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REVIEW ARTICLE **OJMS0502004-615**

USING TELEGRAM WEB-3 MINI-APPS TO CONNECT SMALLHOLDER FARMERS WITH MARKETS FOR SUSTAINABLE FOOD CHAINS IN LAGOS

[1]Akisanmi, D. O. & [2]Ogunderu, O.

[1]*Marketing&Strategic Management Consultant and Tutor*
[2]*Department Of Marketing Federal Cooperative College, Eleyele, Ibadan, Oyo State*

***Corresponding Author Email:** davidola.akisanmi@gmail.com*

ABSTRACT

With Lagos facing significant challenges due to rapid urbanization, including inefficient food distribution systems and limited market access for farmers, this decentralized approach proposes an innovative solution. By leveraging blockchain technology, decentralized finance (defi), and smart contracts, the platforms aim to streamline transactions, reduce intermediaries, and ensure fair pricing. This paper explores the potential of utilizing Telegram decentralized web-3 mini-applications as e-commerce platforms to connect smallholder farmers with structured markets, enhancing the sustainability of food supply chains in Lagos, Nigeria. The paper examines the role of these technologies in improving transactional transparency, empowering smallholder farmers, and fostering equitable participation in the urban food supply system. It also proposes a comprehensive framework for platform implementation, assessing its potential economic, environmental, and social impacts. The study recommends a pilot project, policy advocacy, capacity building, and scalability plans to ensure the platform's success and long-term sustainability. Ultimately, this decentralized e-commerce platform holds promise for revolutionizing food supply chains, empowering farmers, and promoting sustainable development in Lagos and other regions across Nigeria and Africa.

Keywords: *Blockchain technology, decentralized e-commerce platform, food distribution systems, smallholder farmers, sustainability of food supply chains, Telegram web-3 mini-applications.*

INTRODUCTION

CONTEXT AND SIGNIFICANCE

Lagos, Nigeria's primary hub for finance, culture, and education, is one of the largest urban centers globally (Akanle & Adejare, 2017). As of 2024, it is the most populous city in sub-Saharan Africa, with over nine million residents (Sasu, 2024). In contrast, Kano, the second largest city, has around 3.6 million people (Sasu, 2024). Rapid population growth in Lagos has strained infrastructure, creating challenges in urban planning, housing, transportation, and food supply management (Auwalu & Bello, 2023; Opoko & Oluwatayo, 2014).

Lagos contributes 25% to Nigeria's GDP, valued at over $136 billion, attracting industries from finance to entertainment (Omeje, 2024). However, overpopulation and inadequate infrastructure hinder sustainable development (Auwalu & Bello, 2023). The city's growing population drives demand for affordable food, yet inefficient supply chains, climate change, and food wastage limit market access and pricing power for smallholder farmers (Alade *et al.*, 2022; Odudu, 2015; Edeoghon & Izekor, 2017). Studies show up to 40% of food produced in Nigeria is lost due to poor storage, transportation, and market systems (Babatunde & Oyatoye, 2005; Adegbola *et al.*, 2011), with supply chain disruptions exacerbating price volatility (Okonkwo *et al.*, 2022).

This paper suggests integrating decentralized web-3 technologies, particularly Telegram mini-apps into these issues. By leveraging decentralized finance and blockchain, this strategy could revolutionize Lagos's agricultural landscape, providing equitable market access for smallholder farmers (Kamilaris, Fonts, & Prenafeta-Boldú, 2019). Such innovations are crucial for building a more resilient urban food ecosystem.

OBJECTIVES AND SCOPE

The primary aim of this paper is to explore Telegram's decentralized Web-3 mini-applications as e-commerce platforms connecting smallholder farmers with structured markets in Lagos. The objectives include:

Examine Web-3 Technologies in Market Access for Farmers: It will explore how decentralized applications (dApps) can reduce barriers, limit intermediaries, and give farmers greater control over pricing and market participation.

Explore Decentralized Finance (DeFi) and Smart Contracts: This section will analyze how DeFi and smart contracts enhance transactional transparency, automate processes, ensure fair pricing, and reduce fraud, promoting equitable economic benefits.

Develop a Decentralized E-Commerce Framework via Telegram: The paper will propose a scalable framework covering technical architecture, user interface, and integration with Lagos' agricultural and financial systems.

Assess Economic, Environmental, and Social Impacts on Lagos' Food Supply: The analysis will address benefits such as increased farmer income, sustainable farming, food security, and social empowerment through equitable access to fresh produce and reduced transaction costs.

LITERATURE REVIEW

THE ROLE OF E-COMMERCE IN AGRICULTURE

E-commerce has transformed industries by directly connecting producers and consumers, reducing intermediaries, and improving transparency. In agriculture, it allows farmers to bypass middlemen, increasing profits. However, traditional e-commerce faces challenges like centralized control, high fees, and barriers for small producers, especially in developing countries with limited digital literacy and infrastructure (Li & Zhang, 2024). E-commerce can enhance market access but must address agriculture's specific challenges like perishability, pricing, and logistics (Ji *et al.*, 2020; Zhuo, 2020). Decentralized technologies offer solutions by reducing intermediaries, lowering costs, and improving transparency (Berdik *et al.*, 2021). Decentralized platforms are crucial for handling perishability and supply chain complexities, especially in emerging economies (Li & Huang, 2020).

DECENTRALIZED FINANCE (DEFI) AND WEB-3 TECHNOLOGIES

Decentralized Finance (DeFi) uses blockchain to eliminate intermediaries like banks, enabling peer-to-peer transactions, automated smart contracts, and transparent financial operations crucial for trust in decentralized marketplaces (Jha *et al.*, 2023; Thomason & Ivwurie, 2023). In agriculture, DeFi and Web-3 offer smallholder farmers access to secure financial services, fair pricing, and smart contracts that automate payments, ensuring timely compensation without risk of default (Ibrahimy *et al.*, 2023). DeFi also provides decentralized lending and insurance tailored to farmers' needs, mitigating risks like price volatility and crop failures, and fostering more equitable food systems in developing countries (Tripoli & Schmidhuber, 2018; Das Nair & Landani, 2020; Kanjere, 2021).

TELEGRAM MINI-APPLICATIONS AS DECENTRALIZED PLATFORMS

Telegram, a globally popular messaging platform, has integrated Web-3 functionalities via mini-applications, enabling decentralized marketplaces, peer-to-peer transactions, and blockchain-based voting systems. With its vast user base and secure infrastructure, Telegram is ideal for decentralized e-commerce solutions, particularly in regions where mobile access is more common than traditional internet (Nardini *et al.*, 2020; Witt & Schoop, 2024). Leveraging these mini-applications, an agricultural e-commerce platform could connect smallholder farmers directly with urban markets, bypassing barriers to market access. This would streamline the agricultural supply chain and enhance food distribution efficiency in megacities like Lagos, facing pressure from rapid urbanization (Quayson *et al.*, 2020; Kumarathunga *et al.*, 2022). Decentralized technologies would ensure transparent, secure transactions and facilitate smart contracts for automated payments, reducing disputes and ensuring compliance. Telegram’s mini-applications could thus modernize agricultural markets and promote sustainable food systems in urban Africa (Zutshi *et al.*, 2021; Liu *et al.*, 2021).

CONCEPTUAL REVIEW

DESIGNING A DECENTRALIZED E-COMMERCE PLATFORM

The proposed decentralized e-commerce platform will be built on Telegram’s mini-applications, utilizing web-3 technologies to create a marketplace where smallholder farmers can directly interact with buyers. The platform will integrate several key components to ensure efficiency, transparency, and sustainability:

Decentralized Marketplace: Farmers can list their produce, set prices, and negotiate directly with buyers without intermediaries. The marketplace will be powered by block-chain, ensuring all transactions are transparent and immutable.

Smart Contracts: These will automate the entire transaction process, from order placement to payment and delivery. Smart contracts will be coded to release payments to farmers once the delivery is confirmed, minimizing the risk of fraud and ensuring timely payments.

Escrow Services: To build trust among users, the platform will offer escrow services that hold funds until both parties fulfill their contractual obligations. This will provide additional security for transactions, particularly in the initial stages when trust levels may be low.

Integrated Logistics: The platform will collaborate with local logistics providers to ensure that produce is transported efficiently from farms to urban centers. Real-time tracking and decentralized logistics management will help minimize delays and reduce food wastage.

Community Governance: A decentralized governance model will allow all stakeholders, including farmers, consumers, and logistics providers, to participate in decision-making. This could include voting on platform policies, dispute resolution mechanisms, and fee structures.

PILOT IMPLEMENTATION STRATEGY

To assess the viability of the proposed decentralized e-commerce platform, a pilot project will be launched in Lagos Island, an area known for its commercial activity and logistics access, due to its high population density and diverse consumer base. The pilot will also target agricultural zones in Ogun, Oyo, and Ekiti States:

Ogun State: Focus on Ifo and Abeokuta, which are known for crops like cassava and maize.

Oyo State: Target Ibadan and Ogbomosho, recognized for yams and established agricultural networks.

Ekiti State: Involve Ado-Ekiti and Ikole-Ekiti, known for cocoa and fruits.

Key local entities include:

Local Farmer Cooperatives: Collaborations with associations in Ogun, Ibadan, and Ekiti to reach smallholder farmers.

Logistics Companies: Partnerships with Jumia Logistics, Konga Express, and GIG Logistics for efficient distribution.

Consumer Groups: Engagement with The Lagos Foodies Network and The Lagos Urban Agriculture Forum to promote local food consumption.

A digital literacy campaign will equip farmers and stakeholders with essential skills through:

Workshops and Training: Focus on platform navigation and digital transactions.

Educational Materials: Development of guides and video tutorials tailored to varying digital literacy levels.

On-Site Support: Dedicated teams providing hands-on assistance at cooperative offices and community centers.

Feedback Mechanisms: Regular surveys to gather user input and improve the platform.

Insights from the pilot will refine features, address challenges, and prepare for a broader rollout, aiming to enhance market access, streamline logistics, and benefit farmers and consumers in Lagos and surrounding areas.

CASE STUDY: LAGOS, NIGERIA

THE AGRICULTURAL LANDSCAPE AROUND LAGOS

Lagos faces food supply challenges due to a disconnect between rural smallholder farmers and urban consumers, resulting in high post-harvest losses. Farmers lack proper infrastructure, making it difficult to transport fresh produce to urban markets. This lack of a "cold chain" system results in nearly 50% of fresh produce being lost, especially fruits and vegetables (Nduka,2020; Magda du Toit, 2022).

The high cost of logistics and reliance on intermediaries exacerbate financial burdens on small-scale farmers in Lagos. Without direct market access, they sell produce at lower prices, reducing earnings and perpetuating food insecurity, leaving many in poverty. The proposed platform aims to bridge this gap by providing a direct link between farmers and consumers, supported by an efficient, decentralized logistics network (Olawoyin, 2024; Magda du Toit, 2022).

ADDRESSING URBAN FOOD DEMAND AND SUPPLY CHAIN INEFFICIENCIES

Lagos's food supply chain faces challenges due to reliance on intermediaries and inadequate infrastructure, leading to increased costs for consumers and reduced profit for farmers. Decentralized e-commerce solutions, such as FarmNow Direct and Releaf, can improve efficiency by connecting farmers directly with consumers, cutting out middlemen, lowering prices, and improving food security and sustainability. These solutions can minimize spoilage, reduce post-harvest losses, and optimize processing centers for high-demand crops. Implementing decentralized solutions in Lagos could create a more resilient and fair food supply chain that meets consumer demand, supports farmer income, and reduces environmental impact (Brand Press, 2021; Morrison, 2023).

ANTICIPATED IMPACTS

ECONOMIC IMPLICATIONS

The introduction of a decentralized e-commerce platform presents a transformative opportunity to elevate the economic status of smallholder farmers while advancing environmental sustainability and fostering social equity. This section elaborates on the anticipated benefits across these dimensions, providing a comprehensive analysis of the platform's potential impacts.

ECONOMIC IMPACTS

Increased Incomes for Farmers: By eliminating intermediaries from the agricultural supply chain, the decentralized e-commerce platform enables farmers to engage directly with buyers. This direct access allows

farmers to secure better prices for their produce, thereby enhancing their income and financial stability. Research supports that reducing intermediary layers in the supply chain can lead to significant income gains for producers, as evidenced by similar models in other regions (Liu, & Li, 2020; Wang *et al.*, 2023).

Job Creation: The implementation of the platform will stimulate job creation across various sectors. New employment opportunities will arise in logistics, technology development, and platform management. This job creation will contribute to economic growth in both urban and rural areas, helping to bridge the economic divide between these regions. The development of digital infrastructure and logistical networks is expected to spur local economic activity and generate additional employment (Tombe, & Smuts, 2023).

ENVIRONMENTAL SUSTAINABILITY

Reduction in Food Waste: A key benefit of the platform is its potential to significantly reduce food waste. By optimizing supply chain logistics and ensuring timely deliveries, the platform addresses issues related to post-harvest losses and spoilage. Efficient management and real-time data integration can streamline the distribution process, minimizing waste and enhancing the overall efficiency of food supply chains (Lezoche., 2020; Rejeb., 2021).

Promotion of Sustainable Farming Practices: The platform's integration of smart contracts can incentivize sustainable farming practices. Farmers who adopt environmentally friendly methods such as organic farming or conservation tillage, can be rewarded through the platform's automated mechanisms. This not only encourages the adoption of practices that protect the environment but also supports biodiversity and long-term agricultural sustainability (Pretty., 2018; Gangwar, 2024)

SOCIAL AND COMMUNITY BENEFITS

Enhanced Food Security: By improving access to fresh and affordable produce, the platform will bolster food security in urban areas. Consumers will benefit from a more reliable and consistent supply of high-quality food, addressing issues of food scarcity and accessibility. The platform's ability to connect smallholder farmers with urban markets ensures a steady flow of fresh produce, which is essential for maintaining food security (Kariuki., 2018).

Community Empowerment: The decentralized governance model of the platform promotes inclusivity and gives local communities a stake in its management. Stakeholders, including farmers and consumers, will have opportunities to participate in decision-making processes, fostering a sense of ownership and empowerment. This model enhances community engagement and ensures that the platform operates in a manner that reflects the needs and preferences of its users (Helling., 2005).

CHALLENGES AND MITIGATION STRATEGIES

The implementation of a decentralized e-commerce platform in Lagos presents several challenges that need to be addressed to ensure its success. These challenges encompass technological barriers, regulatory and legal

considerations, and issues related to market adoption and trust. Each of these factors requires a strategic approach to mitigate risks and facilitate the platform's effective integration into the local context.

TECHNOLOGICAL BARRIERS

1. Digital literacy

A key challenge for the platform's adoption is the digital literacy of smallholder farmers, many of whom may have limited experience with digital technologies. To address this, a robust training program will be essential, including:
Hands-On Workshops: In partnership with local agricultural extension services and community organizations, these workshops will provide practical guidance on using the platform. Sessions will be tailored to varying levels of digital proficiency and cover topics like account creation, transaction management, and data security.
Support Materials: A range of user-friendly resources will be developed, including printed manuals and quick reference cards. Short instructional videos will be available on platforms like YouTube and embedded within the platform, produced in local languages such as Yoruba, Igbo, and Hausa to overcome language barriers. Interactive content will feature online courses with quizzes and simulations, along with webinars in local languages for real-time assistance. All materials will be optimized for mobile devices and low-bandwidth conditions.

Local Support Centers: Field teams will provide hands-on assistance and training to ensure smooth platform adoption.

2. Internet Accessibility

Despite the increasing availability of mobile internet, connectivity issues persist in certain rural and peri-urban areas around Lagos. To ensure the platform's functionality in low-bandwidth environments, the following measures should be considered:

Optimized Platform Design: The platform should be designed to operate efficiently with minimal data requirements. This includes developing lightweight applications and employing data compression techniques to enhance performance in areas with limited internet speeds.

Offline Functionality: Implementing features that allow users to perform essential tasks offline and synchronize data once connectivity is restored can further mitigate issues related to inconsistent internet access.

REGULATORY AND LEGAL CONSIDERATIONS

1. Engagement with Policymakers

The integration of blockchain and decentralized technologies in Nigeria faces several regulatory hurdles, particularly regarding the use of cryptocurrencies and data protection. To navigate these challenges, it is crucial to:

Proactive Dialogue: Establishing early and ongoing communication with relevant regulatory bodies, such as the Central Bank of Nigeria (CBN) and the National Information Technology Development Agency (NITDA), will be key to ensuring the platform's compliance with local regulations. This dialogue will help in aligning the platform's operations with existing legal frameworks and obtaining necessary approvals.

Compliance with Regulations: Developing a thorough understanding of Nigerian regulations on financial transactions, data protection, and digital currencies will be essential. The platform should incorporate features that adhere to these regulations, such as secure data encryption, user consent protocols, and transparent financial reporting.

2. Legal safeguards

Incorporating legal safeguards into the platform's design will protect users' rights and ensure regulatory compliance. This includes:

User Agreements: Drafting clear and comprehensive user agreements that outline the rights and responsibilities of all parties involved. These agreements should address issues such as dispute resolution, data privacy, and transaction security.

Data Protection: Implementing robust data protection measures in line with Nigeria's data protection laws, ensuring that user information is securely stored and handled under legal standards.

MARKET ADOPTION AND TRUST

1. Building trust

The platform's success will largely depend on the trust it builds among farmers, consumers, and logistics providers. Key strategies to establish and maintain trust include:

Transparency and Security: The platform must ensure that all transactions are transparent and secure. Utilizing blockchain technology to provide immutable records of transactions and integrating escrow services to protect both buyers and sellers will be crucial.

User Testimonials: Encouraging early adopters to share their positive experiences and success stories will help build credibility and foster trust among potential users. Highlighting these testimonials in marketing efforts and on the platform itself can serve as powerful endorsements.

2. Incentivizing participation

To encourage widespread adoption and active engagement with the platform, the following incentives can be implemented:

Reduced Transaction Fees: Offering lower transaction fees for early adopters can make the platform more attractive and financially viable for users.

Loyalty Rewards: Implementing a loyalty program that rewards users for continued participation and transactions can help retain users and promote platform growth.

Access to Financial Services: Providing additional financial services, such as microloans or insurance products, through the platform can enhance its value proposition and appeal to users.

By addressing these technological, regulatory, and market challenges, the platform can successfully integrate into the Lagos food supply ecosystem, benefiting smallholder farmers, consumers, and the broader community.

CONCLUSION

The proposed decentralized e-commerce platform utilizing Telegram's web-3 mini-applications aims to transform the food supply in Lagos, Nigeria. Connecting smallholder farmers directly with urban consumers enhances market access, ensures fair pricing, and creates a sustainable food supply chain. Integrating blockchain technology, decentralized finance (DeFi), and community governance fosters a transparent and equitable system for all stakeholders. Blockchain enhances trust, while DeFi facilitates secure financial transactions. Community governance empowers users, promoting a participatory approach to decision-making and platform management.

RECOMMENDATIONS

To fully realize the potential of this innovative platform, several strategic steps are recommended:

Pilot Implementation: Initiate a comprehensive pilot project in Lagos to test the platform's functionality and effectiveness. Target key agricultural zones within Lagos, such as Alimosho and Agege, as well as, surrounding agricultural areas in Ogun, Oyo, and Ekiti states. Collaborate with established farmer cooperatives, logistics providers, and consumer groups to ensure a representative sample and gather meaningful data. The pilot will focus on refining the platform, assessing its impact on market access, transaction efficiency, and user satisfaction, and making necessary adjustments based on real-world feedback.

Policy Advocacy: Engage proactively with policymakers and regulatory bodies to foster a conducive regulatory environment for decentralized e-commerce platforms. Advocate for clear and supportive regulations regarding blockchain technology, digital transactions, and cryptocurrencies. Collaborate with legal experts and regulators to address potential compliance issues and ensure that the platform operates within the legal framework of Nigeria.

Capacity Building: Develop and implement a robust capacity-building program to enhance digital literacy among farmers and other stakeholders. This program should include hands-on training workshops, digital literacy courses, and comprehensive support materials such as user guides and video tutorials. Partner with local educational institutions and community organizations to deliver training sessions and provide ongoing support. This will ensure that users can effectively navigate and utilize the platform's features.

Scalability and Expansion: Upon successful completion of the pilot, devise a detailed plan for scaling the platform to other regions in Nigeria and potentially across Africa. Adapt the platform to local contexts and needs, considering regional agricultural practices, market conditions, and technological infrastructure. Establish partnerships with regional agricultural organizations and logistics companies to facilitate expansion and ensure the platform's sustainability in diverse settings.

These recommendations aim to leverage the platform's innovative approach to create a more efficient, equitable, and sustainable food supply system, ultimately contributing to the economic and social development of Lagos and beyond.

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