Heisei: Streamlining Disaster Relief with Real-Time Coordination

Ajeeb Kunhuty Abdul Raheem[1], Akash V V[2], Akhil K K[3], Ashwin Nambiar[4], Amrutha B K[5]
[1,2,3,4] *Department of Computer Science College of Engineering Thalassery Kannur, India*
[5]*Assistant Professor Department of Computer Science College of Engineering Thalassery Kannur, India*

Abstract:- **This paper explores the details of the Heisei system, a comprehensive framework designed to improve disaster relief operations by leveraging real-time coordination and efficient resource allocation. The system addresses the challenges of mismatched supply and demand, outdated information, and lack of coordination that often hinder effective disaster response. By utilizing blockchain technology, Heisei ensures secure and transparent transactions, allowing for accurate tracking of donated goods and preventing misuse. The system also incorporates real-time inventory management, enabling relief organizations to dynamically adjust resource allocation based on evolving needs. Heisei aims to revolutionize disaster relief by minimizing delays, reducing waste, and ensuring that critical resources reach those in need promptly and efficiently, ultimately contributing to more resilient communities.**

Keywords*:- *SHA-256 , IoT , RFID , ICRC , MAC

1. INTRODUCTION

Disaster relief operations often face significant challenges, including mismatched supply and demand, outdated information, and a lack of coordination among various stakeholders. This can lead to inefficiencies, delays in aid delivery, and ultimately hinder effective disaster response. The Heisei system is a comprehensive framework designed to address these challenges by leveraging blockchain- technology and real-time coordination to improve the efficiency and effectiveness of disaster relief operations. At the heart of Heisei lies the utilization of blockchain technology. By recording all transactions on an immutable and transparent ledger, Heisei ensures the secure and transparent tracking of donated goods, preventing misuse and fostering accountability. This technology also enables real time inventory management, allowing relief organizations to dynamically adjust resource allocation based on evolving needs. For example, if a particular region experiences an unexpected surge in medical needs, relief organizations can quickly identify and redirect resources accordingly, ensuring that critical supplies reach those who need them most. Furthermore, Heisei integrates real-time data analysis and a user-friendly interface to connect donors, volunteers, and relief organizations seamlessly.

1.1 BLOCKCHAIN

A Blockchain system's design prioritizes user engagement and accessibility. Donors can easily contribute through the platform, confident that their donations are being utilized effectively. Real-time inventory updates empower relief organizations to make informed decisions, ensuring that aid is directed where it's most needed. By promoting transparency and accountability, Heisei fosters trust among stakeholders, encouraging greater participation and support for disaster relief initiatives. For instance, by providing real-time data on resource distribution and impact, Heisei can enhance the public's trust in the effectiveness of relief efforts, motivating increased donations and volunteer participation. Beyond immediate disaster response, Heisei contributes to building more resilient communities. By streamlining resource management and facilitating efficient coordination, the system empowers individuals and organizations to participate actively in relief efforts. This fosters a sense of collective responsibility and ensures that disaster-affected areas receive the support they need to recover and rebuild effectively. Heisei represents a paradigm shift in disaster relief, leveraging technology to create a more responsive, efficient, and humane approach to crisis management.

1.2 SUPPORTING SYSTEMS

The Heisei system is built using a scalable and efficient technology stack to improve disaster relief efforts with real-time coordination and secure

transactions. It features a user-friendly interface that allows donors, volunteers, and relief organizations to track aid distribution and contribute easily. The system is designed for high performance, ensuring smooth data management and quick processing of requests. To enhance security and transparency, it incorporates a blockchain developed with Spring Boot, creating a secure and tamper-proof ledger for tracking donations and resource allocation. Data storage is handled using PostgreSQL for structured records like user and transaction details, while MongoDB is used for managing unstructured information, including real-time updates and logs. Security measures include SHA-256 encryption to protect data integrity, along with the Bouncy Castle Library, which provides strong cryptographic support. By integrating these technologies, the Heisei system ensures a reliable, secure, and efficient approach to disaster relief, making aid distribution more transparent and effective.

2. LITERATURE REVIEW

In paper[1], an innovative approach to managing intricate, multi-vendor supply chains in project-based industries by leveraging blockchain, IoT, and RFID technologies. It emphasizes the importance of real-time tracking and tracing to enhance transparency, reliability, and security in supply chain operations. The study introduces a cloud-based portal that integrates these technologies to create a decentralized, immutable tracking system. Key contributions include a blockchain framework to ensure data authenticity, IoT-based real-time monitoring, and robust performance measurement metrics. This system enhances supply chain visibility, mitigates risks, and supports informed decision making, offering significant value to sectors such as construction and shipbuilding.

In paper[2], it identifies the challenges associated with traditional paper-based and centralized digital systems in humanitarian aid distribution, particularly regarding scalability, security, and privacy concerns. In collaboration with the International Committee of the Red Cross (ICRC), the authors present a decentralized, token-based solution that prioritizes recipient privacy while maintaining accountability and scalability. The proposed system features two implementations-smart cards and smartphones designed for low-resource settings with minimal reliance on advanced hardware or stable connectivity. Key innovations include cryptographic household-specific tags to prevent double dipping, privacy-preserving auditing without centralized data storage, and anonymous proof of entitlement. This approach underscores the importance of protecting sensitive recipient information, adhering to humanitarian values of safety, dignity, neutrality, and trust in aid distribution.

In paper[3], introduces a strategy for efficient logistics distribution in disaster-affected areas. The proposed two-phase bounded heuristic approach aims to address key challenges in relief distribution, including unmet demand and excessive travel distances. Phase I focuses on assigning demand nodes to their nearest supply nodes and mitigating deficits by reallocating demands to alternative nodes when resources are insufficient. Phase II employs a bounded heuristic search to further optimize resource allocation by utilizing distributed supply nodes while minimizing travel distance. This strategy improves resource utilization, reduces unmet demand, and ensures timely relief delivery. The approach's effectiveness is demonstrated through a case study and simulation, highlighting its potential to enhance disaster response operations.

In paper[4], This review focuses on offers a thorough analysis of smart contracts, examining the key challenges encountered during their creation (readability, functionality), deployment (correctness, control flow), execution (trustworthy oracles, transaction order, efficiency), and completion (privacy, security). It delves into recent advances addressing these challenges, such as reverse engineering tools for readability, bytecode analysis for correctness, decentralized oracles for trustworthy data feeds, and privacy-preserving cryptographic protocols. Furthermore, the paper provides a comparative analysis of popular smart contract platforms (Ethereum, Hyperledger Fabric, Corda, Stellar, Rootstock) and explores their wide-ranging applications across diverse domains, including IoT, distributed system security, finance, data provenance, sharing economy, and the public sector, emphasizing their transformative potential.

In paper[5], it explores the implementation of a custom blockchain from scratch, motivated by a real-world use case in the energy domain where customers trade portions of their photovoltaic power plant. The authors argue that while generic blockchains exist, they often lack the lightweight and customizable

nature required for specific applications, particularly those involving user interaction and privacy sensitive data like the energy trading scenario presented. They detail the design and implementation of their private, permissioned blockchain, highlighting the chosen architecture, data structures, consensus algorithm (Proof-of-Work), and security measures. The paper also discusses the challenges and lessons learned during the implementation process, such as the need for efficient resynchronization algorithms, the security implications of idle chains, and the potential benefits of alternative consensus mechanisms like Byzantine Fault Tolerance (BFT) for smaller networks. Ultimately, the authors demonstrate the feasibility and advantages of building a custom blockchain tailored to specific application requirements, offering valuable insights for others considering similar endeavors.

In paper[6], it proposes SC-EOS, a blockchain-based decentralized framework designed to address the inefficiencies and limitations of traditional spatial crowdsourcing systems and existing blockchain-based alternatives. Traditional systems rely on centralized platforms, which suffer from single points of failure, operational opacity, and high service fees, while blockchain-based systems face challenges such as inefficient task assignment, high transaction costs, low block generation speeds, and the need for user deposits in untrusted systems. SC-EOS overcomes these issues by leveraging the EOS blockchain and smart contracts to enable efficient, transparent, and user-customizable spatial crowdsourcing without requiring deposits. Its innovative features include a batched task assignment mechanism that matches tasks and workers based on customizable preferences, ensuring efficient and fair distribution. SC-EOS also employs protocols that link user actions to prevent misbehavior and ensure compliance without relying on deposits. The framework achieves high performance using the Delegated Proof of Stake (DPoS) consensus, which facilitates fast block generation and reduces costs. Implementation and trace-driven evaluations demonstrate that SC-EOS achieves comparable task assignment efficiency to an idealized clairvoyant scheme while significantly reducing economic costs—over 10 times lower than Ethereum-based systems. SC-EOS stands out as a robust and scalable model that enhances transparency, minimizes costs, and provides a deposit-free solution for spatial crowdsourcing, with potential applications in broader crowdsourcing scenarios.

In paper[7], it explains a system designed to enhance transparency, trust, and accountability in the donation process for disaster relief using blockchain technology. The proposed platform leverages the Ethereum blockchain, smart contracts, and decentralized systems to enable secure, traceable, and efficient transactions. It integrates features like donor authentication, campaign creation, and real-time tracking of donations, ensuring that funds are utilized as intended without intermediaries. Smart contracts automate processes such as fund transfers and compliance checks, minimizing human error and reducing the risk of fraud. The system uses ReactJS and Web3.0 for its user-friendly interface and database control, while MetaMask facilitates wallet management and transaction execution. Through decentralization, the platform overcomes the limitations of traditional centralized databases, such as vulnerability to corruption and lack of real-time transparency. Key entities in the system include donors, relief organizations, recipients, and validators, all working collaboratively to uphold the integrity and traceability of donation flows. The platform's deployment on a test network demonstrates its potential to replace conventional donation systems with a transparent, efficient, and secure alternative, fostering trust between donors and recipients and promoting a robust donation ecosystem.

In paper[8], it proposes a structural framework that leverages blockchain to revolutionize supply chain management (SCM). It highlights five key transformations enabled by blockchain: the creation of a common platform, end-to-end information sharing and traceability, real-time updates, prompt and efficient asset transfers, and contract automation. The study argues that a blockchain-based supply chain consolidates multi-tier systems into a single platform, reducing redundancy, time delays, and data inconsistencies while improving supply chain resilience (SCRes). Analytical models quantify the benefits of blockchain, demonstrating enhanced inventory management, cost savings, and streamlined material and financial flows. The system ensures transparency, eliminates the bullwhip effect, and reduces risks across supply chain tiers. By automating contracts and utilizing decentralized databases, the framework enables faster, more secure, and efficient operations. These advancements not only lower operational costs but also foster collaboration and adaptability, offering a robust solution for modern supply chain challenges.

In paper[9], it focuses on improving blockchain security by enhancing the SHA256 algorithm, which is widely used for ensuring data integrity and security in digital systems. Blockchain relies on hash functions like SHA256 to make sure data cannot be tampered with, but recent attacks have highlighted the need for stronger protections. The authors propose a new algorithm, SHA288, which increases the hash size from 256 bits to 288 bits, making it much harder for attackers to find two inputs that produce the same output (collisions). SHA288 also reduces the number of processing rounds from 64 to 44, making it faster while still maintaining its ability to handle even small changes in data effectively. Tests showed that SHA288 is better at resisting attacks like brute force and collisions compared to SHA256. It also produces more secure, random outputs while being quicker to compute, even for larger amounts of data. By improving both security and speed, SHA288 provides a stronger and more efficient solution for protecting information in blockchain systems, making it harder for hackers to manipulate or break into the data. This makes SHA288 an important step forward for cryptographic security in today's digital world.

3. ALGORITHMS AND SECURITY

This section deals with the algorithm and security part of the Heisei system which makes its more securable and efficient in performance

3.1 SHA-256

SHA-256 is a cryptographic hash function which is used in Heisei that takes any input data, regardless of size, and produces a unique, fixed-size output of 256 bits (32 bytes). This output, known as a hash or digest, is essentially a fingerprint of the input data. Key characteristics of SHA-256 include its one-way nature (it's virtually impossible to reverse the hashing process to recover the original input), its collision resistance (it's extremely unlikely that two different inputs will produce the same hash), and its determinism (the same input will always generate the same hash output). These properties make SHA-256 a valuable tool for various applications, including data integrity verification, digital signatures, and blockchain technology, where it's used to secure transactions and ensure data integrity.

3.2 BOUNCY CASTLE

Bouncy Castle is a widely-used Java library that provides a comprehensive set of cryptographic primitives. It offers a wide range of cryptographic algorithms, including encryption (AES, RSA), decryption, hashing (SHA-1, SHA256, MD5), message authentication codes (MACs), and digital signatures. This extensive library empowers developers to easily incorporate robust cryptographic functionality into their Java applications. Bouncy Castle's versatility and open-source nature make it a valuable resource for various security-critical applications, including blockchain technologies. By utilizing Bouncy Castle, developers can implement strong encryption and authentication mechanisms, ensuring the security and integrity of data within the Heisei system.

4. RELATED WORKS

Zenventory is a comprehensive e-commerce operations platform that streamlines inventory management, order fulfilment, and purchasing processes for businesses. It offers a suite of features including multi-channel inventory tracking, order processing, purchase order management, and robust reporting capabilities. By centralizing inventory data and automating key workflows, Zenventory empowers businesses to improve efficiency, reduce operational costs, and enhance customer satisfaction. The integration of blockchain technology within inventory management systems like Zenventory has the potential to revolutionize supply chain operations. Blockchain's inherent features, such as transparency, immutability, and enhanced security, can address several challenges faced by traditional inventory management systems. For instance, blockchain can provide real-time visibility into inventory movements across the entire supply chain, from raw material sourcing to final delivery. This increased transparency can help businesses identify and mitigate potential disruptions, improve forecasting accuracy, and reduce the risk of stockouts. Furthermore, blockchain can enhance the security of inventory data, minimizing the risk of fraud and counterfeit goods. By leveraging blockchain technology, inventory management systems like Zenventory can achieve greater efficiency, transparency, and security, ultimately improving business outcomes for all stakeholders

5. FUTURE SCOPES

The Heisei system has the potential for significant advancements and wider applications in disaster

relief and related areas. Future improvements could focus on integrating artificial intelligence and machine learning to better predict disaster needs and optimize resource allocation. By using predictive analytics, the system could anticipate the demand for medical aid, food, and shelter based on historical data and real-time information. Further developments in blockchain technology could enable the use of smart contracts to automate transactions between donors, suppliers, and relief organizations, ensuring greater transparency and efficiency. Implementing decentralized identity management could also allow disaster victims to securely access aid without requiring physical documents, making the process more accessible and reliable. Expanding the system to incorporate edge computing and 5G technology would improve real-time disaster monitoring, especially in remote areas with limited connectivity. The integration of IoT with drones and autonomous vehicles could enhance supply chain logistics by automating the delivery of emergency resources to affected regions. Cloud infrastructure could be further developed by adopting multi-cloud deployment across different platforms such as AWS, Google Cloud, and Azure. This would improve scalability and ensure the system remains operational even during large-scale disasters.

6. CONCLUSION

The Heisei system represents a significant advancement in disaster relief by leveraging a multifaceted approach that integrates cutting-edge technologies with robust security measures. The system's foundation lies in a robust backend infrastructure built upon technologies like Spring Boot, which facilitates rapid development and efficient application deployment. At the core of this backend is the integration with a permissioned blockchain network, such as Corda or Hyperledger Fabric, ensuring the transparency and immutability of all transactions. This blockchain integration, further fortified by cryptographic libraries like Bouncy Castle and Java Security APIs, enhances data security and safeguards against fraud. The frontend, developed using technologies like HTML, CSS, and JavaScript, provides a user-friendly interface for seamless interaction with the backend, allowing stakeholders to easily access information, track progress, and contribute effectively to relief efforts. By combining these technological advancements with a focus on transparency, accountability, and efficient resource allocation, the Heisei system has the potential to revolutionize disaster relief operations, improving the speed, effectiveness, and impact of aid delivery to those in need

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