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A Web-Based Agricultural E-Commerce System for Direct Farmer-to-Consumer Sales

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Abstract: *The agricultural sector remains challenged by the exploitation of producers by middlemen, resulting in diminished farmer profit. This is a description of the design and implementation of "Farmer's E-Market," a web-enabled digital trading platform developed with the express purpose of removing the dependency on middlemen by allowing direct sales to consumers. The system was designed using a three-tier architecture, utilizing ASP.NET for the presentation layer, C# for business logic, and Microsoft SQL Server 2015 for the database management layer. The platform also contains designated modules for farmers, buyers and administrators to manage product listings, order processing, and secure financial transactions. The implemented system delivers a useful, reliable and user-friendly e-market place that provides transparent trade, increase producer profit, and a scalable platform for digital commerce in agriculture.*

Keywords: E-Agriculture, E-Marketplace, ASP.NET, SQL Server, Digital Trading Platform, Agricultural Supply Chain

I. INTRODUCTION

Farming remains a principal occupation in India; however, many individuals involved in this sector exist in conditions of poverty. A key factor in this scenario is the slow uptake of more advanced methods and automated solutions in agriculture, whether due to ignorance or lack of access to either. When they manage to produce something successfully, farmers are often subject to exploitation via the marketplace that has not at all altered from previous eras.

The issue at hand stems from insufficient agricultural marketing facilities. Farmers commonly have to rely on local traders and middlemen to sell their product, often at low and unprofitable prices. This situation is compounded by fragmented Agricultural Product Market Committee (APMC) acts and a lack of price discovery, enabling local middlemen with high lobbying power to take advantage of farmers who do not receive a fair price for their crop.

To overcome the aforementioned challenges, the "Farmer's E-Market" web portal was proposed and developed. The system was designed to allow farmers to sell their products directly to consumers without middlemen. Our mission is to create local sellers and producers and embrace a "sell local and buy local" environment. The key idea behind the application is to promote virtual shopping and allow customers to purchase products they choose directly from the producers. This system is designed to enhance services for both buyers and producers by removing traditional intermediaries.

The research aims to achieve the following objectives:

- To create and implement an online e-marketplace platform that removes intermediaries by providing direct trade to consumers (purchasers) from farmers (producers).
- To implement a three-tier architecture with ASP.NET as the presentation layer, C# as the middle business logic layer, and Microsoft SQL Server as the database management model layer.
- To create three separate modules to manage system interactions, a Farmer module for listing products and prices, a Buyer module for browsing and purchasing products, and an Administrator module for high-level control of the database and e-marketplace.

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- To implement a complete workflow for e-commerce, including product catalog management, wishlist management, checkout and processing, and transaction management for effective sales cycle functionality.
- To give the user a better chance of accidentally using a transactional platform to allow farmers 6direct access to control their own sales and prices to increase profitability, while giving consumers transparency and a "farm to table" purchasing model.

II. RELATED WORK

C.K. Gomathy, V. Jaswanth Reddy, and P. Venkatesh [1] conducted research on the role of e-commerce in agriculture and the impact of exploitation of farmers by middlemen on their earning potential. The resulting study provided a multi-vendor e-commerce platform specifically for farmers to facilitate sales and increase earnings. The study highlighted important features for farmers including product management, order tracking, and ratings but did not provide any implementation architecture. The "Farmer's Product Selling E-Website" proposed idea detailed in this paper fulfills this gap with a complete system design and implementation using ASP.NET and SQL Server with a focus on database structure.

G. M. Tumibay, F. T. Layug, D. S. Yap, and M. S. M. Sembrano [2] suggested an e-commerce platform that allows farmers or cooperatives to sell directly to consumers, avoiding price and profit control by middlemen. The goal is to demonstrate the difference between existing multi- intermediary models and a digital approach to trading that benefits both producers and consumers. The primary contributions of their study include identifying core entities and technical expectations, and exploring the lack of digital literacy among farmers as a barrier to adoption. Their e- commerce "Farmer's Product Selling E-Website" is designed to mitigate this challenge by creating a simplified and user- friendly interface requiring minimum technical understanding.

P. "Farm E-Market" is a web-based agricultural commerce system created by P. Raja Logaiyan and O. Pavani [3] and is intended to remove intermediaries who extract a large portion of profit from farmers. The system was developed in AngularJS, PHP, and SQL and allows farmers to sign up, list their produce, and set fair prices through Admin, Farmer and Consumer modules. This system provides a functioning PHP based framework, but this proposal for a "Farmer's Product Selling E-Website" will implement a modular structure showcased in this framework, but will be built using Microsoft's .NET framework (ASP.NET, C#) creating a framework with greater robustness, improved security, and greater scalability.

A "Farmer Marketplace Website" was designed by V. S. Patil, M. P. Patil, P. R. Shimpi, R. S. Nikam, and P. Biswas [4], which connects farmers, buyers, suppliers and service providers on a unified digital service platform to better connect farmers and buyers and to improve transparency and profitability. In addition to connecting farmers and buyers, the system's features include product listings, equipment rentals, finance and warehousing services, market data and information. The "Farmer Marketplace Website" is an expansive service ecosystem for farmers, but it is more than just a way to sell produce. The proposed "Farmer's Product Selling E-Website" narrows the purpose and scope of the service, as the features of the service are intended for direct B2C and B2B transactions to minimize intermediaries or 'middlemen' with the intention of strengthen farmer's link to the consumer.

M. S. Sengar, M. Gharewal, and N. Patidar [5] presented the "Farmer's E-Market," an e-trading platform to facilitate trading agricultural products between producers and buyers without middlemen by using dedicated Admin, Farmer, and Customer modules. The system uses a secure and easy-to-use interface for trading agricultural products; however, only simulates transactions since the integration of online payment would be discussed in a later study. The proposed "Farmer's Product Selling E-Website" extends this concept and adds a fully functional payment gateway along with multi-product booking capability, which fully provides a complete e- commerce solution that is operational.

K. Saini and I. Mishra [6] presented the design and architecture of a system called the "Farmer's E-Mart," an e-commerce portal which allows farmers to trade digitally with other farmers and buyers, skipping all the middlemen. They concentrate primarily on system modeling, domain modeling, and architectural patterns to arrive at an affordable solution for digital agriculture. It remains mostly at the conceptual stage focused on design and not on implementation. The "Farmer's Product Selling E-Website" presented here is built upon the above design offering a complete

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implementation across many levels including design and implementation of data flow diagrams, an ER diagram, normalization, and project cost estimates through the COCOMO model.

C. J. Varma, C. A. Sai, and B. R. Reddy [7] introduced "Homegrowns"- an e-commerce system designed to eliminate the middlemen between farmers and consumers. They claimed that direct access to markets would allow farmers to price their products competitively, increase their income, and improve transparency in agricultural trade. While the study offers a strong theoretical argument and is intended for end- users, it remains conceptual and is not a detailed system design with development metrics. The development of "Farmer's Product Selling E-Website" provides a fully realized version of this idea by demonstrating full implementation, even including database normalization, detailed DFD and ER diagrams, and project estimates through COCOMO.

S. D. Zapata, O. Isengildina-Massa, C. E. Carpio, and R. D. Lamie [8] analyzed the MarketMaker e-commerce program for any possible changes for farmers' engagement, connections and visibility in the local food systems. The research used an outcomes-based framework aimed at short-, mid-, and long-term outcomes including market viability, and website presence for producers. Although MarketMaker enhanced farmer physical market networks, it does not provide a direct online selling mechanism. The new "Farmer's Product Selling E-Website" addresses this limitation, including a 3-tier transactional system for direct digital trade, and removal of intermediaries.

V. Jayashree, B. Dayanand, M. Nirmal, J. V. Raghul, and

M. Dhanush [9] proposed the "Farmers Online Selling Portal", an e-commerce site to facilitate the straight sale of farm produce from the producers to the consumers, and removed the multiple layers of intermediaries. The system is complete with Admin (Administrator), Farmer (Seller), Vendor (Buyer), and Public (Views) modules for the management and access, and built using the PHP stack and XAMPP. Although successful in allowing the transaction of farm produce directly to the consumer, the chosen technology limits potential scalability. The "Farmer's Product Selling E- Website" recommendation will alleviate these issues using the Microsoft .NET framework (ASP.NET, C#) designed specifically for large-scale agricultural trading applications. This structure will provide more robust security protocols, which PHP did not utilize in any fashion.

S. Shirke, S. Badarkhe, A. Ubale, and V. Vedpathak [10] described "Development of Portal for Farmers to Sell Products at Better Rate," a web-based e-commerce system for eliminating the middle-man and maximizing the profit for farmers by establishing a route for the farmers to sell products directly to consumers. Although the system focuses on quick and easy registration and sales process to increase usage, there is no clear or detailed analysis of the technical elements, which leaves implementation oscillating in subjective experiences. The proposed "Farmer's Product Selling E- Website" is more thorough by providing a complete design and experience from a proposed design. This proposal and evaluation uses a robust ASP.NET/SQL implementation and uses the COCOMO model, a pre-trained COCOMO model for evaluation.

III. SYSTEM MODEL

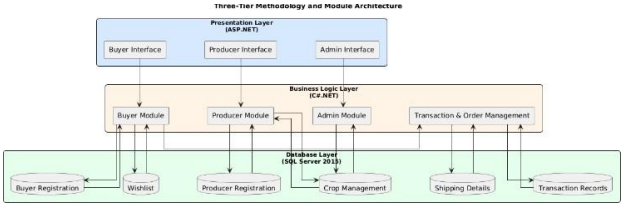

Fig. 1. Three-Tier Architectural Model diagram of the system

The system is built based on a three-tier architecture, separating the application's concerns between presentation, logic, and data layers. The front end, or presentation layer, is built in ASP.NET and is responsible for rendering the web pages and handling the user input. The middle layer is built in C#.NET and is used as the application core, executing all business logic and data processing while managing communication across the front end and the back end. The back end or data layer is built in Microsoft SQL Server 2015 and acts as the database manager. ADO.NET is used to connect the C# middle layer to the SQL Server database.

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The system's architecture depends on the flow of data and relationships between entities involved. The model the data flow in the system is represented within the Data Flow Diagram (DFD). The Context Analysis Diagram (Level 0 DFD) consists of the whole system represented as a single process that interacts with entities outside the process such as the Producer (Farmer), the Buyer, and the Admin. The Level

1 DFD identifies the high-level processes of the system, which include user management, product management, and order management.

Level 2 Data Flow Diagrams (DFDs) present more details about individual modules. For example, the Admin Level 2 DFD identifies specific processes that show how an administrator operates the product catalog, such as "Add Crop" and "Delete Crop." The Buyer Level 2 DFD separates the process stages of order and payment. The order process contains functions like "Add to wishlist," "Delete from wishlist," and "Give order." Finally, the payment process involves handling the transaction flow.

The database structure utilizes a normalized Entity Relationship (ER) model to maintain data consistency and minimize redundancy in the database architecture. The main entities include the Buyer Registration and Producer Registration tables, which are utilized for establishing user credentials and profiles. Product details can be managed using the Add Crop and Update Crop tables. Transactional operations are managed by the Transaction, Final Transaction, Wishlist, and Shipping tables. The Transportation table will manage logistics and delivery details. This structured and normalized schema allows for improved data manipulation, integrity, and scaling capabilities.

IV. METHODOLOGY & MODULES

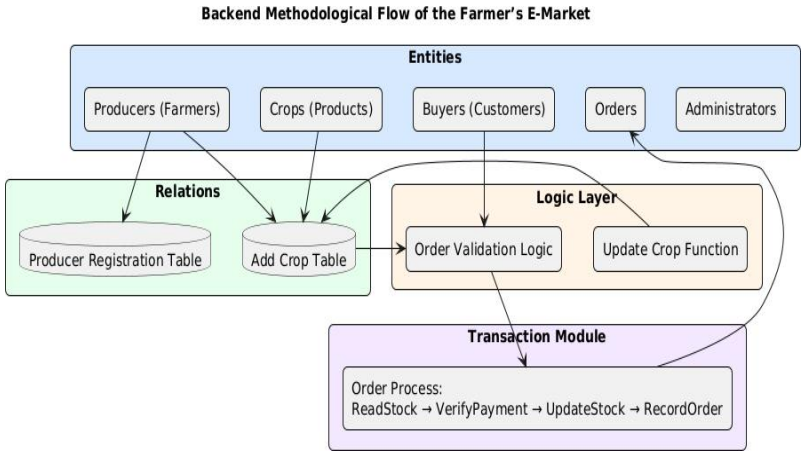

Fig. 2. Functional Flow Diagram of the System's Backend Methodology

The establishment of the Farmer's E-Market took place according to a three-dimensional organizational model. - The development process involved creating an SQL Server 2015 database that was populated/ populated/ deleted according to the normalized schema. Then, develop the C#.NET business logic for each of the modules, as well as the ASP.NET web pages used by the end users.

Backend Methodological Formulation:

The backend logic of the system which is run by the C#.NET middle layer directs the flow of information exchanged between the users and the SQL Server database. This process can be formally defined by utilizing and combining set theory for data modeling and predicate logic for business rules.

Let the primary entity sets be:

$A = \{a_1, a_2, \ldots\}$: The set of Administrators.

$P = \{p_1, p_2, \ldots\}$: The set of Producers (Farmers).

$B = \{b_1, b_2, \ldots\}$: The set of Buyers (Customers).

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$C = \{c_1, c_2, \ldots\}$: The set of Crops (Products).
$= \{o_1, o_2, \ldots\}$: The set of Orders.
The backend logic, implemented in C#.NET, governs interactions between users and the SQL Server 2015 database. Each table represents a relation among entity sets:
$R \subseteq P \times D$ — Producer Registration, where D
holds producer attributes.
$R \subseteq C \times P \times D$ — Add Crop Table, linking crops (C) with producers (P) through attributes such as price, quantity, and image URL.
The Update Crop function is defined as $f_{(}$update crop$_{)}$:
$P \times C$details $\rightarrow R'$, mapping producer inputs to the updated
product catalog state.
Order validation follows the predicate CanPlaceOrder(o), true only if for all $c_i \in C_o$,
CheckStock(c_i, q_i) = True $\wedge$ VerifyUser(b) = True.
Here, *CheckStock* ensures availability and *VerifyUser* authenticates the buyer.
The transaction sequence Torder = ⟨ ReadStock, VerifyPayment, UpdateStock, CreateOrderRecord ⟩ is executed atomically under ACID principles. Any failure triggers rollback, maintaining database consistency and integrity.

Admin Module
This module offers centralized command of the platform. The administrator will be in charge of registering the core data of the system. The key tasks include overseeing the crop listings such as adding to the crop listings or deleting crops from the listing as outlined in the "Add Crop (Admin)" table. The admin will also manage all users and transactions assuring the platform operates appropriately.

Producer (Farmer) Module
This module is intended for the farmer to manage their sales. After successful registration (data is stored in the "Producer Registration Table"), the farmer can login and create their own produce listings. This can be done in the "Update Crop Table (Producer)" module, in which it allows the farmer to upload the crop information, which includes crop name, crop quantity available, descriptive text for the items, price per item, and crop images. This module enables the farmer to take control of their own product listings.

Buyer (Customer) Module
This module makes it easy for consumers to buy products. Buyers must first register (data is saved in "Buyer Registration Table"). After logging in, buyers can view the listing of commodities that are for sale, see commodity details, and add desired things to their personal "Wishlist Table". From either the wishlist table or product pages, the buyer can then make their purchases and proceed with the transaction.

Transaction and Order Management Module
This module serves as the e-commerce foundation. When a buyer submits an order, the system records the transaction in both the "Transaction Table" and the "Final Transaction Table". This module will handle the payment details and all relevant logistics with the delivery details tracked via the "Shipping Table". This included all sales information in a complete and traceable manner from sale to delivery.

V. RESULTS

The Farmer's E-Market has produced a working, dynamic, and interactive web platform. The outcomes are evident in the working web pages and modules, which directly address the main objectives of the project.
Web pages in the system are designed to be intuitive to navigate and use. The "Home Page" is the central point of access, providing users with clear guidance to all other areas of the site. An "About Farmers" page will be part of

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the system's content to set context and indicate the importance of the agricultural industry, emphasizing the aims of the project. Regarding functional outcomes, the platform is successful in achieving its primary purpose: linking farmers (producers) and buyers together. The producer module is functioning as intended, allowing farmers to open an account, manage product listings, and set their own prices while avoiding traditional middle-persons. The buyer module is designed to be easy for customers to browse, compare, and securely
purchase goods.

The admin backend includes necessary tools for administering the comfort platform, including overseeing transactions and maintaining product catalogs. The system has been proven to be highly functional for transactions, with records appropriately stored in database tables. The platform is designed with usability in mind, making it easy for farmers and buyers to use the platform with basic computer skills. The modules connect seamlessly to create a stable and usable platform that has all the functionality needed for transactions.

VI. CONCLUSION

In summary, this integrated "Farmer's E-Market" system demonstrates a successful resolution to the inefficiencies associated with the traditional, intermediary-based supply chain for agricultural products and primarily operates on a user-friendly ASP.NET front end, C# business logic, and SQL Server database environment. The system exhibits reasonable functionality for direct-to-consumer transactions, accountability for inventory management for farmers, and scalability for user-ability. Moreover, the technology could increase its socio-economic impact with proposed technological advancements that similarly focus on social welfare objectives including but not limited to, real-time logistics tracking systems, mobile-based payment systems, and machine learning algorithms for forecasting crop prices and demand. All in all, the system provides a valuable service for the financial exploitation of farmers and higher profitability for producers resulting in a valuable participatory food economy that is transparent.

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