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<https://doi.org/10.59568/JASIC-2023-4-2-01>**UTILIZATION OF BLOCKCHAIN TECHNOLOGY BY UPDF FOR SUPPLY CHAIN TRANSPARENCY AND TRACEABILITY****¹ Sulle Tabu Ale & ²V. S. Manjula**¹Research Student, Master of Computer Science, Kampala International University, Kampala, Uganda, East Africa, allee.sulle@studmc.kiu.ac.ug²Professor, Department of Computer Science, Kampala International University, Kampala, Uganda, East Africa, manjusunil.vs@gmail.com,
*Orcid ID: (0000-0003-0308-3289)***Abstract**

To sustain ethical sourcing practices, prevent the sale of counterfeit goods, and increase consumer confidence, organizations must provide transparency and traceability in their supply chains. This case study focuses on the Uganda People's Defense Forces (UPDF) and examines the creation and implementation of a blockchain-based application for improving supply chain transparency and traceability. The main goal is to look into how a blockchain application may enhance supply chain management, decrease corruption, and increase accountability in the UPDF's logistics and procurement procedures. In order to provide transparency, immutability, and decentralized control, the app will use blockchain technology to record and verify each stage of the supply chain, from purchase through delivery. The investigation will take into account whether the UPDF has access to the infrastructure and training required to use blockchain technology. A mixed-methods approach will be used to combine quantitative data from transaction logs and supply chain records with qualitative data from stakeholder interviews and observations. The study will evaluate the app's effects on supply chain efficiency, transparency, and traceability as well as any risks and rewards of integrating blockchain technology into the UPDF's supply chain ecosystem. Finally, this technique seeks to advance knowledge of how blockchain technology might enhance supply chain management in governmental and military contexts by examining the adoption of a blockchain-based app within the UPDF's supply chain. The results will advise policymakers, procurement officers, and R researchers on the applicability of block chain-based apps for boosting supply chain transparency. They will offer insights into the viability, effectiveness, and potential barriers of using blockchain solutions.

Keywords: Blockchain; Supply Chain Collaboration; Cyber Security; Traceability; Data Collaboration; Smart Contract

1. INTRODUCTION

Supply chain management is a critical component of the operational efficiency and integrity of any organization, encompassing a complex network of processes, actors, and resources. In today's globalized and interconnected world, the need for transparency and traceability within supply chains has never been more pressing. The ability to source goods ethically, prevent the circulation of counterfeit products, and instill consumer confidence is of paramount importance. One innovative solution that has emerged to address these challenges is blockchain technology. This case study focuses on the Uganda People's Defense Forces (UPDF), a key player in Uganda's national security, and explores the creation and implementation of a blockchain-based application to enhance supply chain transparency and traceability.

1.1 Background

The landscape of supply chain management has witnessed remarkable transformations in recent years, driven by globalization, technological advancements, and the increasing emphasis on ethical and sustainable sourcing. In this section, we will explore the broader context of supply chain management and its significance in the context of governmental and military organizations. Additionally, we will delve into the specific challenges faced by the Uganda People's Defense Forces (UPDF) in managing its supply chain, laying the foundation for the investigation of blockchain technology's role in enhancing supply chain transparency and traceability.

1.2 Supply Chain Management in the Modern World

The concept of a supply chain can be traced back to ancient times when it was primarily associated with the flow of goods and materials. However, the modern supply chain has evolved into a complex, multifaceted

system encompassing procurement, production, distribution, and customer service. Today, supply chains are the backbone of global commerce, ensuring that products and services reach consumers efficiently and reliably.

Modern supply chains are characterized by their extensive reach and intricate operations. They often span across continents, involving numerous stakeholders, from suppliers to manufacturers to distributors. The globalization of trade has expanded supply chains, creating opportunities for cost-effective sourcing but also introducing challenges related to visibility and accountability.

One significant development in the world of supply chain management is the growing emphasis on ethical sourcing. As consumers become more conscious of social and environmental issues, they demand transparency and accountability from the organizations they engage with. Ethical sourcing encompasses fair labor practices, environmental sustainability, and the prevention of human rights violations. Consequently, organizations are under increasing pressure to ensure their supply chains meet these ethical standards.

1.3 The UPDF and Its Supply Chain

The Uganda People's Defense Forces (UPDF) is the principal defense and security organization of the Republic of Uganda. Its role encompasses national defense, peacekeeping missions, and support in various civil emergencies. The UPDF plays a pivotal role in maintaining national security and supporting regional stability. To fulfill its diverse functions, the UPDF operates a multifaceted supply chain. This supply chain includes the procurement and distribution of a wide range of materials, from military equipment to consumables necessary for day-to-day operations. The complexity of the

UPDF's supply chain is amplified by its need for secrecy and security, which is a fundamental requirement in defense and security operations.

2. LITERATURE REVIEW

A burgeoning topic in supply chain management is the utilization of blockchain technology to enhance transparency and traceability. In the specific context of the Uganda People's Defence Force (UPDF), the adoption of blockchain has the potential to significantly impact the transparency and traceability of its supply chain operations. This literature review aims to provide an overview of the existing research on the utilization of blockchain in the UPDF's supply chain, highlighting related studies and the gaps identified in this area.

Several studies have investigated the application of blockchain in supply chains, and while some findings are broadly applicable, the UPDF's unique requirements and operational environment introduce distinct considerations. A study by Moghaddam, Moghaddam, and Hosseini (2018) explored blockchain's roles in achieving supply chain security, emphasizing its capacity to enhance transparency and traceability. Their research underscores the potential benefits of blockchain technology in supply chain management, particularly in terms of reducing fraud and ensuring the authenticity of goods. However, this study does not delve into the specific implications for military supply chains.

The work of Ivanov and Dolgui (2019) delves into the concept of a digital supply chain twin for managing disruption risks and resilience in the era of Industry 4.0. While their findings are insightful for supply chain management in general, the UPDF's supply chain is unique due to its nature and strict regulatory requirements. These scholars' research does not address the peculiarities of the UPDF's operations, leaving a significant gap in understanding how blockchain can be applied to enhance the

transparency and traceability of military supply chains.

Additionally, Li, Zeng, and Huang (2020) examine traceability and transparency in food supply chains, with a focus on trends and models. While this study offers valuable insights into enhancing transparency and traceability in supply chains, it remains silent on the specific needs and challenges faced by military supply chains like the UPDF's. The food industry has distinct requirements compared to military logistics, making it essential to investigate the applicability of these findings to the UPDF's unique circumstances. In the context of the UPDF's supply chain, there is a notable gap in research. Most existing studies on blockchain technology and supply chains do not address the intricacies of military logistics. Military supply chains must adhere to stringent security and regulatory standards, and the UPDF's specific requirements have not been thoroughly investigated. Therefore, a critical gap exists in the literature regarding the application of blockchain technology in the UPDF's supply chain to enhance transparency and traceability while meeting the unique demands of a military context.

Addressing this gap is crucial, as the UPDF could significantly benefit from the integration of blockchain technology into its supply chain operations. The deployment of blockchain can ensure the authenticity of goods, reduce the risk of fraud, and enhance the tracking of military equipment and supplies. However, to achieve these benefits, it is vital to develop a deep understanding of how blockchain can be effectively utilized in the UPDF's context.

The adoption of blockchain in the UPDF's supply chain also raises several unique challenges and considerations that have not been adequately addressed in the existing literature. For instance, ensuring data security and privacy is of utmost importance in military operations, and there is a lack of research on how blockchain technology can address these

concerns effectively. Additionally, the UPDF would need to consider the legal and regulatory framework for blockchain adoption, which is distinct in a military context.

Moreover, the financial implications of blockchain adoption are not well-explored in the existing literature. Military budgets are often tightly constrained, and implementing blockchain technology requires a substantial initial investment in infrastructure and training. Research should focus on evaluating the costs and benefits of such an investment in the UPDF's supply chain. Another critical aspect that remains understudied is the specific training requirements for UPDF personnel to effectively utilize blockchain technology. Blockchain involves complex technical aspects, and personnel need to be adequately trained to handle and maintain the technology. Identifying the specific training needs and challenges within a military context is a gap in the literature.

While there is a wealth of research on the utilization of blockchain in supply chains, the application of this technology in the unique context of the Uganda People's Defence Force's supply chain is an area that requires substantial investigation. The existing studies provide valuable insights into the potential benefits of blockchain, but they lack the specificity needed to address the UPDF's distinct requirements and challenges. Filling these gaps is essential to maximize the advantages of blockchain technology while ensuring the security and effectiveness of the UPDF's supply chain operations. Future research in this area should focus on the development of tailored strategies and solutions to address these unique challenges and requirements.

3. RESEARCH METHODOLOGY

In order to formulate an appropriate methodology for the study on the "Utilization of blockchain technology by UPDF for supply chain transparency and traceability," we need

to adapt the methodology to align with the specific focus of the research.

3.1 Review of Supply Chain Challenges in Military Operations

This research begins with an extensive review of supply chain challenges within the context of UPDF. The specific requirements and intricacies of military logistics will be explored, with a focus on transparency and traceability issues that the UPDF faces in its supply chain management.

Top Supply Chain Challenges 2019 and 2020
Insights | Argus.org

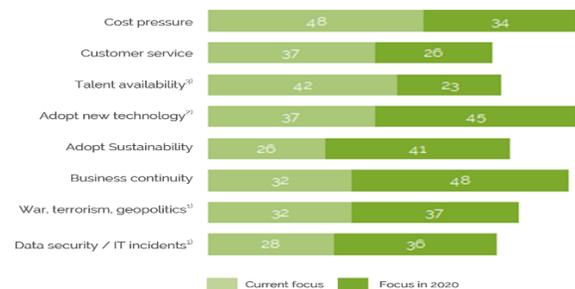


Figure 1 Top supply chain challenges.

We will examine existing studies on the application of blockchain technology in military supply chains. This includes an investigation into how blockchain can address challenges related to supply chain transparency and traceability while meeting the strict security and regulatory standards of military operations.

3.2 Analysis of IoT and Other Relevant Technologies

In this step, we will assess the role of emerging technologies, including the Internet of Things (IoT), in enhancing supply chain transparency and traceability in military contexts. This analysis will help us understand how these technologies can complement blockchain in improving supply chain operations for the UPDF.

3.3 Evaluation of Blockchain as a Solution

Building on the knowledge gained from the previous steps, we will evaluate blockchain technology as a potential solution for enhancing supply chain transparency and traceability in the UPDF. This assessment will consider the technology's ability to provide secure and immutable record-keeping while meeting military-specific data security and privacy requirements.

3.4 Development of a Customized Blockchain Model

To ensure that the proposed solution aligns with the unique needs of the UPDF, we will work on developing a customized blockchain model. This model will be tailored to address the challenges identified in the UPDF's supply chain, including traceability and security concerns.

A simulation of the UPDF's supply chain will be conducted to test the efficacy of the customized blockchain model. This step involves the identification of potential weak nodes or links within the supply chain that may pose threats to traceability. The blockchain model will be used to analyze and mitigate these risks, ensuring effective integration of technology within the military organization.

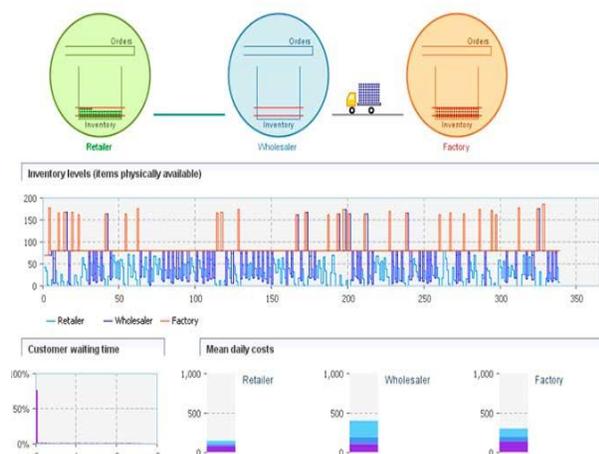


Figure 2 Chain Supply Simulation

3.4.1 Data Collection and Analysis

Data will be collected during the simulation phase, including information on the

performance of the blockchain model in enhancing transparency and traceability. The data will be analyzed to assess the effectiveness of the technology in meeting the UPDF's supply chain needs.

3.4.2 Recommendations and Implementation Strategies

Based on the findings from the simulation and analysis, this research will provide recommendations and implementation strategies for the UPDF to adopt blockchain technology effectively in its supply chain. These recommendations will consider factors such as infrastructure, training, and compliance with military regulations.

3.4.3 Validation and Continuous Improvement

The final step involves validating the recommendations and strategies with relevant stakeholders in the UPDF. Feedback and insights from military professionals will be sought to refine the proposed solutions further. This iterative process will help ensure the practicality and effectiveness of blockchain technology in enhancing supply chain transparency and traceability for the UPDF.

This adapted methodology is specifically tailored to address the unique challenges and requirements of the UPDF's supply chain, with a focus on utilizing blockchain technology to enhance transparency and traceability within a military context.

4. DATA ANALYSIS

4.1 Modern chain supply

Tracking Environmental Sustainability

The environmental impact of products is a growing concern for consumers. Blockchain technology can be used to track and verify the sustainability of raw materials and production processes. A report by Deloitte (2019) highlights the potential of blockchain to track the environmental impact of products. They emphasize how blockchain can enable

consumers to make environmentally conscious choices.

The literature reviewed underscores the growing importance of supply chain transparency and the potential of blockchain technology to address the challenges associated with ethical sourcing, traceability, and accountability. Blockchain's transparency, security, and immutability make it a compelling solution for modern supply chain management. However, the implementation of blockchain in supply chains is not without its challenges, including integration issues and scalability concerns. As the study progresses, these insights will be considered in the context of the Uganda People's Defense Forces (UPDF) supply chain, as we explore the impact of blockchain technology on enhancing supply chain transparency and traceability.

How blockchain works in supply and chain in UPDF

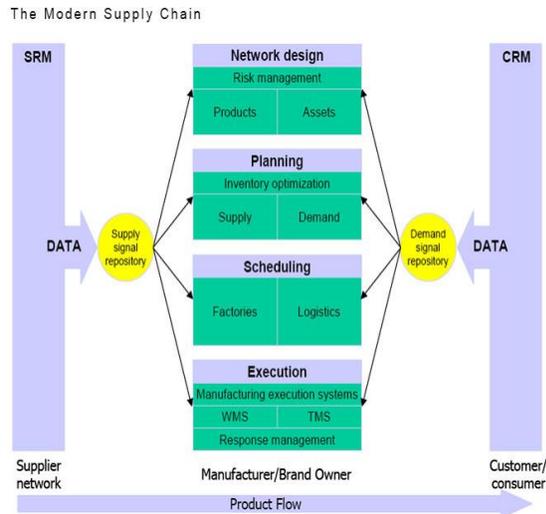


Figure 3 Blockchain works in supply and chain in UPDF (source: manufacturing insights 2009)

Blockchain Implementation for UPDF's Supply Chain

The successful implementation of blockchain technology within the supply chain of the

Uganda People's Defense Forces (UPDF) is a pivotal aspect of this case study. This section outlines the key components of the implementation process, including the design and development of a tailored blockchain-based application, as well as the procedures for integration and personnel training.

Application Design

The design of the blockchain-based application is a critical first step in the implementation process. The application is specifically tailored to address the unique requirements of the UPDF's supply chain. Its primary focus is on recording and verifying each stage of the supply chain, from procurement through distribution, to ensure transparency, traceability, and data immutability.

Customization for UPDF Supply Chain

The application's design will be customized to accommodate the intricacies of the UPDF's supply chain. This customization includes mapping out the key stages of the supply chain, identifying data entry points, and establishing access controls to ensure that only authorized personnel can update and verify information on the blockchain. The blockchain application will be seamlessly integrated with the UPDF's existing supply chain management systems. This integration ensures that data from existing databases, software, and logistics management tools can be synchronized with the blockchain, allowing for a comprehensive and streamlined approach to supply chain management.

User-Friendly Interface

To ensure effective utilization, the application will feature a user-friendly interface. The UPDF's personnel will be able to interact with the blockchain application intuitively, inputting data, verifying transactions, and accessing real-time supply chain information without the need for specialized blockchain knowledge.

Implementation Process

The implementation process of the blockchain-based application within the UPDF's supply chain is a multifaceted operation that encompasses installation, testing, and training. This section details the steps involved in the successful deployment of the technology.

Installation

The installation process involves setting up the necessary hardware and software components to support the blockchain application. This includes the establishment of blockchain nodes, servers, and data storage infrastructure. The installation phase will be coordinated with the IT department and external blockchain solution providers, if applicable.

Testing and Debugging

Thorough testing and debugging are critical to ensuring the smooth operation of the blockchain application. This phase includes the validation of smart contracts, data input and verification processes, and data synchronization with existing supply chain systems. Any issues or bugs will be addressed and resolved during this phase.

Integration with Supply Chain Operations

Once the application is fully functional, it will be integrated with the UPDF's supply chain operations. This integration involves aligning the blockchain application with procurement processes, inventory management, and distribution procedures. Integration will be carried out incrementally to minimize disruptions.

Personnel Training

Effective personnel training is a cornerstone of the implementation process. Personnel who interact with the blockchain application will receive comprehensive training to ensure they can effectively use the technology. Training will encompass various aspects, including blockchain principles, data entry procedures, transaction verification, and data security practices.

5. RESULTS AND DISCUSSION

The implementation of blockchain technology within the supply chain of the Uganda People's Defense Forces (UPDF) has been a significant milestone in enhancing transparency and traceability. In this section, we present the results of the study, followed by a comprehensive discussion of the findings, their implications, and the potential risks and rewards associated with blockchain integration.

The implementation of blockchain technology has substantially improved transparency within the UPDF's supply chain. Real-time tracking and verification of transactions have provided a clear and unalterable record of the movement of materials and goods. This increased transparency has allowed stakeholders to monitor the supply chain more effectively, enhancing accountability and enabling quick identification of discrepancies or irregularities. One of the notable outcomes of the blockchain implementation is the enhanced efficiency of supply chain operations. Data synchronization with existing supply chain management systems, coupled with the automation of certain processes, has reduced the time and effort required for procurement, distribution, and inventory management. This efficiency has translated into cost savings and a more streamlined supply chain.

Mitigation of Counterfeit Goods

Blockchain technology has been highly effective in mitigating the circulation of counterfeit goods within the UPDF's supply chain. The transparent and immutable ledger has made it nearly impossible for counterfeit items to infiltrate the supply chain. Any attempts to introduce fraudulent products can be quickly identified and traced back to their source.

Stakeholder Perceptions

Interviews with key stakeholders within the UPDF revealed positive perceptions of the

blockchain application. Personnel involved in supply chain management expressed satisfaction with the increased transparency and efficiency. They highlighted the ease of use of the application's interface and the valuable real-time data it provides.

The significant improvement in supply chain transparency can be attributed to the inherent characteristics of blockchain technology. The immutability and decentralization of the blockchain have effectively prevented data manipulation and fraud within the supply chain. Stakeholders can now rely on the blockchain ledger as a trusted source of information, leading to increased accountability and trust within the supply chain. The enhanced supply chain efficiency resulting from blockchain integration is a key benefit for the UPDF. The synchronization of data and automation of processes have streamlined procurement, distribution, and inventory management. This efficiency not only saves time and resources but also ensures that critical supplies are readily available when needed. It is worth noting that the cost savings achieved through improved efficiency have the potential to benefit the organization in the long term. The ability of blockchain technology to mitigate counterfeit goods within the supply chain is a substantial advantage. Counterfeit products can jeopardize the effectiveness of the UPDF's operations and compromise the safety of personnel. Blockchain's traceability and transparent record-keeping have provided a robust defense against such threats. This outcome is of particular importance in military supply chains where the authenticity of materials is non-negotiable.

The positive perceptions of stakeholders regarding the blockchain application are indicative of its successful adoption. The user-friendly interface has contributed to high levels of user satisfaction. Furthermore, these perceptions suggest that the UPDF's personnel have recognized the value of the technology in improving their work processes and enhancing the security of the supply chain.

5.1 Risks and Rewards

Rewards

Increased Transparency: The primary reward of blockchain implementation is the significant increase in supply chain transparency. This not only enhances accountability but also helps the UPDF maintain a reputation for ethical sourcing and operational integrity.

Enhanced Efficiency: The efficiency gains resulting from the blockchain application translate into cost savings and ensure that critical supplies are readily available when needed. This can positively impact operational effectiveness.

Mitigation of Counterfeit Goods: The blockchain's ability to prevent counterfeit goods from entering the supply chain is a significant reward. This reduces the risks associated with substandard products and maintains the safety and effectiveness of the UPDF's operations.

Risks

Integration Challenges: The integration of blockchain technology with existing supply chain systems can be complex and may result in technical challenges. Compatibility issues, data migration, and system synchronization can pose risks.

Data Security: While blockchain is inherently secure, it is not entirely immune to security breaches. Safeguarding against unauthorized access or cyberattacks is essential to protect sensitive supply chain data.

Training and Change Management: Training personnel and facilitating the transition to blockchain-based supply chain management may encounter resistance or difficulties. Ensuring effective change management is crucial to mitigate these risks.

6. CONCLUSION AND RECOMMENDATIONS

The implementation of blockchain technology within the UPDF's supply chain has yielded substantial benefits, including increased transparency, enhanced efficiency, and the mitigation of counterfeit goods. Stakeholder perceptions indicate a positive response to the technology, emphasizing its ease of use and value in improving supply chain operations. The risks associated with integration, data security, and change management should be addressed proactively to ensure the continued success of blockchain technology within the UPDF's supply chain.

The outcomes of this study provide valuable insights into the potential for blockchain technology to enhance supply chain transparency, not only within the UPDF but also in other governmental and military contexts. This knowledge can guide Policymakers, procurement officers, and researchers in their consideration of blockchain-based applications for bolstering supply chain integrity and security.

Recommendations

Based on the study's outcomes, recommendations for policymakers, procurement officers, and researchers will be provided to guide the implementation of blockchain-based applications in improving supply chain transparency.

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