

Bee Berry Honey Shop: An Intelligent Full-Stack E-Commerce Platform Integrating AI-Based Recommendations, Blockchain Verification, and Real-Time Delivery Tracking

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Abstract

The rapid growth of e-commerce technologies and increasing demand for transparency in food products have created a need for intelligent, secure, and user-centric platforms. This paper presents the design and development of **Bee Berry Honey Shop**, a full-stack e-commerce web application focused on providing a personalized and trustworthy honey purchasing experience. The application is developed using React.js for the frontend, Node.js with Express for the backend, and Firebase Firestore as the database. A Python Flask-based machine learning microservice is integrated to provide intelligent recommendations using Naive Bayes and Logistic Regression models. Additional technologies include Socket.io for real-time communication, Leaflet for delivery tracking, and Cloudinary for media storage. A key feature is the AI-powered recommendation module, which allows users to describe their health needs in natural language. The platform also implements blockchain-based product verification using the Polygon network, ensuring transparency by providing details such as origin, purity, and beekeeper information. The system includes real-time delivery tracking and an automated restock notification feature. The application follows a modular and scalable architecture, ensuring better performance and maintainability.

Keywords: E-Commerce, Artificial Intelligence, Blockchain, React.js, Node.js, Machine Learning, Firebase, Real-Time Tracking, NLP, Polygon Network.

I. INTRODUCTION

In today's digital world, the demand for online shopping—especially for organic and health-focused products—has grown rapidly. Consumers are increasingly choosing natural items like honey for benefits such as improved immunity, digestion, and overall wellness. However, selecting the right type of honey based on individual needs remains challenging.

Most existing e-commerce platforms offer multiple options but lack personalization and proper guidance. Users often have limited knowledge about different honey types, leading to confusion and poor purchasing decisions. Additionally, rising concerns about honey adulteration have significantly reduced trust in online products.

There is a clear need for a smart, user-friendly platform that not only sells honey but also helps users choose the right product while ensuring transparency and authenticity. To address this, the Bee Berry Honey Shop was developed as a full-stack e-commerce platform using React.js, Node.js, Firebase, Machine Learning, and Blockchain technology.

II. LITERATURE REVIEW

Zhang and Abdullah [1] conducted an empirical study on cross-border e-commerce exports and identified the growing importance of intelligent platforms for product discovery and consumer trust. Their work highlighted the

The key problems identified in existing e-commerce systems for organic honey include: (1) lack of personalized recommendations based on health needs; (2) absence of product transparency regarding origin and purity; (3) trust issues due to adulteration; (4) no real-time delivery tracking; (5) inefficient stock notification systems; and (6) lack of integrated AI and Blockchain technologies.

This paper presents the complete architecture, methodology, implementation, and evaluation of the Bee Berry Honey Shop system. The proposed solution integrates AI-powered recommendations, blockchain-based product verification using the Polygon network, real-time delivery tracking using Socket.io and Leaflet maps, and an automated restock notification system.

The remainder of this paper is organized as follows: Section II reviews related literature; Section III describes the system architecture and methodology; Section IV covers implementation details; Section V presents results and discussion; and Section VI concludes the paper.

Roopnarain [5] studied factors influencing blockchain adoption in e-commerce and identified user trust, system transparency, and regulatory compliance as key adoption

role of personalization in improving customer satisfaction in digital commerce environments.

Pi [2] investigated the impact of blockchain adoption on supply chain financing and e-commerce platform dynamics. The study demonstrated that blockchain integration significantly improves product traceability and reduces fraud in supply chains, particularly for organic and food-based products.

Liu et al. [3] proposed dynamic optimization of e-commerce supply chains using blockchain, showing that decentralized data storage enhances transparency and reduces operational costs. This work directly informed the blockchain design in our proposed system.

Darmawan et al. [4] reviewed the benefits and challenges of blockchain in e-commerce, concluding that while implementation complexity exists, the transparency and immutability features provide significant advantages for consumer trust.

drivers. This research validated our approach of combining blockchain with QR-based verification.

Zhao et al. [6] developed an e-commerce recommendation system using semantic mining and neural networks, achieving high accuracy in product matching. Their NLP preprocessing techniques inspired the health-query processing in our AI recommendation module.

Albshaier [7] provided a comprehensive review of blockchain's role in e-commerce transactions, highlighting immutability, decentralization, and smart contract capabilities as essential features for trustworthy platforms.

Valencia-Arias et al. [8] and Geetha et al. [9] independently surveyed AI-based recommendation systems in e-commerce, demonstrating that machine learning models like Naive Bayes and Logistic Regression are effective for domain-specific recommendations with limited training data.

Treiblmaier [13] established a comprehensive framework for blockchain's impact on e-commerce, which served as the theoretical foundation for our blockchain integration strategy using the Polygon network.

III. SYSTEM ARCHITECTURE AND METHODOLOGY

A. Multi-Tier Architecture

The Bee Berry Honey Shop follows a multi-tier distributed architecture with three main layers. The Presentation Layer is built using React.js and handles UI rendering, user interactions, routing, and API communication. The Application Layer consists of two subsystems: the Node.js + Express Backend managing authentication, business logic, API routing, database operations, blockchain interaction, and email services; and the Python Flask ML Microservice processing user queries and providing honey recommendations using machine learning models.

The Data Layer comprises Firebase Firestore for storing user data, products, orders, and notifications, and the Polygon Blockchain for storing honey batch verification data. The architecture flow proceeds as: (1) user opens the application in browser; (2) React frontend loads UI via React Router; (3) user actions trigger API calls via Axios; (4) backend processes requests and interacts with database; (5) recommendation requests are forwarded to the ML microservice; (6) verification requests query the blockchain; (7) processed data is returned to the frontend; (8) real-time updates are handled via Socket.io.

B. Technology Stack

The complete technology stack includes:

- Frontend: React.js 18, React Router v6, Axios, Chart.js, Leaflet
- Backend: Node.js + Express, Firebase Admin SDK, Socket.io, Nodemailer
- ML Microservice: Python Flask, Scikit-learn (Naive Bayes, Logistic Regression), NumPy
- Database: Firebase Firestore (NoSQL)
- Blockchain: Polygon Network, Solidity Smart Contracts, Web3.js
- Storage: Cloudinary (image storage and CDN)
- Authentication: JWT + OTP via Email

C. Database Design

Firebase Firestore is used with the following collection structure: users (uid, name, email, role), products (id, name, price, description, stock, batchId), orders (orderId, userId, products[], status, location), batches (batchId, beekeeper, origin, purity, moisture), and restock (email, productId).

IV. MODULE-WISE IMPLEMENTATION

A. Authentication Module

The authentication module implements a secure OTP-based registration and JWT-based session management. During registration, the backend generates a 6-digit OTP

C. Blockchain Verification Module

The blockchain module ensures product authenticity using Polygon (Amoy testnet). The admin creates honey

with expiry and sends it via Nodemailer. Upon verification, the account is created with a hashed password stored in Firebase. Login generates a JWT token with 7-day expiry, which is validated on every protected API call. A separate authentication system handles delivery partner access.

B. AI Recommendation Module

The core AI recommendation module processes user health queries through a pipeline: (1) user inputs natural language query (e.g., 'Honey for immunity and cough'); (2) NLP preprocessing applies lowercasing, stopword removal, and keyword extraction; (3) TF-IDF vectorization transforms text; (4) Naive Bayes / Logistic Regression classifies honey type; (5) backend calculates relevance scores and ranks products; (6) response includes recommended products with match scores and explanations.

Two interfaces are provided: HoneyFinder (card-based UI for structured queries) and HoneyChat (conversational chat-based interface), both connected to the same ML microservice running on Python Flask at port 5001.

batches containing beekeeper name, harvest location, purity percentage, and moisture content. This data is stored on the Polygon blockchain via a Solidity smart contract. A QR code is generated linked to the batch ID. Users scan the QR code to retrieve verified product details. A dual storage mechanism stores data both on blockchain (primary, permanent) and Firebase (fallback), ensuring reliability.

D. Real-Time Tracking Module

The real-time delivery tracking system uses Socket.io for bidirectional communication and Leaflet with OpenStreetMap for map visualization. Delivery partners share GPS location updates which are broadcast via Socket.io through the backend server. The frontend React component updates the Leaflet map marker in real-time, allowing both users and administrators to monitor order delivery status with live location updates.

E. Order & Cart Module

The shopping module supports cart operations (add/remove/update) stored in localStorage, a checkout process with address input and payment selection (COD/UPI/Card), and order management with status transitions: Pending → Confirmed → Shipped → Delivered. Email notifications are sent at each status change.

V. RESULTS AND DISCUSSION

Table I: Comparative Analysis with Existing Platforms

Feature	Amazon/Flipkart	1mg/HealthKart	Generic E-comm	Bee Berry Honey Shop
AI Recommendations	Basic	Limited	No	Yes (ML-Based)
Health-Based Suggestions	No	Basic	No	Yes (NLP-Driven)
Blockchain Verification	No	No	No	Yes (Polygon)
Product Transparency	Limited	Basic	Limited	High
Real-Time Tracking	Limited	No	No	Yes (Socket.io)
Chat-Based Interaction	No	No	No	Yes (HoneyChat)
Restock Notification	Yes	Yes	Limited	Yes (Advanced)
Admin Dashboard	Yes	Yes	Limited	Yes (Full)

As shown in Table I, the Bee Berry Honey Shop offers a unique combination of features not available in any single existing platform. The comparative analysis demonstrates clear superiority in AI-based personalized recommendations, blockchain product verification, real-time delivery tracking, and conversational AI interaction. The AI recommendation system achieved accurate honey suggestions across various health queries. Both HoneyFinder and HoneyChat interfaces successfully processed natural language inputs, with ML model

Blockchain verification was successfully implemented with QR code generation and scanning. Product authenticity data including beekeeper information, harvest location, and purity percentage was retrieved correctly from the Polygon network. The dual storage mechanism (blockchain + Firebase fallback) ensured 100% data availability during testing.

Performance observations showed initial page load of 2–3 seconds with instant SPA navigation thereafter. Firebase Firestore queries averaged 500ms–1500ms.

response times of approximately 1–2 seconds. NLP processing correctly extracted health intent from queries such as 'immunity boost', 'diabetes control', and 'digestion support'.

Socket.io real-time location updates showed negligible latency in local network testing. All 47 functional test cases passed across authentication, product, AI, blockchain, order, tracking, restock, admin, chat support, and delivery partner modules.

Table II: Summary of Functional Test Results

Test Case	Module	Input	Expected Output	Status
TC-01	Authentication	Valid credentials	Account created / JWT issued	PASS
TC-02	Product Module	Open shop page	Products listed correctly	PASS
TC-03	AI Recommendation	Health query input	Relevant honey suggestions	PASS
TC-04	Blockchain	Admin creates batch	Data stored on Polygon	PASS
TC-05	Order & Cart	Add to cart & checkout	Order placed successfully	PASS
TC-06	Real-Time Tracking	Delivery partner moves	Map updates live	PASS
TC-07	Restock Notification	Product restocked	Email alert sent	PASS

Identified limitations of the current system include: (1) requirement of internet connectivity with no offline support; (2) limited ML training dataset which could be expanded for higher accuracy; (3) absence of multi-language support; (4) slight latency introduced by blockchain verification queries; and (5) absence of advanced payment gateway integration.

Future enhancements planned include mobile native applications for Android and iOS, integration of deep learning models for improved recommendation accuracy, multi-language support for regional markets, advanced payment gateway integration, and expansion of the honey product catalog with additional variety types and health classifications.

VI. CONCLUSION

This paper presented the design, development, and evaluation of Bee Berry Honey Shop—a full-stack intelligent e-commerce platform that successfully integrates Artificial Intelligence, Blockchain technology, and real-time communication to address key challenges in the online organic honey market.

React.js proved effective for building dynamic and responsive user interfaces through its component-based architecture. Firebase Firestore provided a scalable and efficient database solution with real-time synchronization. The AI-based recommendation system (HoneyFinder and HoneyChat) using NLP and machine learning models demonstrated effective personalization capabilities.

The integration of Blockchain (Polygon) ensured product transparency and authenticity by storing batch details such as origin and purity in a tamper-proof manner, accessible via QR codes. Real-time delivery tracking using Socket.io and map integration further enhanced the user experience with live order monitoring.

The system successfully demonstrated that combining AI, Blockchain, and real-time technologies creates a modern, intelligent, and reliable e-commerce solution that significantly surpasses existing platforms in personalization, transparency, and user engagement. All 47 functional test cases passed, validating the system's correctness and reliability.

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