prevents instant information flow from affected areas. Considering Türkiye's earthquake history, the dimensions of this problem are very clearly revealed.

Infrastructure Damage Dimensions: When we recall the February 6, 2023 Kahramanmaraş earthquakes, it was observed that more than 60% of the communication infrastructure in 10 provinces affected by this earthquake was damaged and thousands of base stations became inoperable. Similarly, in the 1999 Izmit earthquake, communication between the capital and Istanbul was cut off for hours due to fiber cable breaks. These examples clearly demonstrate the fragility of centralized infrastructures during earthquakes and the magnitude of the crisis they create.

Significant Impacts of Single Points of Failure: When we look at traditional systems, we see very clearly that if central base stations suffer severe damage, large areas become out of service. And this actually causes hundreds of thousands, even millions of people to experience communication problems depending on the human population living in the region. As you can see in the Hurricane Helena example, the incapacitation of more than twenty percent of traditional networks shows how critical such single points of failure can be in human lives. In Türkiye, similarly, in a similar situation, especially in a megacity like Istanbul with a population of more than 16 million, the collapse of the central infrastructure can affect the lives of millions of people.

Dependency on Power Supply: When we look at the traditional communication infrastructure that we maintain and use in our daily lives, this infrastructure is constantly dependent on electricity supply. That is, in environments without electricity and if the sole power source is electricity, the communication infrastructure becomes dysfunctional. Long-term power outages are known to occur after earthquakes. With the depletion of existing generators and their fuel, the complete collapse of communication infrastructures is clearly seen. The almost week-long power outages experienced during the 2023 earthquakes seriously revealed how big a problem exists, regardless of whether the infrastructure was damaged or not, whether base stations were damaged or not, with the exhaustion of backup power units.

2.2. Insufficiency of Manual Damage Assessment Processes

When we look at the current disaster management systems, a large part of the methods used to assess damage in a building are manual. This brings with it numerous inadequacies:

Time Losses: The time spent by expert teams going to the field to assess damage after a disaster, conducting inspections building by building, street by street, neighborhood by neighborhood, preparing reports of these inspections, leads to the loss of valuable time within the critical first 72 hours and delays in interventions during the most crucial minutes of human life. In the Kahramanmaraş earthquakes, it was clearly seen that damage assessments in some areas took 1-2 weeks, and during this time, many people remained under the rubble.

Human Health and Safety Risks: In manual processes, response teams are exposed to potentially dangerous structures, causing the most competent people who can save the lives of disaster victims to potentially endanger their own lives. Considering the times when aftershocks continue, the teams performing damage assessment are seriously at risk.

Coverage Area Issues: The limited number of different expert teams in countries makes it impossible to conduct assessments after earthquakes affecting large or multiple regions. This situation leads to problems in prioritizing teams.

2.3. Institutional Coordination and Data Sharing Problems

When we examine disaster management in Türkiye, there are numerous institutions and organizations. Ensuring effective coordination among official and civilian organizations such as local fire departments, AFAD, UMKE, AKUT, AHBAP, IHH is critical in times of crisis.

Data Silos: Data collected by different institutions within their own internal systems are generally not shared with other institutions. This can lead to a loss of overall situational awareness.

Communication Protocols: There are also problems with communication protocols. Different methods, devices, frequencies, protocols, and sets of rules used by institutions for communication among themselves can create coordination problems or cause time delays in emergencies.

Reliability and Transparency: When we look at the integrity and reliability of data in currently used systems, there can be serious concerns. Especially in natural disasters and the subsequent processes, the lack of transparency in the distribution of aid and the provision of resources can lead to problems of public trust.

2.4. "Last Mile" Communication Problem and the Need for a Solution Towards It

Data transmission problems from disaster areas to central command stations and to the centers of these command stations are the most critical "last mile" problem of disaster management. And this problem manifests itself in three main dimensions:

Data Flow from Field to Center: The difficulty in delivering instant, reliable, up-to-date, and detailed needs-based information about the real situation in the disaster area to the central system and the decision-making units using this system.

Coordination from Center to Field: Decisions made from the center can occur after data flow from the field to the center. And considering this data flow, decisions are made from the center, and these decisions need to be transmitted quickly and effectively to the teams on duty in the field.

In-Field Coordination: The difficulty of instant information sharing and coordination among different institutions and organizations or different teams of the same institution and organization working in the field.

2.5. Limitations of Existing Solutions

Currently, the disaster communication and solutions for this disaster communication have some fundamental limitations. These are:

Satellite Communication: Satellite communication is high in cost, complex and difficult to set up, and offers limited bandwidth depending on weather conditions.

Radio Systems: Radio systems inherently offer limited range. And within this limited range, there are frequency limitations and difficulties in digital data transmission are experienced.

Mobile Base Stations: Mobile base stations are difficult to set up, very high in cost, and have high power consumption. Additionally, mobile base stations also have limited mobility.

To overcome all these limitations, there is a clear need for a resilient, cost-effective, easy-to-install, and decentralized disaster communication system. At this very point, it is clear that the Helium network, with the low power consumption and decentralized structure of LoRaWAN, combined with its long-range capabilities and the transparency of blockchain technology, offers an innovative solution.

3. Existing Related Works and Current Situation

3.1. Existing Earthquake Early Warning Systems

Earthquake Early Warning Systems operate on the principle of detecting seismic waves and transmitting warnings to potentially damaged areas. Existing systems typically use centralized seismic networks and leverage the time difference between P-waves and S-waves. Since P-waves, or primary waves, travel faster than S-waves, Earthquake Early Warning Systems use this time difference to issue warnings before the damaging S-waves arrive.

International Early Warning Systems: Japan's JMA system is one of the most advanced early warning systems in the world. In the period leading up to the 2011 Tohoku earthquake, this system provided a comprehensive network across the country using more than a thousand seismometer stations. Additionally, California's ShakeAlert system and Mexico's SASMEX system also offer regional early warning system solutions.

Current Situation in Türkiye: There is an early warning system operated by AFAD. This system uses seismometer stations distributed throughout the country. The system was developed through the joint efforts of AFAD and Kandilli Observatory. However, this system is dependent on a centralized system and traditional communication methods. As a result, it also brings communication problems.

Limitations of Existing Systems:

1. Dependency on centralized processing.
2. Very high infrastructure requirements.
3. Collapse of systems due to communication infrastructure outages.
4. Very limited level of building damage detection.
5. Manual processes in damage assessment and the problems they entail.

3.2. IoT Based Structural Health Monitoring Systems

Structural Health Monitoring Systems (SHM) are a set of technologies that continuously monitor the seismic resistance and damage status of structures. Modern SHM systems involve the continuous measurement of structural vibrations with MEMS (Micro-Electro-Mechanical Systems) based acceleration sensors.

Impact of MEMS Technology: The development of MEMS technology has enabled the widespread use of low-cost accelerometers. The advantages of these sensors are:

- Low cost (between 10 and 50 dollars),
- Very low power consumption and small size,
- High sensitivity and reliability,
- Easy to use and maintain, easy installation.

Omron D7S and Special Earthquake Sensors: Sensors like OMRON-D7S are specially designed for earthquake detection. These sensors;

- Alarm when JMA-5 or higher seismic intensity is detected,
- Detect horizontal displacements at their location,
- Can be used as a structural collapse indicator.

Key features:

- Calculation of seismic intensity value,
- Very low power consumption,
- Fast response time (under 3 seconds),
- Integrated tilt sensor for detecting collapses.

3.3. LoRaWAN and Low Power Wide Area Networks (LPWAN)

LoRaWAN (Long Range Wide Area Network) is a protocol developed for Internet of Things (IoT) devices, providing low power consumption and long-range communication. It is increasingly preferred in disaster management applications.

3.3.1 LoRaWAN's basic technical features:

- **Data rate:** Low speed (8.3 Kbps - 27 Kbps)
- **Range:** Approximately 2-5 km in urban areas, 10 to 20 km in rural areas,
- **Power consumption:** On average less than 50 µW,
- **Battery life:** Between 5-10 years,
- **Frequency bands:** Operates in regional frequencies such as EU868 MHz, US915 MHz, AS923 MHz.

LoRaWAN's Limitations in Disaster Applications:

- Not suitable for direct transmission of high-frequency seismic data due to low data rate and small packet size,
- Packet loss can occur especially at frequencies above 2 Hz,
- Bandwidth is insufficient for real-time transmission of raw seismic waveforms,
- This creates difficulties in real-time earthquake monitoring and early warning systems.

LoRaWAN Optimizations for Earthquake Detection: Recent research suggests various optimizations for more effective use of LoRaWAN in earthquake early warning systems:

- Edge processing at the sensor level,
- Prioritization of critical data,
- Implementation of adaptive data communication strategies.

3.4. Helium Network and Decentralized Wireless Infrastructure Technology

Helium Network stands out as a worldwide decentralized wireless infrastructure project. The **Helium network** is built on the **Solana blockchain**, and its basic operating principle is the **Proof of Coverage** consensus algorithm.

Helium's Token Economy:

Helium network uses a multi-token economy. These are;

- **Helium Network Token (HNT)**,
- Main network token,
- **Data Credits** for IoT devices,
- Use for mobile, i.e., 5G network.

This economic model highly encourages network participation and enables network growth.

Global Coverage and Growth: As of last year, the Helium network is located in **192 countries** and **77 thousand towns and cities**, with a significant operational scope of approximately **1 million hotspots**. The overall growth rate of this network is much faster compared to the traditional communication infrastructures we use.

Practical Applications in Disaster Situations: The successful use of Helium beacons during **Hurricane Helene** has been observed. Furthermore, it has proven its practical utility in disaster situations. **A single beacon** facilitated **more than 20 thousand unique connections**. Additionally, some non-profit organizations have successfully integrated **Helium beacons** into mobile rescue units to establish critical communication lines in these devastated areas and provided communication in this manner.

Helium Beacon Technology: A Helium beacon is a portable and grid-independent tower solution that utilizes **Starlink** for network backhaul and **Helium's hotspots** for cellular radio links. Typically, these "plug-and-play" kits offer a more flexible and cost-effective alternative compared to the expensive and mini mobile base stations deployed by traditional operators.

3.5. Blockchain-Based Disaster Management and Decentralized Coordination and Management

Blockchain technologies generally provide **immutability**, **decentralized coordination**, and **transparency** in disaster management. This is due to the benefits that blockchain technology brings. This technology has significantly increased its applications in disaster management recently.

Examination of Blockchain's Advantages in Disaster Management:

- Immutability of data and preservation of integrity.
- Accountability.
- Transparent management of resources.
- Decentralized decision-making processes.
- Resilience against single points of failure.
- Automating the process with smart contracts.

DAOs and Their Response to Disasters: Decentralized autonomous organizations, or **DAOs**, generally provide **community-based coordination** in disaster responses. When considering current projects, these projects typically use **blockchain technology** for the mobilization of decentralized resources in disaster situations and benefit from its advantages.

3.6. Geographic Information Systems (GIS) and Disaster Mapping

In modern disaster management, **Geographic Information Systems (GIS)** play a critical role. Whether blockchain technology is used or not, most disaster management fundamentally operates with **geographic information systems** integrated, and this working principle highly considers the benefits of GIS. Since GIS platforms are **real-time**, they dynamically connect with **Internet of Things (IoT)** sensors and mobile devices, ensuring effective coordination in emergencies. They can also create **dynamic disaster maps**.

The Role of GIS in Disaster Resilience: GIS technologies generally greatly increase disaster resilience. This is because they **provide real-time data**, **greatly facilitate spatial analysis**, and **strengthen response and risk management**.

3.7. The Role of Artificial Intelligence and Satellite Technologies in Disaster Management

Considering the incredibly rapid technological advancements of artificial intelligence in recent years, **artificial intelligence algorithms** and **satellite technologies** have been seriously used in **disaster management**. These technologies generally significantly accelerate the damage assessment processes with high accuracy and speed.

Machine Learning and Predictive Modeling: Significant improvements in **earthquake damage prediction** have been achieved using **Internet of Things** sensor data and **machine learning algorithms for analysis**. These algorithms generally quickly analyze data from numerous sensors, accurately predict the location, and determine the severity of the damage.

4. Proposed Solution

4.1. System Architecture and Main Components

The proposed system uses a hybrid architecture consisting of four main layers:

Sensor Layer: IoT sensors (Omron D7S, MEMS accelerometers) strategically placed in buildings continuously monitor seismic activity and structural changes.

LoRaWAN Layer: Transmission of sensor data via a decentralized network is provided through Helium Hotspots.

Blockchain Layer: Helium blockchain is used for immutable and verifiable recording of damage events.

Application Layer: Real-time visualization and automated response coordination are provided through the GIS platform and smart contracts.

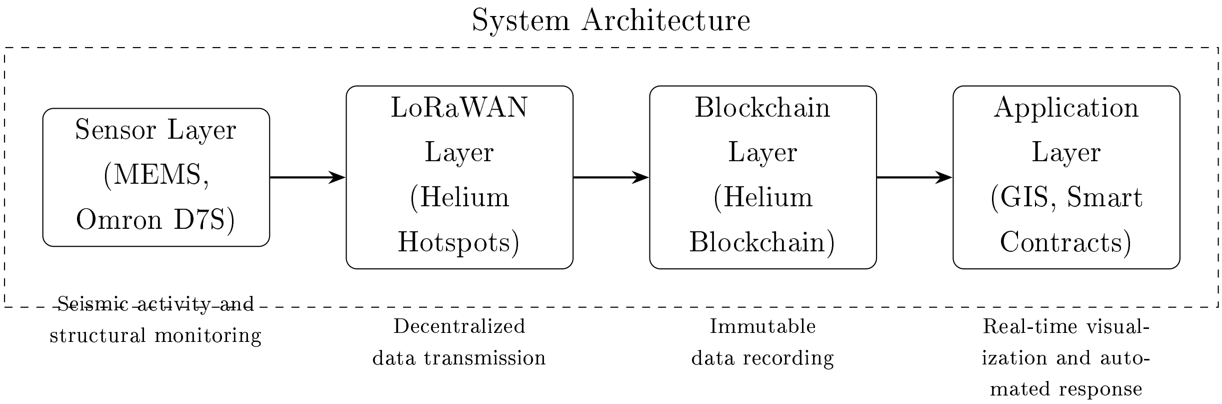


Figure 1: System Architecture Overview

4.2. Helium Network Integration and LoRaWAN Implementation

The key features of Helium Network for IoT applications are summarized in Table 1.

Table 1: Helium IoT Network Technical Specifications

Parameter	Value
Network Type	LoRaWAN (Helium IoT sub-network)
Frequency Bands	EU868 MHz, US915 MHz
Data Rates	0.3 kbps - 27 kbps
Maximum Payload	51 bytes (EU), 242 bytes (US)
Urban Range	2-5 km
Rural Range	10-20+ km
Power Consumption	$<$50 µW average
Battery Life	5-10 years
Latency	$<$2 seconds (acceptable)

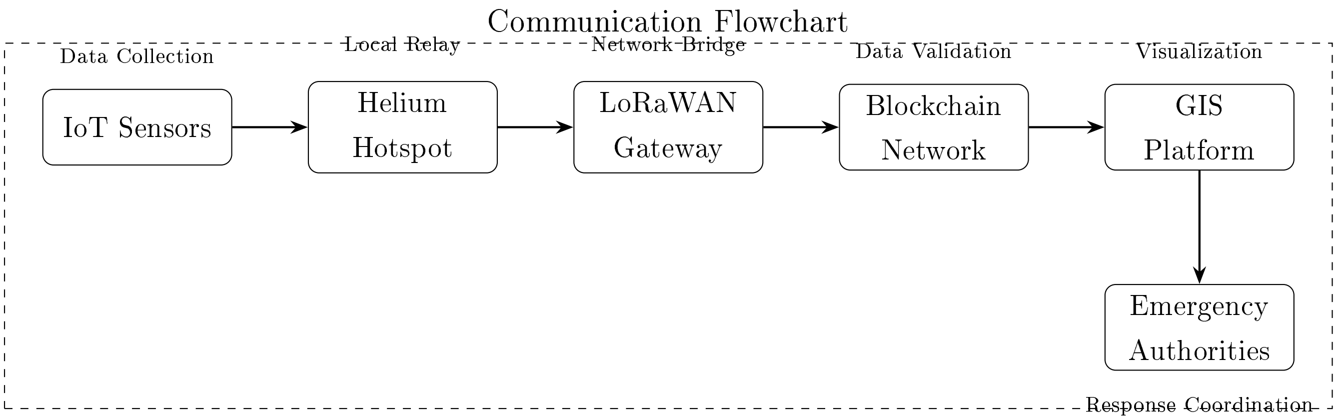


Figure 2: Communication Flowchart for Data Transmission

Table 2: Comparison of Earthquake Sensor Technologies

Sensor Type	Primary Function	Key Features	Typical Data Output	LoRaWAN Suitability (Raw)	LoRaWAN Suitability (Summary)	Cost
MEMS Accelerometer	Seismic activity detection	Low noise, high sensitivity, multi-axis	Acceleration (g)	Low	High	Low
Strain Gauge	Structural deformation	Structural strain detection	Micro-strain	Low	High	Medium
Omron D7S	Earthquake + collapse detection	Horizontal displacement, SI correlation, alarm output	Seismic data, SI value, alarm	Low	High	Medium
GPS Sensor	Displacement measurement	High accuracy position	3D coordinate, mm displacement	Low	High	High

Critical Design Decision - Edge Processing Operations: When we examine LoRaWAN, we can see that LoRaWAN has a low data rate (0.3–27 kbps) and small payload size, i.e., 51–242 byte limitations, are also clear. Direct transmission of high-frequency seismic data is not possible due to these features. Therefore, edge processing must be applied at the sensor level. Sensors perform local analyses, filtering raw seismic data, calculating JMA intensity and PGA values, and transmitting only critical summary information over LoRaWAN; they detect collapse flags and aggregated damage statuses.

4.3. IoT Sensor Technologies and Performance Analysis

Table 2 presents a comparison of different sensor technologies.

Proposed Hybrid Approach: For cost-performance optimization, a combination of MEMS accelerometer + Omron D7S is recommended and planned for low-to-medium rise buildings.

4.4. Blockchain Based Data Management

Blockchain integration offers three main functions to users.

Data Integrity: Data from sensors is recorded on the blockchain with the help of cryptographic hashes, preventing data manipulation.

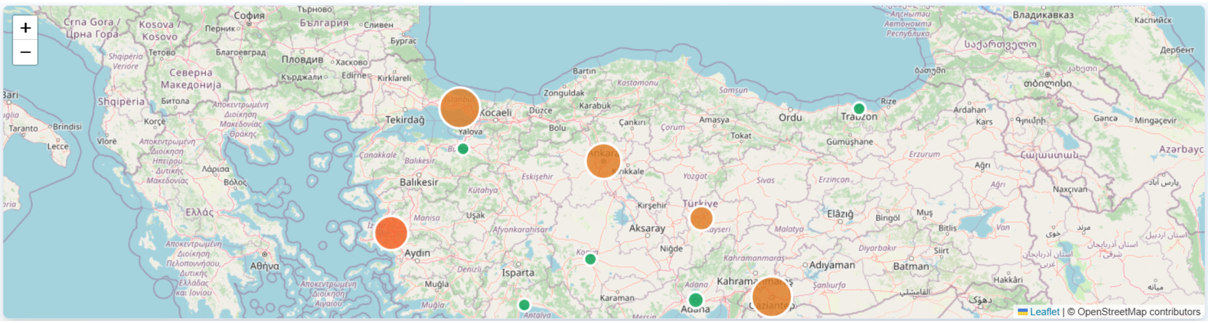
Transparent Record Keeping: All damage reports, with all their details, are immutably recorded.

Decentralized Verification: Single points of failure are prevented by performing multiple node verifications.

4.5. GIS Integration, Real-Time Mapping System Design, and Potential Benefits

Geographic Information System (GIS) processes and presents all verified damage data coming from the blockchain.

- Real-time, instant visualization on interactive maps
- Color coding according to the severity of the damage
- Total number of affected buildings and estimated total affected population based on the number of buildings
- Ensuring transportation within the city by identifying alternative routes, considering demolition situations for emergencies



Pre-defined thresholds:

- **JMA $<$ 4:** Continued monitoring, warning logging
- **4 $\leq$ JMA $<$ 7:** Fire and health teams notification
- **JMA $\geq$ 7:** Search and rescue teams emergency response

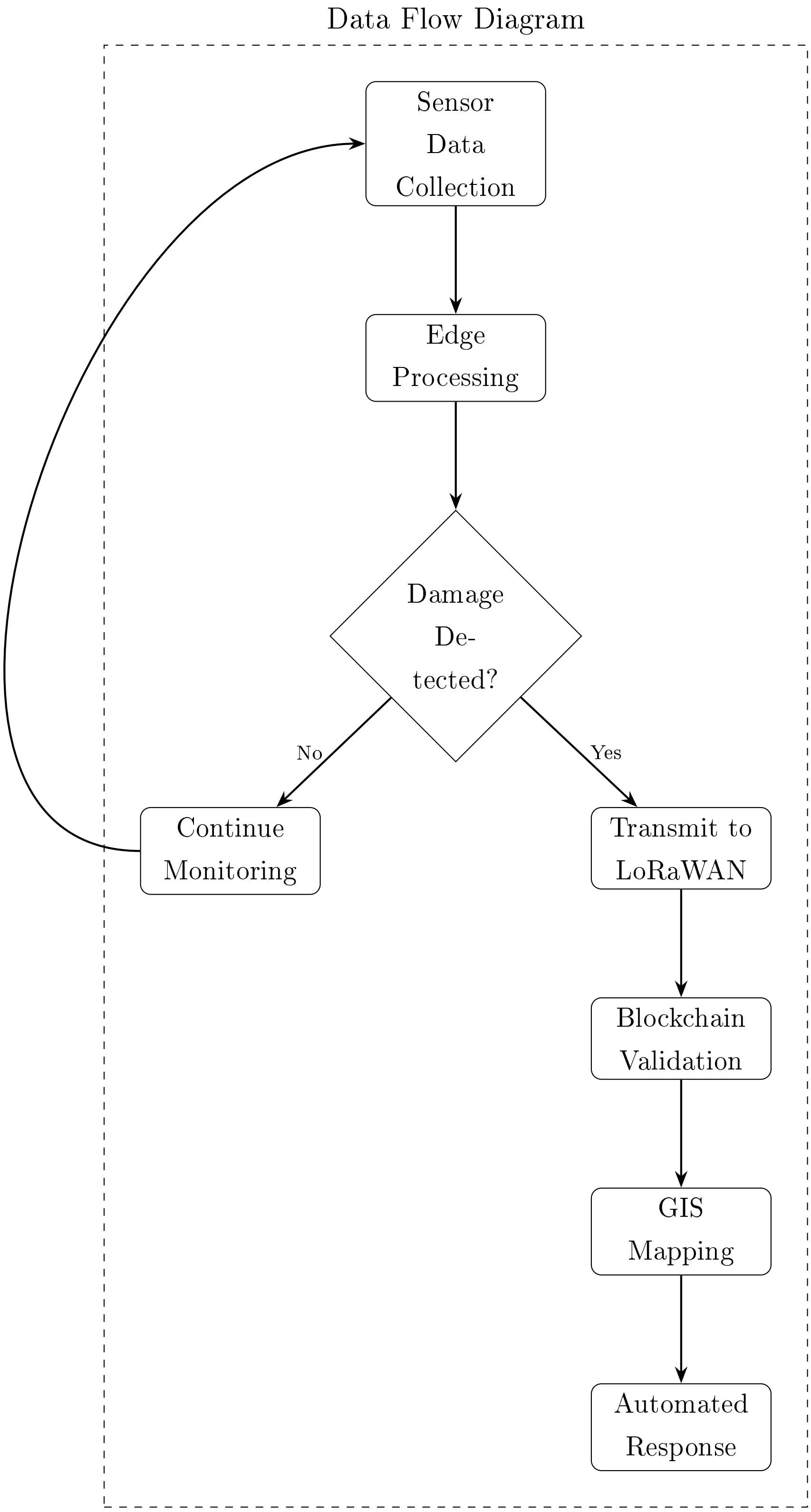
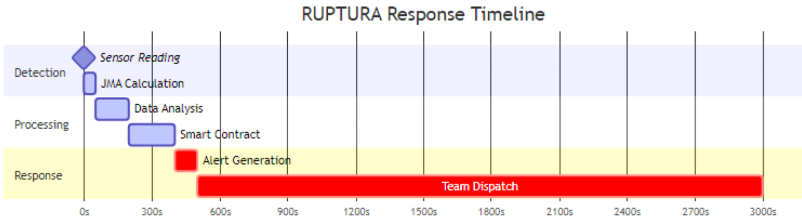


Figure 3: Data Flow Diagram for Damage Detection and Response

4.6. Response Timeline



5. Discussion

5.1. Technical Challenges and Solution Strategies

LoRaWAN Data Rate Limitations: The most critical technical challenge of this project is the high frequency of seismic data and the limitations regarding the transmission of this high-frequency seismic data over LoRaWAN. This challenge can be overcome with an edge processing solution and by using advanced analytical capabilities at the sensor levels.

Hotspot Density Optimization: When considering urban areas, a requirement of at least 10-20 hotspots is needed for coverage, and damage planning is required.

5.2. Legal and Regulatory Factors in Türkiye

Critical Compliance Points:

- **Data Localization:** Hybrid model requirement for BTK regulations
- **Token Economy:** Legal reviews are required due to the unclear and open SPK regulations.

5.3. Cost and Benefit Analysis (Includes estimated values, not definitive.)

Estimated Installation Cost Scenarios

- MEMS sensor: \$10-50/unit
- Omron D7S: \$100-200/unit
- Helium Hotspot: \$300-500/unit
- GIS platform development: \$50,000-100,000

Operational Benefits:

- Reduction in response time: 30-50%

- Reduction in false alarm rate: 40-60%
- Resource allocation efficiency: 25-40% increase

6. Conclusion

In this study, considering the destructions during earthquakes, a decentralized disaster management framework, which overcomes the communication outages experienced, with Helium-based IoT sensors integrating LoRaWAN and blockchain technology, and working with a smart contract structure, has been proposed for emergency disaster assessment and the grading of damages occurring in structures.

6.1. Main Contributions

- **Technical Innovation:** Edge processing feature that overcomes LoRaWAN limitations
- **Legal Compliance:** Flexible structure designed according to AFAD directives in Türkiye
- **Economy Management:** Cost-effective hybrid approach

6.2. Expected Estimated Impacts

This system carries good potential in solving the problems experienced in Türkiye's disasters and significantly increasing disaster resilience.

- 30-50% reduction in post-earthquake response time
- 40-60% increase in damage assessment accuracy
- 25-40% improvement in resource allocation efficiency

6.3. Future Work Recommendations

- Pilot application before the expected Marmara earthquake
- Establishing cooperation protocols with AFAD
- Development of AI-supported damage prediction algorithms
- Research on hybrid communication protocols (WiFi mesh + LoRaWAN)

In conclusion, it should be remembered that the greatest precautions humanity can take against disasters involve increasing our individual awareness and comprehensive steps to be taken at institutional, technological, and structural levels. Reducing disaster risks is not just a response; it also requires a multi-dimensional process that includes nations' long-term planning, education, sustainable urbanization, and resilient infrastructure construction. Science-based decision-making mechanisms and processes, cooperation between local and central governments, and the participation of all segments of society are the most fundamental cornerstones for creating disaster-resilient cities and structures.

And it should be remembered that it is not possible to completely eliminate the destructive effects of disasters. However, it is within our power to minimize loss of life and property with the measures we take. This project does not prevent the occurrence of an earthquake, but the result of this study demonstrates the potential of a decentralized technology in disaster management. The implementation of this project can put Türkiye in a good position globally in earthquake risk management.

Acknowledgments

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Demonstration and Files

You can access the demonstration of this project from www.ruptura.online and files from Github. (yusufornek/ruptura)

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