A Synopsis of Project on

DefenseLedger – Blockchain-Powered Ammunition and Supply Chain

Submitted in partial fulfillment of the requirements for the award
of the degree of

Bachelor of Engineering

in

Computer Science and Engineering
Data Science

by

Tanaya Patil(21107017)
Ayush Mistry(21107029)
Mayank Kumar(21107016)
Sahil Mujumdar(21107050)

Under the Guidance of

Prof. Sarala Mary
Prof. Richa Singh

Department of Computer Science and Engineering
Data Science
A.P. Shah Institute of Technology
G.B.Road,Kasarvadavli, Thane(W)-400615
UNIVERSITY OF MUMBAI

Academic Year 2024-2025

Approval Sheet

This Project Synopsis Report entitled ***"DefenseLedger – Blockchain-Powered Ammunition and Supply Chain "*** Submitted by ***"Tanaya Patil"(21107017),"Ayush Mistry"(21107029),"Mayank Kumar"(21107016),"Sahil Mujumdar"(21107050)*** is approved for the partial fulfillment of the requirenment for the award of the degree of ***Bachelor of Engineering*** in ***Computer Science and Engineering (Data Science)*** from ***University of Mumbai***.

Prof. Richa Singh
Co-Guide

Prof. Sarala Mary
Guide

Prof. Anagha Aher
HOD, CSE(Data Science)

Place:A.P.Shah Institute of Technology, Thane
Date:

CERTIFICATE

This is to certify that the project entitled ***"DefenseLedger – Blockchain-Powered Ammunition and Supply Chain "*** submitted by ***"Tanaya Patil"(21107017),"Ayush Mistry"(21107029),"Mayank Kumar"(21107016),"Sahil Mujumdar"(21107050)*** for the partial fulfillment of the requirement for award of a degree ***Bachelor of Engineering*** in ***Computer Science and Engineering (Data Science)***,to the University of Mumbai,is a bonafide work carried out during academic year 2024-2025.

Prof. Richa Singh
Co-Guide

Prof. Sarala Mary
Guide

Prof. Anagha Aher
HOD,CSE(Data Science)

Dr. Uttam D.Kolekar
Principal

External Examiner(s)

1.

2.

Internal Examiner(s)

1.

2.

Place:A.P.Shah Institute of Technology, Thane
Date:

Acknowledgement

We are pleased to present the synopsis report on **DefenseLedger – Blockchain-Powered Ammunition and Supply Chain.** We take this opportunity to express our sincere thanks to our guide **P**rof.Sarala Mary and Co-Guide **P**rof. Richa Singh for providing the technical guidelines and suggestions regarding the line of work. We want to express our gratitude for his constant encouragement, support, and guidance throughout the development of the project.

We thank **Prof. Anagha Aher** Head of Department for his encouragement during the progress meeting and for providing guidelines to write this report.

We express our gratitude towards BE project co-ordinators **Prof. Poonam Pangarkar and Prof. Ashwini Rahude**, for being encouraging throughout the course and for their guidance.

We also thank the entire staff of APSIT for their invaluable help rendered during the course of this work. We wish to express our deep gratitude towards all our colleagues of APSIT for their encouragement.

Tanaya Patil
(21107017)

Ayush Mistry
(21107029)

Mayank Kumar
(21107016)

Sahil Mujumdar
(21107050)

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Tanaya Patil(21107017)

Ayush Mistry(21107029)

Mayank Kumar(21107016)

Sahil Mujumdar(21107050)

Date:

Abstract

DefenseLedger is a revolutionary blockchain-based platform designed to transform ammunition management by providing unparalleled transparency, traceability, and security throughout the entire lifecycle. By leveraging the power of a decentralized ledger, DefenseLedger enables real-time tracking of ammunition from manufacturing to decommissioning, ensuring complete visibility and accountability. At the core of DefenseLedger lies its robust security framework, which safeguards sensitive information and prevents unauthorized access or tampering. The platform incorporates advanced cryptographic techniques to protect data integrity and maintain the highest levels of confidentiality. Additionally, DefenseLedger employs smart contract automation to streamline processes, reduce errors, and enhance operational efficiency. One of the standout features of DefenseLedger is its ability to facilitate secure identity management. The platform enables the creation and verification of digital identities for all authorized personnel, ensuring that only authorized individuals can access and interact with the system. This stringent identity management strengthens security, streamlines access control, and simplifies compliance efforts. DefenseLedger also empowers stakeholders with powerful data analytics and visualization tools. DefenseLedger provides actionable insights into ammunition inventory levels, demand patterns, and operational performance by harnessing the vast amount of data captured on the blockchain. These analytics enable informed decision-making, optimize resource allocation, and identify potential risks or inefficiencies. Furthermore, DefenseLedger is designed to seamlessly integrate with existing systems and processes, minimizing disruption and maximizing its value to organizations. The platform's user-friendly interface and comprehensive reporting capabilities ensure stakeholders can easily access and utilize the information provided.

Keywords: *DefenseLedger, blockchain, ammunition management, traceability, security, smart contracts, identity management, data analytics.*

Contents

List of Figures

List of Tables

List of Abbreviations

IoT: Internet of Things
DFD: Data Flow Diagram
UML: Unified Modeling Language
SCM: Supply Chain Management
NFT: Non-Fungible Token
ARIMA: Autoregressive Integrated Moving Average

Chapter 1

Introduction

The ammunition supply chain faces significant challenges in transparency, traceability, and security, all of which are critical for national security. Traditional manual tracking methods are often error-prone, time-consuming, and lack the real-time visibility required for effective decision-making. These shortcomings can lead to supply chain disruptions, unauthorized access, and potential misuse of ammunition.To address these challenges, DefenseLedger leverages the power of blockchain technology to provide a decentralized, secure, and transparent solution. By utilizing a distributed ledger, DefenseLedger ensures that all transactions and data related to ammunition are recorded immutably, creating a tamper-proof audit trail. This eliminates the risk of data manipulation or fraudulent activities, enhancing the overall integrity of the supply chain. Furthermore, DefenseLedger incorporates smart contract automation to streamline processes and reduce the potential for human error. Smart contracts are self-executing contracts with terms directly written into lines of code. They automate tasks such as order fulfillment, inventory management, and compliance checks, ensuring that all transactions are executed accurately and efficiently. This not only saves time and resources but also minimizes the risk of unauthorized access or fraudulent activities. DefenseLedger's real-time monitoring capabilities provide stakeholders with up-to-date information on ammunition inventory levels, location, and movements. This enables timely decision-making, efficient resource allocation, and proactive risk management. By having visibility into the entire supply chain, organizations can identify and address potential vulnerabilities before they escalate into serious security threats. In addition to enhancing transparency, traceability, and security, DefenseLedger also improves operational efficiency. The platform's automated processes and data-driven insights enable organizations to optimize their supply chain operations, reduce costs, and improve overall performance. By streamlining workflows and eliminating manual tasks, DefenseLedger frees up resources that can be allocated to other critical missions. In conclusion, DefenseLedger offers a comprehensive solution to the challenges faced by the ammunition supply chain. By leveraging blockchain technology and smart contract automation, DefenseLedger provides unparalleled transparency, traceability, security, and efficiency. This innovative platform empowers organizations to make informed decisions, mitigate risks, and ensure the safe and effective management of ammunition throughout its lifecycle.

1.1 Motivation

The ammunition supply chain faces significant challenges in transparency, traceability, and security, all of which are critical for national security. Traditional manual tracking methods are often error-prone, time-consuming, and lack the real-time visibility required for effective decision-making. These shortcomings can lead to supply chain disruptions, unauthorized access, and potential misuse of ammunition. To address these challenges, DefenseLedger leverages the power of blockchain technology to provide a decentralized, secure, and transparent solution. By utilizing a distributed ledger, DefenseLedger ensures that all transactions and data related to ammunition are recorded immutably, creating a tamper-proof audit trail. This eliminates the risk of data manipulation or fraudulent activities, enhancing the overall integrity of the supply chain. Furthermore, DefenseLedger incorporates smart contract automation to streamline processes and reduce the potential for human error. Smart contracts are self-executing contracts with terms directly written into lines of code. They automate tasks such as order fulfillment, inventory management, and compliance checks, ensuring that all transactions are executed accurately and efficiently. This not only saves time and resources but also minimizes the risk of unauthorized access or fraudulent activities. DefenseLedger's real-time monitoring capabilities provide stakeholders with up-to-date information on ammunition inventory levels, location, and movements. This enables timely decision-making, efficient resource allocation, and proactive risk management. By having visibility into the entire supply chain, organizations can identify and address potential vulnerabilities before they escalate into serious security threats. In addition to enhancing transparency, traceability, and security, DefenseLedger also improves operational efficiency. The platform's automated processes and data-driven insights enable organizations to optimize their supply chain operations, reduce costs, and improve overall performance. By streamlining workflows and eliminating manual tasks, DefenseLedger frees up resources that can be allocated to other critical missions.

1.2 Problem Statement

Traditional ammunition management systems are often plagued by a lack of transparency, traceability, and accountability, leading to security vulnerabilities such as theft, unauthorized access, and mismanagement. These issues are exacerbated by manual record-keeping and reliance on outdated systems that make it difficult to monitor and control the movement of ammunition across its lifecycle. To overcome these challenges, the proposed solution introduces blockchain technology and smart contracts to create a more secure, automated, and transparent management system. Blockchain technology offers an immutable, decentralized ledger where each transaction—from procurement, storage, and distribution to eventual disposal—is permanently recorded. This ensures full traceability, with every action logged in a tamper-proof and easily auditable system. Smart contracts further enhance security by automating processes like transfer approvals, usage tracking, and compliance checks, ensuring that all actions are executed in accordance with predefined protocols and without the need for manual intervention. This approach minimizes the risk of human error and prevents unauthorized access by ensuring that only individuals with proper clearance can interact with the system. It also increases logistical efficiency by automating inventory management and real-time tracking, reducing administrative overhead. In doing so, blockchain-based

ammunition management creates an environment of heightened accountability, where every transaction is visible and verifiable, reducing the likelihood of corruption, misplacement, or misuse of critical resources.

1.3 Objectives

- Develop a Blockchain-Enabled Framework and Automate the Supply Chain using Smart Contracts: The framework will use smart contracts to automate military logistics, reducing manual interventions and enhancing efficiency. Blockchain ensures decentralized, secure, and transparent operations, enabling automated order processing, inventory management, and shipment verification.

- Establish Real-Time Tracking of Ammunition and Supplies: IoT devices will provide real-time updates on the location and status of ammunition and supplies. Blockchain records these updates securely, enabling accurate, transparent tracking throughout the supply chain, improving accountability and resource management.

- Predict Ammunition Requirements Based on Zone-Specific Data Using Time-Series Algorithms Like ARIMA: ARIMA will forecast ammunition needs by analyzing historical data and usage patterns in specific zones. This predictive capability ensures timely deliveries and optimizes logistics by anticipating future demands based on zone-specific factors.

- Enhance Security using Decentralized Data Storage and Enable Secure Access and Authorization for Military Personnel: Decentralized data storage ensures that sensitive logistics information is tamper-proof and secure. Access will be restricted to authorized military personnel via encrypted keys, enhancing data security and preventing unauthorized access while maintaining transparency.

1.4 Scope

- Multi-national Collaboration: Blockchain enables secure and transparent data sharing among allied nations, ensuring compliance with international regulations. This enhances coordinated military logistics, allowing real-time updates and collaborative decision-making while maintaining data sovereignty.

- IoT Monitoring: IoT sensors monitor environmental factors like temperature and humidity in storage facilities or during transport. These conditions are recorded on the blockchain to ensure that ammunition is stored under optimal conditions, preventing degradation and ensuring operational readiness.

- Predictive Analytics: By leveraging historical data and predictive models, the system can forecast future ammunition requirements. This allows military operations to proactively manage procurement, avoiding shortages or excess, and optimizing inventory management.

- Quantum-resistant Blockchain: The framework will incorporate quantum-resistant encryption algorithms to safeguard the blockchain against the advanced computational power of future quantum computers, ensuring long-term data security and preventing potential breaches.

- Scalability and Security: The system is designed to scale with growing operational needs while maintaining robust security. It uses advanced encryption, decentralized architecture, and smart contract protocols to defend against evolving cybersecurity threats, ensuring future-proof logistics operations.

Chapter 2

Literature Review

Ammunition and military logistics management face critical challenges in ensuring transparency, traceability, and security throughout the supply chain. Traditional methods of tracking and managing ammunition are often manual, leading to inefficiencies, errors, and potential security risks such as theft, unauthorized access, or mismanagement. As military operations increasingly demand real-time decision-making and swift resource deployment, the need for innovative solutions to enhance oversight and streamline processes has become more pressing.

Blockchain technology presents a promising solution to these challenges by offering a decentralized, tamper-proof ledger system. This technology enables the secure and automated tracking of ammunition across its entire lifecycle—from procurement to storage, distribution, and disposal. Unlike traditional centralized databases, blockchain's decentralized nature ensures that no single entity can tamper with the records, thus providing greater accountability and transparency. Each transaction or movement of ammunition is recorded immutably on the blockchain, ensuring a clear audit trail that can be accessed in real-time by authorized personnel.

One of blockchain's most transformative features is the use of smart contracts—self-executing contracts with predefined conditions that automate various supply chain processes. For instance, smart contracts can be used to automatically reorder ammunition when inventory levels fall below a certain threshold, reducing human error and improving operational efficiency. Additionally, blockchain can be integrated with Internet of Things (IoT) devices, such as RFID tags and sensors, to enable real-time monitoring of ammunition conditions, such as temperature or humidity, ensuring the quality and safety of stored ammunition.

Blockchain also strengthens security within the supply chain by providing encrypted, permission-based access to sensitive data. Only authorized military personnel can access specific parts of the supply chain, reducing the risk of unauthorized access or cyber threats. Furthermore, decentralized data storage prevents single points of failure, making it more resilient to attacks or data breaches.

However, the adoption of blockchain in military logistics is not without challenges. Scalability remains a significant issue, as the current blockchain infrastructure may struggle to handle the high volume of transactions and data generated by military supply chains. Additionally, integrating blockchain with existing military IT systems and legacy infrastructure can be complex and costly, requiring substantial investment in both technology and personnel training. Regulatory and compliance issues also need to be addressed, as military operations span multiple jurisdictions, each with its own legal frameworks for data handling

and security.

Despite these challenges, the potential benefits of blockchain in military logistics are immense. By providing greater transparency, improving traceability, enhancing security, and automating key processes, blockchain can significantly improve the efficiency and reliability of ammunition and supply chain management. Ongoing research and development are required to refine these technologies, address scalability concerns, and ensure successful integration with existing military systems. As blockchain matures, it could play a vital role in modernizing military logistics and ensuring more secure, efficient operations in future military engagements.

2.1 Comparative Analysis of Recent Studies

Table 2.1: Comparative Analysis of Blockchain Studies in Supply Chain Management

Sr.no	Title	Author(s)	Year	Methodology	Drawback
1	Improving Supply Chain Management Processes Using Smart Contracts in the Ethereum Network Written in Solidity	Eren Yigit and Tamer Dag	2024	The methodology explores blockchain and smart contract technologies, assessing their advantages, limitations, and potential applications in supply chain management. It includes a review of existing implementations and various technological frameworks for smart contracts.	A key drawback is the complexity of introducing digital technologies to supply chains, which requires skilled workers and robust IoT equipment. Additionally, tailoring the system to meet the unique needs of each supply chain is critical for successful deployment.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
2	Blockchain technology in supply chain management: a comprehensive review	Osato Itohan Oriekhoe, Bankole Ibrahim Ashiwaju, Kelechi Chidiebere Ihemereze, Uneku Ikwue and Chioma Ann Udeh	2024	Industry-specific solutions address challenges unique to sectors like pharmaceuticals, agriculture, and manufacturing. Hybrid blockchain models combine public and private blockchains to meet diverse needs. Collaborative frameworks with regulatory bodies help tackle blockchain challenges, while AI and IoT integration enhances real-time data analysis, logistics, and predictive capabilities, improving supply chain resilience.	High costs, technical complexity, and scalability issues challenge blockchain adoption, requiring significant investments in technology, infrastructure, and training. Regulatory uncertainties further hinder widespread use, while blockchain's transparency raises privacy concerns, especially for sensitive data.
3	Securing Blockchain-Based Supply Chain Management: Textual Data Encryption and Access Control	Imran Khan, Qazi Ejaz Ali, Hassan Jalil Hadi, Naveed Ahmad, Gauhar Ali, Yue Cao and Mohammed Ali Alshara	2024	The approach uses blockchain with smart contracts, Hyperledger, and Ethereum, focusing on data encryption, permission-based access, and secure event logs to improve supply chain management and prevent unauthorized access.	Key drawbacks include scalability limits on transaction processing, costly integration with older IT systems, privacy concerns due to blockchain's immutability (especially under GDPR), and potential security risks from compromised network nodes.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
4	Role of Blockchain Technology in Supply Chain Management	Gokuleshwaran Narayanan, Ivan Cvitić, Dragan Peraković, and S. P. Raja	2024	The system uses blockchain for transparent, immutable transaction records, combining NFTs and a private blockchain for controlled access. A Supply Chain Consensus (SCC) algorithm optimizes node validation and efficiency. RFID and NFT integration enable real-time tracking and authenticity checks, while a voting-based dispute resolution mechanism ensures fairness using blockchain records.	The system's technical complexity demands significant expertise and high initial costs. Public acceptance may be slow due to resistance to new technologies, requiring educational efforts. Scalability issues could emerge with higher transaction volumes, impacting performance. Additionally, the upfront investment in technology and infrastructure may deter organizations from adopting the system, despite long-term cost savings.
5	Web3-Based Decentralized Autonomous Organizations and Operations: Architectures, Models, and Mechanisms	Rui Qin, Wenwen Ding, Sangtian Guan	2023	The methodology for developing DAOs involves creating a universal framework that integrates new principles, models, and algorithms for sustainable DAO development, emphasizing distribution and decentralization. It leverages advanced technologies like natural language processing and smart contract programming to enhance governance and operational efficiency.	A major drawback is the lack of a unified framework for all DAOs, leading to operational and governance inconsistencies. Current smart contracts often implement only basic deterministic rules, resulting in vulnerabilities and poor governance. Moreover, risks such as Sybil attacks jeopardize the integrity and functionality of DAOs.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
6	Blockchain and sustainable supply chain management in developing countries	Nir Kshetri	2021	The methodologies primarily emphasize using blockchain to enhance sustainability in supply chains through improved transparency, traceability, and verification of product quality and environmental impact. This approach, as noted by Seawright and Gerring (2008), allows for selecting diverse cases and employs case study analysis to evaluate blockchain's role in promoting sustainability across various contexts.	A major drawback is that small firms in developing countries struggle to invest in technology for tracking and measuring data, limiting their compliance with sustainability standards. Additionally, the high costs of implementing systems like grades and standards (G and S) can be prohibitive, despite the benefits of blockchain technology.
7	Supply chain inventory sharing using Ethereum blockchain and smart contracts	Ilhaam A. Omar, raja jayarman	2021	The methodology involved mapping key stakeholders with a sequence diagram and implementing smart contracts for inventory sharing, order processing, and reputation tracking. These contracts were deployed and tested on a simulated Ethereum network using Remix IDE, ensuring functionality and performance through thorough validation and transaction logging.	The methodologies encounter challenges due to a lack of trust among supply chain partners, making them hesitant to share sensitive information. High investment costs and deployment difficulties hinder collaboration. Additionally, the lack of standardized data formats and differing KPIs create communication inefficiencies, while concerns about data integrity and security complicate blockchain adoption.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
8	Consortium blockchain for military supply chain	Syarifah bahiyah rahayu, sharmelen A/L vasanthan	2021	The research analyzes prior studies to identify problems in military supply chain management (MSCM) for defense shipments. It collects secondary data from academic literature and case studies on military blockchains and MSCM operations, ultimately modeling a new blockchain framework specifically for MSCM procedures in navy depots.	MSCM encounters issues such as limited logistics visibility, scheduling optimization challenges, and slow operations due to centralized approvals, hindering agility and speed. These constraints impact military performance, while existing systems are vulnerable to cyber threats, jeopardizing data integrity and privacy.
9	Architecture to Enhance Transparency in Supply Chain Management using Blockchain Technology	Dnyaneshwar J. Ghode, Rakesh Jaina, Gunjan Sonia, Sunil K. Singha, Vinod Yadav	2021	The methodologies discussed involve adopting blockchain technology in supply chain management to enable secure, decentralized transactions, enhancing transparency and accountability. Companies are implementing smart contracts and improving traceability among stakeholders to streamline operations, reduce costs, and gain a competitive advantage in the global market.	Drawbacks include inefficiencies from traditional centralized architectures that require third-party authentication, leading to reliance on intermediaries. Organizations also struggle with fully integrating blockchain due to complex existing supply chain processes and the need for widespread participation. Additionally, risks of data tampering and inaccurate inputs can undermine blockchain's effectiveness in reliable information management.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
10	A Framework for Exploring Blockchain Technology in Supply Chain Management	Abbas Batwa, Andreas Norrman	2020	The methodology involves a systematic exploration of blockchain technology applications in supply chain management, using a mixed-methods approach that combines literature review, case studies, and interviews. It develops a conceptual framework covering SCM drivers, limitations, success factors, and BCT impacts on supply chain objectives. The analysis employs open and axial coding to derive insights and establish connections among study components.	Drawbacks include the scattered nature of existing literature across disciplines, complicating the integration of findings into a cohesive framework. Reliance on case studies and interviews may introduce biases from select informants, affecting the generalizability of results. Additionally, as blockchain technology is relatively new, there may be limited empirical evidence to support its effectiveness in various supply chain management contexts.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
11	Retail-level Blockchain transformation for product supply chain using truffle development platform	Rana M. Amir Latif, Muhammad Farhan, Osama Rizwan, Majid Hussain, Sohail Jabbar, Shahzad Khalid	2020	The methodologies focus on integrating blockchain technology within the Internet of Things (IoT) and supply chain management. Key aspects include designing a blockchain IoT architecture to enhance data security and provide transparent, immutable records for product traceability. Additionally, various deployment models are assessed, comparing the performance of node-to-system and gateway implementations.	Drawbacks include vulnerabilities in creating stable blockchain-IoT systems due to privacy concerns and challenges with centralized data management, which can erode trust in supply chains. This reliance on centralized authority may lead to inefficiencies and security risks, as traditional databases often fail to provide trusted, tamper-proof records. Additionally, many supply chains struggle with achieving comprehensive traceability, leading to waste and counterfeiting risks.
12	Adaptation of IoT with Blockchain in Food Supply Chain Management: An Analysis-Based Review in Development, Benefits and Potential Applications	Amanpreet Kaur, Gurpreet Singh, Vinay Kukreja, Sparsh Sharma, Saurabh Singh and Byungun Yoon	2022	The methodologies focus on integrating blockchain with the Internet of Things (IoT) to enhance food supply chain management (FSCM). By leveraging blockchain's traceability features, stakeholders can monitor food safety and quality from farm to table, improving transparency and efficiency in transactions through smart contracts and decentralized data management.	Drawbacks include data fragmentation and centralized controls that complicate data management within the supply chain. Additionally, immature technologies, lack of legislation, and scalability issues hinder the widespread adoption of this integrated approach in the food supply chain.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
13	Agriculture-Food Supply Chain Management Based on Blockchain and IoT: A Narrative on Enterprise Blockchain Interoperability	Showkat Ahmad Bhat, Nen-Fu Huang, Ishfaq Bashir Sofi and Muhammad Sultan	2022	The methodologies focus on integrating blockchain in agricultural supply chain management (Agri-SCM) for product traceability and enhanced transparency, improving company image and customer loyalty. The system emphasizes audibility and tamper prevention for food data, strengthening quality assurance. Additionally, it combines big data analytics and machine learning to optimize supply chain decision-making and forecasting.	Drawbacks include the complexity of implementing a decentralized traceability system with multiple supplier tiers, complicating data management. The expanding blockchain may also affect performance, leading to throughput and storage issues. Additionally, compliance with various regulations can create barriers to widespread adoption, despite improved accountability and transparency.
14	Application of blockchain technology for sustainability development in the agricultural supply chain: justification framework	Archana A Mukherjee, Rajesh Kumar Singh, Ruchi Mishra, Surajit Bag	2021	The methodology involves the Analytical Hierarchy Process (AHP), a multi-criteria decision-making tool developed by SAATY. AHP evaluates complex problems by breaking them into a hierarchical structure and using pairwise comparisons to assign weights to different criteria and alternatives, aiding in informed decision-making for sustainability in supply chains.	A notable drawback of AHP is the potential inconsistency in pairwise comparisons by decision-makers, despite the use of a consistency ratio to address this. Additionally, AHP can be cumbersome with many criteria, leading to decision fatigue or biases among participants, which may affect result reliability.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
15	Factors influencing blockchain adoption in supply chain management practices: A study based on the oil industry	Javed Aslama, Aqeela Saleema, Nokhaiz Tariq Khanb, Yun Bae Kim	2021	The methodologies discussed include SCM practices like delayed differentiation, benchmarking, and blockchain adoption. Blockchain improves SCM by enabling real-time information sharing, enhancing cybersecurity, and providing transparency, traceability, and visibility, significantly boosting operational performance.	A key drawback is that many SCM practices, such as outsourcing and third-party logistics, require high integration to be effective. Without this integration, their impact on operational performance may be limited. Furthermore, although blockchain provides strong cybersecurity features, its implementation in web-based information sharing is often hindered by security concerns and integration complexities.

Continued on next page

Sr.no	Title	Author(s)	Year	Methodology	Drawback
16	Automating procurement contracts in the healthcare supply chain using blockchain smart contracts	Ilhaam A. Omar, Raja Jayarman, Mazin S. Debe, Khaled Salah, Ibrar Yaqoob, Mohammed Omar	2021	The methodologies focus on using blockchain and smart contracts to automate procurement in the healthcare supply chain, enhancing operational efficiency, reducing costs, and improving traceability. By creating a decentralized ledger for tracking medical supplies, the automation of procurement contracts minimizes human intervention, streamlining workflows.	However, integrating blockchain with existing healthcare systems can be complex and costly, requiring substantial investment in technology and training. Data privacy concerns arise from managing sensitive information within the blockchain framework. Moreover, widespread stakeholder adoption is essential; without participation from all parties, the effectiveness of the blockchain solution may be compromised. While these methodologies offer promising advancements, significant barriers must be overcome for full implementation.

Chapter 3

Project Design

3.1 Proposed System Architecture

This diagram illustrates the overall architecture of the blockchain-enabled supply chain management system for military logistics. It highlights key components such as digital wallets for secure access, signers for transaction validation, blockchain service providers (like Infura or Alchemy), and the role of smart contracts in automating processes within the supply chain.

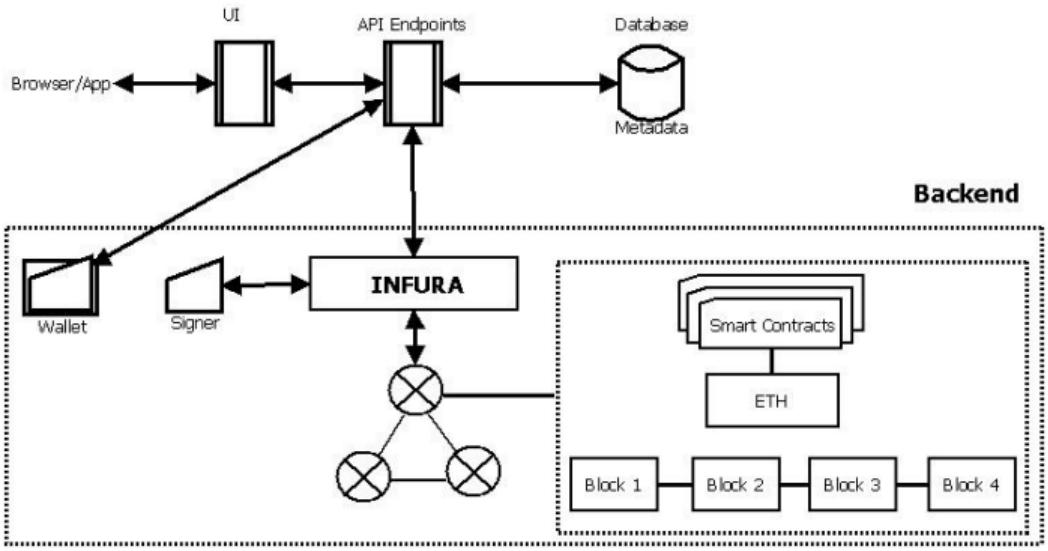

Figure 3.1: System Architecture

In Figure 3.1, the components of system architecture are plotted. These components are:
Digital Wallet: A digital wallet stores cryptographic private keys that grant users access to their blockchain funds. These keys are essential for authorizing transactions and confirming ownership of digital assets.
Signer: A signer utilizes digital signature technology to ensure the authenticity and integrity of a transaction, message, or data. Signers are pivotal in blockchain transactions, offering proof that a transaction is valid.
Blockchain Service Provider (Infura/Alchemy): Infura and Alchemy provide infrastructure services for Ethereum and other blockchain networks. They enable developers to

connect to blockchain networks without managing their own nodes, streamlining the development process.
Smart Contracts: Smart contracts are self-executing contracts with the terms and conditions encoded directly into the software, automatically enforcing the agreement without the need for intermediaries.

3.2 Data Flow Diagrams(DFD)

3.2.1 DFD Level 0 Diagram

The DFD Level 0 diagram provides a high-level overview of how data flows within the system. It outlines the interaction between the user and the system, showing how access is granted after authentication and how the system tracks user transactions within the blockchain network.

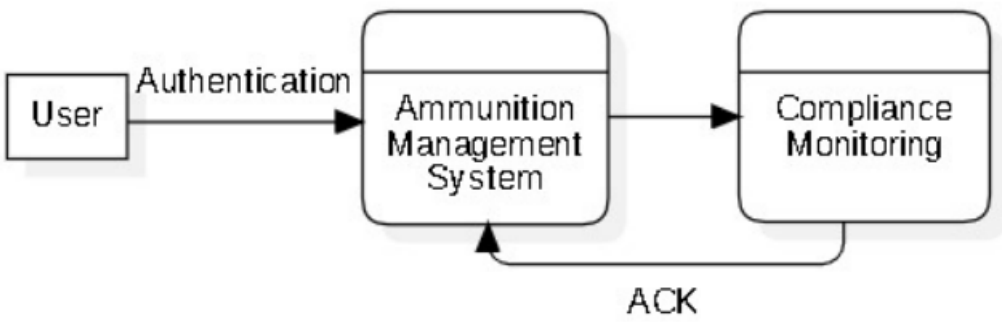

Figure 3.2: DFD Level 0 Diagram

In Figure 3.2, Data Flow Diagram level 0 is plotted. In this diagram user has the access to system once the authentication is done and system creates the monitoring of the user transactions.

3.2.2 DFD Level 1 Diagram

This diagram presents a more detailed view of the data flow. It focuses on the processes after user authentication, illustrating how users can perform ammunition transactions, and how these transactions are monitored in the system.

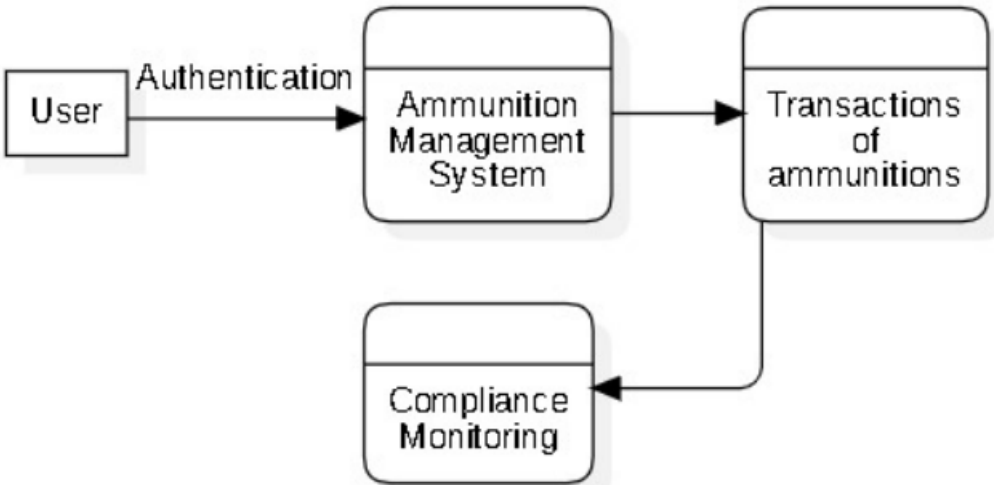

Figure 3.3: DFD Level 1 Diagram

In Figure 3.3, Data Flow Diagram level 1 is plotted. In this diagram user has the access to system once the authentication is done and after that the user can create transactions of require ammunitions and once all transactions are done monitoring will be done.

3.2.3 DFD Level 2 Diagram

In this diagram, the flow of data within specific system components is shown. Key elements such as login access, the blockchain network, ammunition management, and transaction monitoring are outlined, with a focus on how records are tracked and reports are generated.

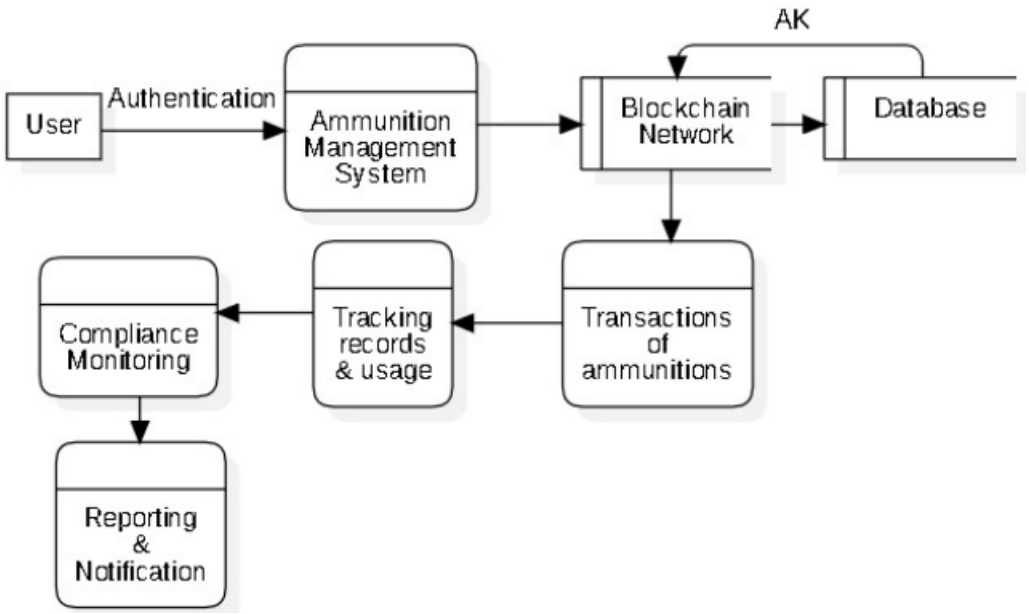

Figure 3.4: DFD Level 2 Diagram

In Figure 3.4, A Data Flow Diagram level 2 visually represents the flow of data within a system. The components present in DFD 2 are : Login : It gives the access to the user to

enter in the system. Blockchain Network : All the servers and the data is proccessed to get into the main block. Ammunition Mangement System : It gives all the modules required for ammuition transaction. Tracking records and usage : All the records are being transferred to the desired location in network and it gives the relevant data. Monitoring and reporting : After all the transactions are finalized the monitoring of the transactions is secured and report is being sent to adminstrator.

3.3 UML Diagrams

3.3.1 Activity Diagram

This UML activity diagram outlines the step-by-step flow of activities within the system. It shows how a user logs in, accesses different system modules, and completes transactions, with a compliance report generated at the end.

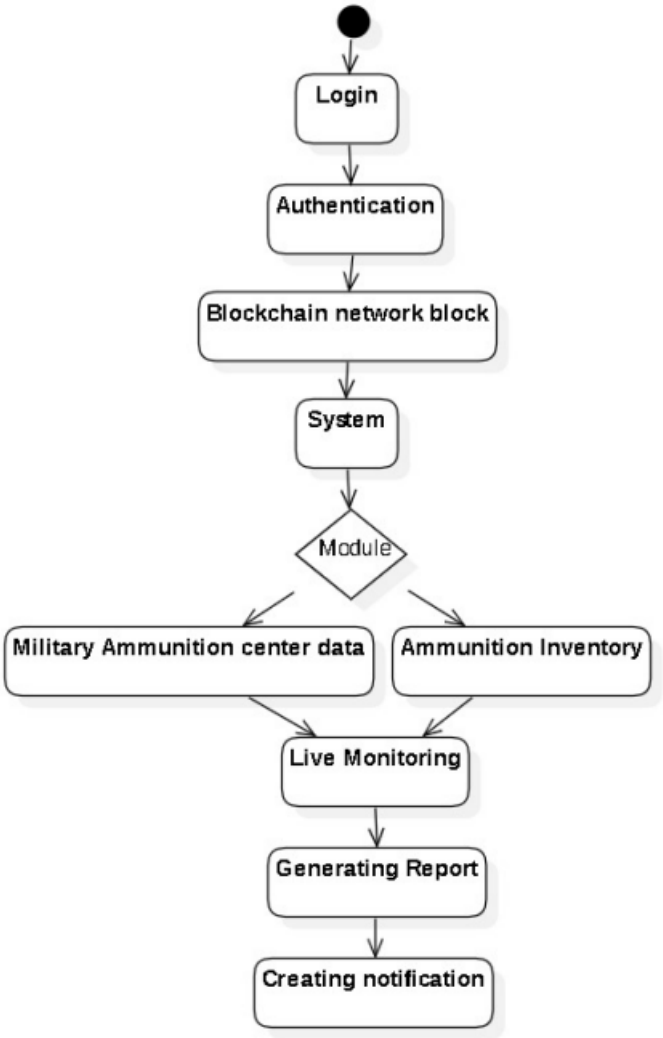

Figure 3.5: Activity Diagram

In Figure 3.5, An activity diagram in UML [6] illustrates the flow of activities and actions within a system. From login into the system to getting into the blockchain network system

the user can choose the desired module like military ammunition center data or Inventory management and after all transactions, the report compliance is formed.

3.3.2 Use Case Diagram

This diagram illustrates the interaction between users and the system, specifically how users authenticate, manage ammunition inventory, track transactions, and generate reports. It highlights the system's key functionalities and user actions.

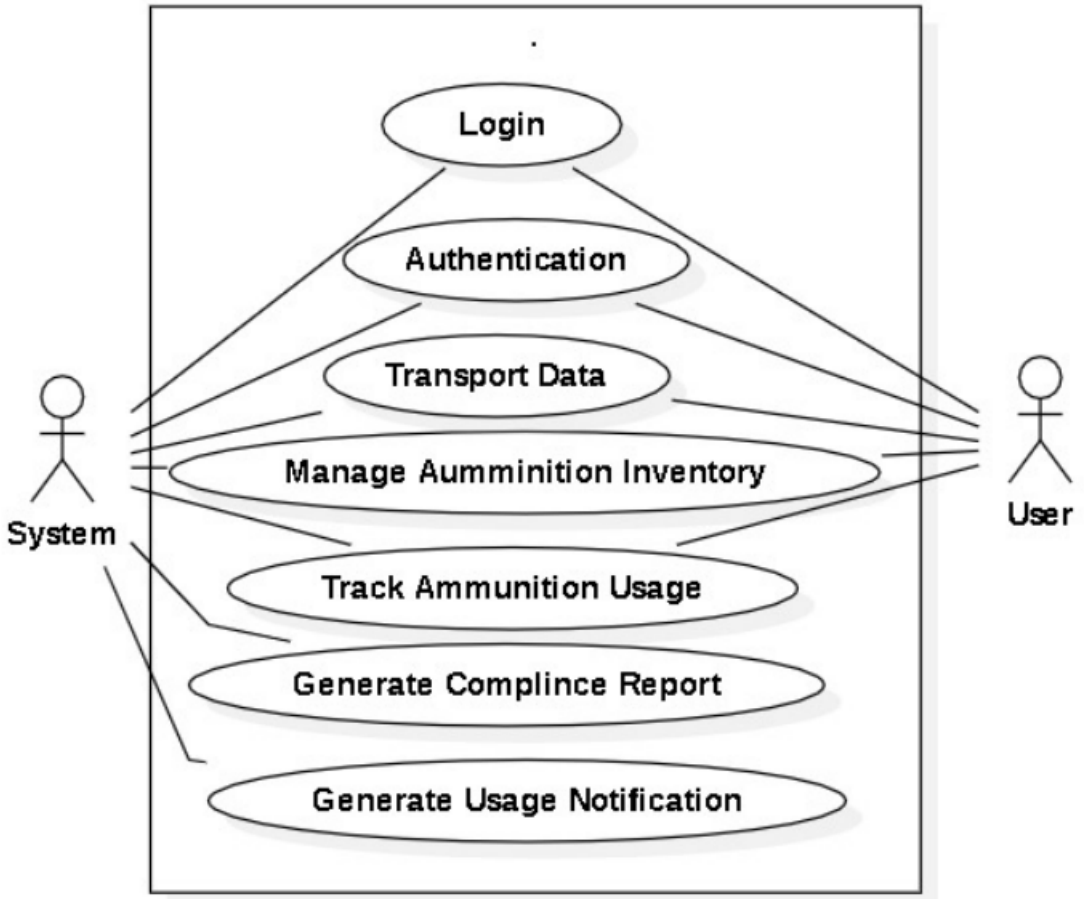

Figure 3.6: Use Case Diagram

Figure 3.6, A Use Case Diagram in UML [8]illustrates the interactions between the system and the user to achieve specific goals. In the context of the ammunition management system, System keeps the track of login, Authentication, Inventory Resources, and Report generation. On the other end user has to authenticate himself to get the inventory data access to make orders and get insights into the ammunition. Login: The user gets login to the interface. Transport Data: All the data of the user is transported from the user interface to the blockchain server. Manage Ammunition Inventory: Inventory is managed by the system. Track Ammunition Usage: After all the transactions are performed the track is being recorded.

3.3.3 Class Diagram

The class diagram provides a static view of the system's structure by representing key classes, their attributes, and relationships. Each class involved in managing ammunition and supply chain transactions is displayed, showing how they interact to ensure secure and efficient operations.

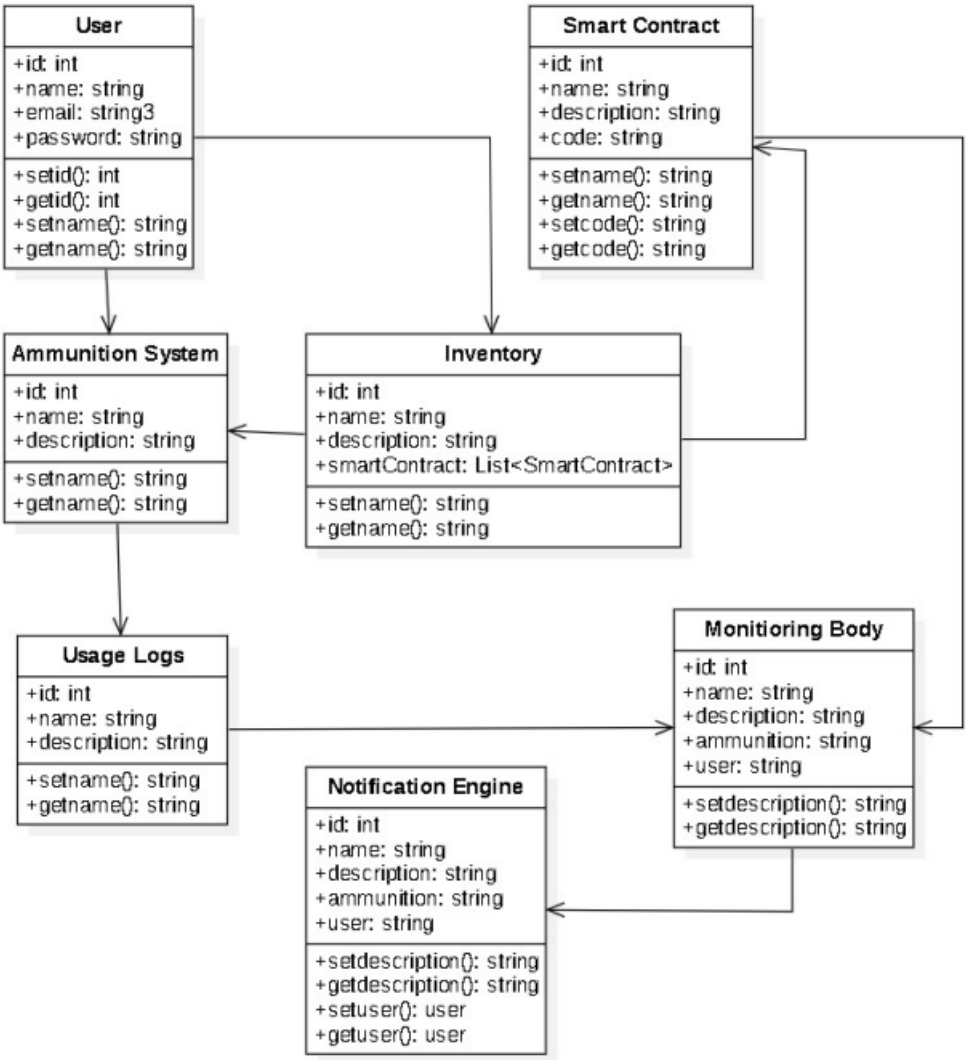

Figure 3.7: Class Diagram

In Figure 3.7, A class diagram in UML provides a static view of the system by illustrating the classes, their attributes, and the relationships between them. Each rectangle represents a class. Class attributes are listed with a "-" prefix. The "+" sign indicates public visibility. Relationships between classes are not explicitly shown in this static class diagram.

Chapter 4

Project Implementation

The implementation phase of the project focuses on turning the planned design and architecture into a functional system that meets the project's objectives. This phase involved building core features, such as backend development, user interface creation, and real-time data processing. Key attention was given to integrating different technologies and tools, optimizing system performance, and ensuring scalability. Critical components and code snippets were tested iteratively to ensure functionality, security, and robustness. Additionally, the project included automated documentation generation and analytics tracking to provide insights into user interactions and system performance. Overall, this phase serves as the foundation for transforming conceptual designs into a working solution ready for testing and deployment.

4.1 Timeline Sem VII

As software development projects grow more complex, effective project management and clear milestones become crucial. This section outlines the project's progress during Semester VII, tracking key milestones from conceptualization to design, implementation, and testing. Each phase was carefully planned to ensure efficiency, mitigate risks, and align with project goals.

The project required close collaboration among team members and adherence to strict deadlines. The Gantt chart visually represents the task schedule, illustrating how each activity contributes to the overall workflow. It also highlights task dependencies, showing how the completion of one task impacts others, which is essential for coordinating overlapping activities and avoiding bottlenecks.

Throughout the semester, the team followed a structured schedule, beginning with project scope definition and research, and moving on to coding, integration, and testing. Regular reviews and progress checks kept the project on track, with task prioritization adjusted as needed.

The Gantt chart (Figure 4.1) also displays task completion percentages, offering a clear snapshot of project progress. The team successfully managed typical large-scale development challenges, including coordinating concurrent tasks and meeting deadlines, thanks to strategic planning and regular updates. Overall, the timeline offers a comprehensive overview of the project's lifecycle, demonstrating how the team managed complexity while meeting deadlines and completing tasks on time.

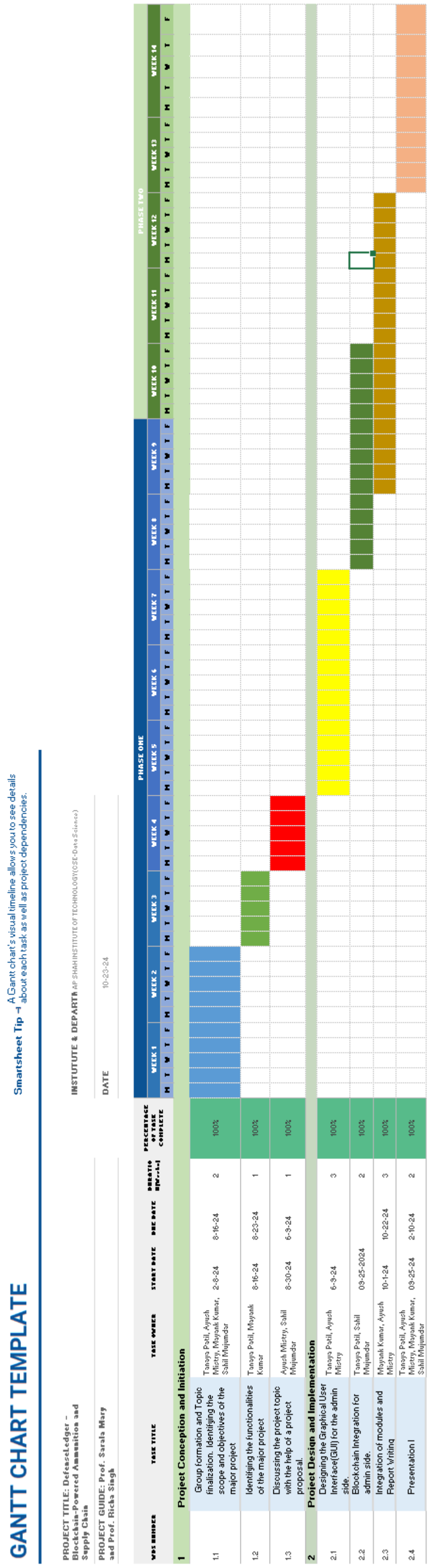

Figure 4.1: Timeline of the Project Milestones

4.2 System Prototype

In this section, the system prototype for DefenseLedger is presented, focusing on the admin interface and blockchain integration. The prototype illustrates how the system leverages blockchain technology to ensure secure, transparent, and efficient management of ammunition in military logistics. The section highlights key features such as real-time tracking, secure data logging, and user management. These prototype visuals provide an in-depth look at the user interface and underlying blockchain mechanics, showcasing how administrators interact with the system to ensure the smooth functioning of ammunition management processes.

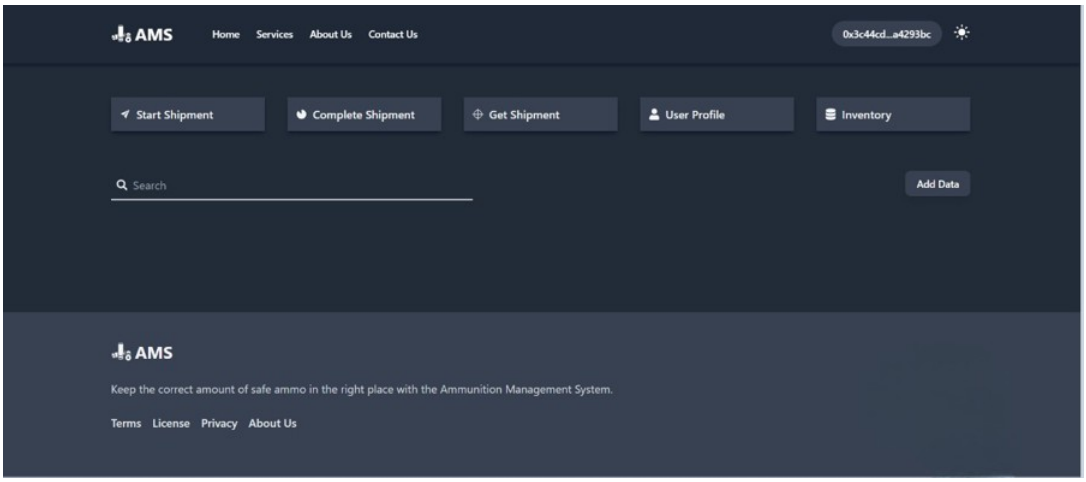

Figure 4.2: GUI Implementation for admin side

This image represents the graphical user interface (GUI) designed specifically for administrators within the DefenseLedger platform. The GUI is built to simplify management tasks, allowing administrators to easily navigate through ammunition inventory data, track shipments, and oversee system users. Key features of the admin interface include access to critical dashboards that display real-time status updates, notification panels for system alerts, and controls for managing transactions. The layout is designed to be user-friendly, ensuring that even with the complexity of military logistics, administrators can efficiently perform tasks with minimal effort. This interface plays a pivotal role in monitoring and ensuring the security of ammunition data across the supply chain.

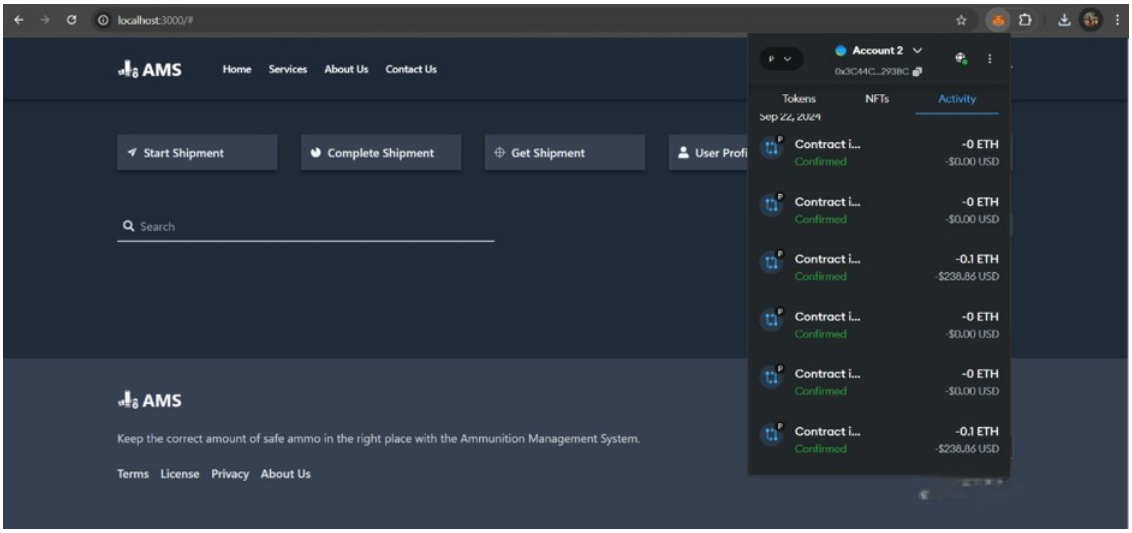

Figure 4.3: Blockchain Integration for admin side

This figure showcases the backend blockchain integration for the admin side of the DefenseLedger system. It highlights how blockchain technology is embedded into the platform to provide secure, immutable records of all transactions and movements of ammunition. Every interaction—from inventory updates to shipment tracking—is securely logged on the blockchain, ensuring that data cannot be altered or tampered with. Smart contracts automate many of the system's processes, such as verifying transactions and managing access control, reducing the need for manual oversight. The blockchain ensures transparency by enabling traceability of every transaction in real-time, which is critical for maintaining trust and accountability in sensitive military operations. This integration offers enhanced security, resilience against cyber threats, and a robust framework for compliance with military standards.

Chapter 5

Summary

In this report, we have explored the intersection of defense technology and strategic military operations, highlighting innovations and their implications for national security. The integration of artificial intelligence (AI) and machine learning enhances decision-making processes, leading to improved operational efficiency. However, the increased reliance on digital systems exposes vulnerabilities, emphasizing the need for robust cybersecurity measures to protect critical infrastructure and sensitive information.

Furthermore, blockchain technology offers promising solutions for secure data sharing and enhanced supply chain transparency, ensuring accountability in logistics operations. International collaboration in defense research and development is vital, as partnerships can foster shared knowledge and innovative solutions to common security threats.

As technology evolves, existing defense policies must adapt to remain relevant and effective. Policymakers should proactively integrate advancements in technology while considering their implications. Future research should focus on exploring autonomous systems and robotics in military operations, developing sophisticated cybersecurity frameworks, and utilizing big data analytics for intelligence enhancement.

Additionally, it is crucial to assess the ethical implications of AI in warfare and promote collaborative defense technology sharing among allied nations to strengthen global security. By addressing these areas, we can better prepare for future challenges and ensure a secure and effective defense landscape.

Bibliography

[1] Yigit, Eren, and Tamer Dag. Improving Supply Chain Management Processes Using Smart Contracts in the Ethereum Network Written in Solidity (2024). Applied Sciences, 14(11): 4738.

[2] Oriekhoe, Osato Itohan, Bankole Ibrahim Ashiwaju, Kelechi Chidiebere Ihemereze, Uneku Ikwue, Chioma Ann Udeh. Blockchain technology in supply chain management: a comprehensive review (2024). International Journal of Management and Entrepreneurship Research, 6(1): 150-166.

[3] Khan, Imran; Qazi, Ejaz Ali; Hassan Jalil Hadi; Ahmad, Naveed; Ali, Gauhar. Securing Blockchain-Based Supply Chain Management: Textual Data Encryption and Access Control (2024). Basel, 12(7): 110.

[4] Gokuleshwaran Narayanan, Ivan Cvitić, Dragan Peraković, S. P. Raja. Role of Blockchain Technology in Supply Chain Management (2024).

[5] R. Qin et al. Web3-Based Decentralized Autonomous Organizations and Operations: Architectures, Models, and Mechanisms (2023). IEEE Transactions on Systems, Man, and Cybernetics: Systems, 53(4): 2073-2082.

[6] Nir Kshetri. Blockchain and sustainable supply chain management in developing countries (2021). International Journal of Information Management, Volume 60: 102376.

[7] Omar, R. Jayaraman, M. S. Debe, H. R. Hasan, K. Salah, and M. Omar. Supply Chain Inventory Sharing Using Ethereum Blockchain and Smart Contracts (2021). IEEE Access, Volume 10, Pages 2345-2356.

[8] Syarifah Bahiyah Rahayu, Sharmelen A/L Vasanthan, Consortium blockchain for military supply chain (2021).

[9] Dnyaneshwar J. Ghode, Rakesh Jain, Gunjan Soni, Sunil K. Singh, Vinod Yadav. Architecture to Enhance Transparency in Supply Chain Management Using Blockchain Technology (2021). Procedia Manufacturing.

[10] Batwa, A., and Norrman, A. A Framework for Exploring Blockchain Technology in Supply Chain Management (2020). Operations and Supply Chain Management: An International Journal, 13(3): 294-306.

[11] Latif, R.M.A., Farhan, M., Rizwan, O. et al. Retail level Blockchain transformation for product supply chain using truffle development platform (2020). Cluster Comput, Volume 24.

[12] Kaur, Amanpreet, Gurpreet Singh, Vinay Kukreja, Sparsh Sharma, Saurabh Singh, and Byungun Yoon. Adaptation of IoT with Blockchain in Food Supply Chain Management: An Analysis-Based Review in Development, Benefits and Potential Applications (2022). Sensors, 22(21): 8174.

[13] Bhat, Showkat Ahmad, Nen-Fu Huang, Ishfaq Bashir Sofi, and Muhammad Sultan, Agriculture-Food Supply Chain Management Based on Blockchain and IoT: A Narrative on Enterprise Blockchain Interoperability (2022).

[14] Mukherjee, A., Singh, R.K., Mishra, R. et al. Application of blockchain technology for sustainability development in the agricultural supply chain: justification framework (2021).

[15] Javed Aslam, Aqeela Saleem, Nokhaiz Tariq Khan, Yun Bae Kim. Factors influencing blockchain adoption in supply chain management practices: A study based on the oil industry (2021). Journal of Innovation and Knowledge, 6(2).

[16] Ilhaam A. Omar, Raja Jayaraman, Mazin S. Debe, Khaled Salah, Ibrar Yaqoob, Mohammed Omar, Automating Procurement Contracts in the Healthcare Supply Chain Using Blockchain Smart Contracts(2021).