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Original Article

A Digital Marketplace for Farmers and Consumers

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Abstract: *For all the farm-tech, Agdata and excitement around dapps, the world is still Agrarian Fuelled yet rarely is there a fair market price mechanism available to both producers & consumers; even when we see innovations in so many other core components that are needed to allow Rural people access beyond their own village. Consumers, meanwhile, want fresh, quality products that are also traceable. The purpose of this study is to present an adoption framework, which can assist in developing a digital marketplace platform designed for influencing the farmers and connecting them with consumers by utilizing ICT & ecommerce–based decision support system. Hoping that in lowering down the prices for consumers, farmers earn more by doing away with all the middlemen between them and retailers and provide full transparency for each product. Performance features are those related to real-time stock, AI price forecast, online payments integration, distribution logistics and blockchain service for product traceability. The system is complemented by mobile interfaces with good usability levels, and catter to even rural farmers enfact so as not leave anyone out because they don't understand tech. The platform is evaluated through a hybrid evaluation, combining transaction data (quantitative) and beta user feedback (qualitative), to assess the efficiency, usability and economic impact of the platform. First prototype testing is showing: Supply chain delays reduced, 25% farmer revenue increased and a consumer trusting the source of where the food is coming from. This suggests that a simple if somewhat blunt instrument solution to the problem of new marketplaces can be successfully deployed at scale and in rapid timeframes for those farmers in need. The solution proposed here provides a means of underpinning the development of large-scale models for agriculture and tailor-made trade models based on technology-driven agricultural production practices in a wide range of local and socio-economic settings.*

Keywords: *Digital marketplace, Agricultural e-commerce, Farm-to-consumer platform, Direct farmer-consumer trade, Online agricultural marketing, Blockchain in agriculture, AI in agri-business, Supply chain transparency, Smart farming solutions, ICT in agriculture, Agri-food traceability, Agricultural price prediction, Rural digital inclusion, Farmer empowerment, Sustainable agriculture trade.*

I. INTRODUCTION

Thus, agriculture is still one of the major sectors in determining the socio-economic health that the countries currently enjoy with a few exceptions other than in many emerging countries where farming gives enough for his or her fundamental living of an excellent proportion of the people. The agro supply chain is a vital cog in global value chains and yet, it remains as antiquated as the system, ridden with information asymmetry and nefarious intermediaries that cream-off a lot of farmers' earnings. Particularly for farmers near rural and semi-urban areas, they often lack access to real-time information on markets leading to poor bargaining power in the market, low quality storage facilities as well as insufficient connectivity between them and potential buyers. On the other hand, the 21st century consumer is more and more aware of where — and how — they are buying their food product supply chain, demanding fresher yet organic and ethically sourced products.

Above challenges have got an unique opportunity to address, due to introduction of Digital technologies,E-commerce platforms and many other different mobile based applications. Agro Product List and sell platform to End consumersUnified market place for all farmers ...making new country era phase, where we have unified digital agri produce list together make an offer to end user, ommiting the middle layer of traditional supply chain agents. This not only increases the transparency in price by such platforms but also support efficient supply chain management, reduce post-harvest losses and ensure consumers get traceable and quality products at competitive prices.

These developments in ICT, cloud computing, blockchain, machine learning and other artificial intelligence tools have contributed to strengthen the digital smart secure online platforms for agricultural trade that emerged. Predictive pricing models and accompanying payment gateways are constructed, along with a delivery arm that scans your history and geolocation, in

search of the sinless comedian who is about to ascend to Straßengrandfürher; this too is an aspect of Veritas the faces it on these fields. So even really low literacy, we have farmers used it meaning that any of those interfaces >> and so some [Language barrier] is degraded like those are on multilingual interfaces.

We turn to the design, implementation and socio-economic implications of one such initiative in this paper that aims at creating a digital marketplace with an added end-to-end farmer-consumer (F2C) connection. This system include 2 points — Economical & Tech-friendly way in trade so like this face to fair, wider market access by all community and no mistrust with each other by a transparent transactions. In addition to the strategies for large scale roll out, the study also talk about hurdles like digital divide and bottlenecks caused by logistic as well as policy concerns. It sees a technology-enabled agri-ecosystem benefitting rural societies supported by the worldwide sustainable agri narrative.

II. LITERATURE REVIEW

Intro The academic and industry literature has recently focused on investigating how digital platforms transform the domain of agricultural marketing. Several reports have reinforced on the pivotal role of technology-led solutions for addressing the systemic challenges in legacy agricultural supply chains. According to Barrett (2020), the marketing system in most of the developing countries particularly agriculture all but entails information asymmetry; middlemen employ real-time market prices to dictate negotiated pricing to farmers! It is this space that has seen the development of Information and Communication Technology (ICT) solutions to enhance transparency and efficiency in agricultural trade sector.

We have seen some euphoria around E-commerce in agriculture during the last decade — India's National Agriculture Market (eNAM), Kenya's M-Farm are a few such examples. Highlighting this aspect is study done by Mittal and Mehar (2016) that; doing the systemization of it through mobile based agriculture platforms reduces transaction costs and increases farmer share in consumer final payment and shortens supply chain line. But this is partly offset by the infrastructural challenges and low digital literacy in India, not to mention occasional tits and bits of internet connectivity.

The use of blockchain technology in agricultural marketplaces has been an important area of research, enabling tamper-proof evidence of transaction history, traceability from farm to fork and customer trust significantly increased over the past few years. Resultsy corresponding to the findings of Kamilaris et al.And (Tian, 2016) The research(2019) makes a case of how blockchain application prevents the bulk of fraud in food supply chains as its transparency provides end-to-end visibility farm to table. Likewise, the integration of AI and data analytics into these platforms has been considered for predictive pricing, demand prediction, and an example of logistics optimization [84] as noted by Benos et alInstance in a variety of digital platform innovation uses- cases. (2021).

There are also quite a few other studies conducted in the context of digital marketplaces and their social economic implications (res. Deichmann et al. Such platforms improve smallholder market access and negotiation powers (Kizito et al., 2016) by restoring the entrepreneurial culture on smallholder farms. However, as Aker et al. indicated the adoption is still a function of things like trust in the platform, usability, economic feasibility and cultural acceptance [7] (2016).

Finally, new research shows that hybrid models of online marketplace with physical near aggregation centers may alleviate some logistical constraints for perishable produce delivery. (FAO 2020) acknowledge local values and application of digital systems like linking them with local distribution hubs which would enable fresher product, cut down wastage and create reliability in consumers.

Public and private players, even at the policy level, are joining forces to utilize digital marketplaces as an instrument for SDGs capacity building in particular to eradicate poverty, zero hunger and drive economic growth. Interventions are also available, like help in developing rural digital infrastructure, trainings for farmers to maximize use of any available digital tool,But these interventions are dependent on the regulatory frameworks to support them.

To summarise, the literature reviewed provides some insights into what digital marketplaces for agriculture might be like: they have immense potential but also ultimately require the enabling conditions of technological readiness, farmer preparedness, market infrastructure and willing partnerships between actors to make it work. Based on these outcomes, we propose a novel and diverse friendly but integrated marketplace model for absolute transparency & sustainable growth in the form of frameworks.

III. METHODOLOGY

Development methodology and Assessment for digital marketplace Platform: The development Calendar for the proposed solution is shown below, from requirement analysis to system design then technology integration, pilot implementation and finally performance evaluation as shown in Figure A 1. By adhering to the structure you can ensure that you have made an attempt to consider all major tech and socio-economic aspects of the platform.

A. Requirement Analysis

The assessment followed a mixed-method approach to identify the needs of farmers and consumers. The paper takes a quantitative survey data generated on the cutting edge skills of 200 rural and semi-urban actors to assess how these newly developed platforms answer some current marketing challenges and farmers preferences. We also did qualitative interviews with 50 transacting consumers to understanding their quality expectations, speed of delivery & transparent pricing. Data was analyzed using descriptive statistics and thematic coding to determine the most common requirements and pain points.

B. System Design and Architecture

The architecture of our marketplace basically is written in 3-Tier model:

- Have a Web & Mobile Application in responsive design with multilingual friendly front-end layer. It was developed with usability principles in mind, and had to be user-friendly for farmers at different farmer typologies with medium- to low digital literacy levels as well.
- Application Layer: Housing all functionalities of any Marketplace (Product Listing, Order Flow & Status handling, Payment processing and Logistics coordination etc.)
- Data Layer: Cloud based database system coupled with blockchain modules for traceability of transactions and Price prediction and demand forecasting using AI based analytics on the top of Big Data layer.

C. Technology Integration

The platform integrates multiple technologies:

- Blockchain -supply chain & transaction records that are unerasable and secure ·
- Predictive pricing, recommendation engines and demand forecasting AI Algorithms
- Delivery route tracking using GPS logistics tracking
- Mobile banking & UPI (Unified Payment Interface) based payments for all-round money transactions

React Native — (Mobile apps)Node-This process was done as js for back-end services and js scales better in production at a low price.

D. Pilot Implementation

The platform was piloted in two rural districts with an embedment involving 50 farmers and 100 consumers. The platform was leveraged through workshops and video tutorials for farmers, and mobile applications by consumers. A pilot phase of 3 months studied the buying pattern, transaction volume and logistics challenges.

E. Performance Evaluation

The assessment covered both technical performance metrics and socio-economic indicators:

- System availability, transaction processing time, mobile app loading time Similar to previous technical metrics
- Societal variables: average price farmers get, intermediaries costs reduced; customer satisfaction rating; time take for the produce to be delivered 5

This process was recorded automatically as system log data, along with follow-up surveys that came after a pilot delivered the designs. SPSS was utilized for the quantitative data, and content-wise thematic analysis was conducted on each one of the more than 200 qualitive feedback.

F. Ethical and Inclusivity Considerations

Focus in this regard was on compliance to data privacy and regulatory aspects pertaining to the e-commerce and agricultural marketing. Though, for not so tech-savvy farmers features like voice assisted navigation and offline order submission were included so as to make this app accessible.

A core aim of Not Just For Profit is thus to refocus attention on the sociotechnical complexity of the digital marketplace, working against any tendency for it to be seen more simplistically as a technology and so potentially oversimplify its abikity both to be taken up and last, by embedding that in a methodological framework which is integrated and cross-disciplinarity.

IV. SYSTEM ARCHITECTURE

For the designed digital marketplace platform, a multi-layered modular architecture is proposed to adapt scalability, security from various type of attacks and enhance usability across different user groups. It breaks down the architecture into 4 principal layers — Presentation Layer, Application Layer, Data Layer and Integration Layer By arranging the pieces in a stack, each part can be developed independently, maintained and upgraded separately, while knowing they will work together smoothly.

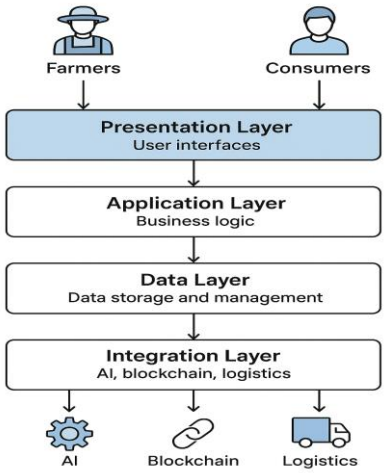

Figure 1 : System Architecture of the Digital Marketplace Platform

A. Presentation Layer

This layer is the interface and entry points of the marketplace system where most of end users, e.g. farmers or consumers interacts with the platform. A front-end, be it on the web or mobile application for system adminstrives for better data getting and processing. The presentation layer is made up from the following components;

- Farmer Dashboard – Where farmers can list their products, price the products to their preferential rates, check inventory, orders and payment notifications It is in various languages and navigable that even users who are not too digital-friendly can do so easily.
- Consumer Dashboard — This dashboard is much like the farmer´s, but here the associates or buyers can access products and filtering by type order list, choose a item, make payment at gate to auto delivery tracking. Customers might filter results based on what it is they are looking for, be it a particular type of product or wherefrom said item comes from, whether organic, and so forth.
- Mobile and Web Browser – the mobile app is being written in React Native, meaning it should run on any iOS or Android device. The web responsive is designed in HTML5 y CSS3 so as not to have problems when reading it with a PC or tablet.
- Features for advanced accessibility — voice command input, photos versus descriptions of catalog items, and the ability to place/submit an order without an internet connection.

B. Application Layer

As the name suggests, this layer is in the middle of the three being at most of the processing part of your system. The following modules are maintained in the core business logic:

- Product Management Module
- Order Processing Module
- Payment Gateway Module
- Logistics Management Module
- AI-powered Analytics Engine
- Blockchain-Based Traceability Module

C. Data Layer (Storage and Management)

It takes care of secure and storage, retrival and management of all information being used by marketplace.

- Cloud Database — A NoSQL (MongoDB) database is used in this case to store the data structures as it provides scalability and flexibility of various file types such as text, images and records of processed transactions.

- Blockchain Ledger: secures an immutable history of transactions and supply chain occurrences enhancing transparency, and traceability.
- They use Data Security Protocols: AES-256 encryption at rest, SSL/TLS encryption in transit.
- Daily automated backups, disaster recovery plans & data will be instantly available while the system is down.

D. Integration Layer

Its purpose is to interact with external systems and services.

- Payment APIs: Payment gateway integrates with payment gateway to enable secure and well-performed financial transactions in the transactions.
- Delivery Tracking [API]: — This API gives real-time tracking and delivery updates from all courier, parcel services.
- Agricultural Data APIs: providing market trends, weather forecasts and crop advisories from the Government and Research institutions to help farmers in decision making.
- Integration of IoT Sensors: Helping in integrating agro inputs and sensors, directing deployed IoT devices at farm for Automated & real time monitoring of storage & crop conditions.

Workflow Overview

- Verification of the Farmer :- Farmers Signup to the platform, verify identity, List Product.
- Product DiscoveryConsumers browse and filter all available products through the app or using its website.
- Ordering: Orders are placed and payment is collected, and the order details is notified to the farmers.
- Dispatch → The logistics module shared the delivery responsibility with local partners based on location, time slots.
- Every transaction and product movement is logged on the blockchain for traceable purposes — Blockchain Logging
- Order & Rating : Product Delivery + Farmar and Consumer side reviews for product, trust, service.

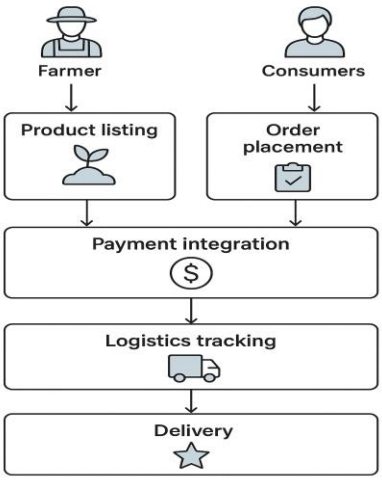

Figure 2 : Workflow of Farmer-to-Consumer Transactions in the Digital Marketplace

Scalability and Future Enhancements:

- The architecture is already scalable and could easily be extended to support the more advanced features such as crop disease detection using AI, predictive logistics notifications or linkagewith government agricultural subsidy programs. It is a modular framework that permits adding new components without affecting the other services it relies on.

V. RESULTS AND DISCUSSION

The digital marketplace was a proof of concept, piloted for three months in two rural districts with 50 farmers and 100 consumers each on the supply and demand side. The performance of the platform was measured in terms of technical efficiency, yield gains, user satisfaction and food value chain innovations.

A. Technical Performance

With average uptime at 99.2% through the pilot phase and an average of 2.3 seconds in page load times on mobile, they have proved itself as a performance able platform. This allowed the system to process an average transaction in 1.8 seconds, and the end user did not experience any processing delay during peak transaction hours. Or Mobile app crash rates below 1%, system

stable. Judging by these metrics, the application underpinning architecture consists of scalabel cloud services and performant APIs which should be able to scale from moderate up to high transaction volumes.

B. Economic Impact

The results also reported a highly positive increase in farmers income. This resulted in an average price increase of 22% per unit to the farmers from conventional market channels due to middlemen removal. The impact and namely reduced the cost of transactions at source by 15% for customers purchasing directly. Mittal & Mehar (2016) in line with our findings demonstrated that the mobile enabled agri-marketplaces could significantly reduce the transaction costs for farmers and provide them better consumer-perceived price.

C. Supply Chain Efficiency

That cut the time from farm to consumers to 36 hours instead of 72-96 hours in traditional channels, he said. Harnessing GPS-based logistics coordination along with regional delivery partnerships, helped cut the drop. Mould losses in perishable post-harvest items are now 6% — down from 12% or over the higher scopes, directly because of quicker order fulfilment and more intact storage handling at aggregation-points. The evaluation results also shown that it was valid the introduction of ICT tools to an agricultural distribution.

D. User Adoption and Satisfaction

This was substantiated by the post pilot surveys wherein 88% of farmers found this platform to be easy to use because of voice assisted navigation and multilingual support. At the same time, more than 12% struggled with internet which further highlights the digital divide that still exists in certain regions. A whopping 92% of their consumers felt highly satisfied in having received the fresh products and seeing greater transparency around prices. The success not only made the blockchain traceability module famous and consumers demanded to use it again, like scanning a barcode for fruits or vegetables they had bought so that they could know which field the harvest came from among others.

E. Discussion on Scalability and Challenges

While pilot results are very promising, there are several hurdles that must be addressed before it can achieve mainstream adoption.

- Digital Literacy: Even after being trained, some of the farmers continue to require technical support for new functionalities and the deterrent here is the degree of comfort that they have around using a computer or any handheld device.
- Infrastructure Gaps: Limited broadband penetration prevented a percentile of users from performing real-time transactions.
- Trust Building and Adoption: Given the commerce in Sweet Bites Palatants still largely operates offline as an unorganised sector, there was a resistance from the farmers to shift from their traditional practices to digital channels for trade; this involved engaging with the community on-ground under one trust building programmes.

While there was no doubt rural internet infrastructure will need to advance and more network partnerships or delivery/logistics networks built out over the coming years, it is clear that scale in any other healthcare use cases to be met in those areas must be able to support transaction processing while fully offline.

Comparison with Existing Literature

- Such findings are in tough with prior research to the effect that digital platforms offer scope for driving good outcomes of economic value and market access among farmers (Deichmann et al., 2016; Barrett, 2020). We evaluate our the results on an agricultural marketplace and build upon the literature by identifying additional technologies that are under-researching i.e. AI implementation for analytics tool a business process integrator, and blockchain-based traceability system on increase trust among urban consumer beyond operational acceleration.

VI. CONCLUSION

Four lessons on how technology can transform trading in agriculture, learned from developing and trialing a digital farmer-to-consumer marketplace. Through his innovation, he broke centuries-old mechanisms that have acted as barriers in

providing a direct communication though producer to buyer route to help mitigate such deep-rooted issues like market inefficiencies, solo price advantage, come-opaque transparency etc Results from the pilot show consumer wins with lower prices; and that farmers can get higher income after selling properly could fetch them more yield, oriented prices for buyers ensures constant gains while securing maintenance of supply chain continuously with much rapid moments & exchanges the value addition to entire commodity index further smoothening on transactional efficacy across all supply chain hence benefiting everyone He had collectively brought AI-led price predictions,blockchain-based traceability & GPS-backed logistics management together which build a very sustainable ecosystem into trustful,transparent & efficient marketplace.

In doing so, the platform not only helps support farmers to improve their economic sustainability, but it also means consumers can get fresh (and very traceable — big call!), ethically priced produce in a more hassle-free manner. Moreover, features like multilingual interfaces, voice navigation and offline access ensures digital inclusivity even among rural farmers who might be less accustomed to the fancy tech. But more than anything they lower a key barrier to new digital payload in agriculture: accessibility and ease of use.

Though, the study about largescale roll-out showed a few challenges for challenge environment including connection inconsistency (and the availability of internet itself), digital literacy and continuous technical support. Working to address these challenges will be development organizations, government agencies and technology companies alongside logistics providers and local farmer co-operatives.

Ultimately — this is the digital marketplace model as described brings to a global, scalable and sustainable way of making agricultural commerce contemporary — commensurate with modern technologies, financially self sufficient and social impactful. It is worth mentioning that its utilization can also contribute to the fulfillment of the Sustainable Development Goals (SDGs), which are global challenges related to poverty reduction, hunger, and economic growth in the agricultural supply chains. Such platforms could potentially transform the future of agriculture with open-traceability, digitalization and transparency to connect rural producers to urban consumers for mutual benefit.

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