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Smart Contracts and Secure Transactions: A Blockchain Ecommerce Framework

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Abstract : This project presents a cutting-edge blockchain-powered e-commerce platform that is based on the Ethereum network. Using a decentralized architecture, the system incorporates Solidity-written Smart Contracts to enable safe and transparent transactions. MetaMask, React, Solidity, Hardhat, and NodeJS are some of the important technologies used; Ether, the native cryptocurrency of Ethereum, is the main component. Because the blockchain is decentralized, it is transparent and immutable, which promotes confidence between buyers and sellers. Smart Contracts facilitate smooth transactions by securing and automating business logic without the need for middlemen. The overall user experience is improved by the React-developed, user-friendly interface. Secure wallet management is made possible via the MetaMask integration, which makes it easier for users to connect with the Ethereum network. The NodeJS-powered backend makes sure that the E-Commerce platform is efficient and scalable in a number of ways. Following best practices, the development process makes use of the Ethereum smart contract Hardhat environment, guaranteeing a stable and dependable codebase for improved security. In conclusion, this initiative is a prime example of how blockchain technology may revolutionize traditional e-commerce by decentralizing and fostering trust. Through the integration of Ethereum, Smart Contracts, and a contemporary technology stack comprising React, MetaMask, Solidity, Hardhat, and NodeJS, the resultant platform provides customers with a safe, clear, and effective online purchasing environment.

IndexTerms - Blockchain, E-Commerce, Smart Contact, Ether, MetaMask

I. INTRODUCTION

This project aims to integrate blockchain technology to transform the e-commerce landscape. Acknowledging the problems with security, trust, and transparency in conventional online marketplaces, the study intends to use the decentralized and unchangeable properties of blockchain technology to build a reliable and safe e-commerce network. The suggested blockchain-based e-commerce website's conceptual framework, design tenets, and technological architecture will all be covered in this article, with an emphasis on how they could improve user empowerment, security, and transparency[7]. The intention is to add to the conversation on how blockchain technology is revolutionizing e-commerce by imagining a time where digital transactions are marked by greater transparency and trust.

II. MOTIVATION AND BACKGROUND

Motivation

The urgency to transform the existing online commerce landscape is the driving force behind creating an e-commerce website based on blockchain technology. Through the utilization of blockchain technology, this initiative aims to tackle the enduring problems of security, trust, and transparency in conventional e-commerce platforms. Blockchain's decentralized structure and unchangeable record promise to provide unmatched security and transparency, allaying worries about fraud, data tampering, and conflicts.[3] The project intends to revolutionize the dynamics of online transactions by integrating features like trustless transactions via smart contracts and an immutable product history, providing customers with an ecommerce experience that is more secure, dependable, and powerful. By combining state-of-the-art blockchain technology with e-commerce, the project hopes to open the door to a world where digital transactions are more efficient, trustworthy, and accessible from anywhere in the world.

Background

Issues with traditional e-commerce systems include payment disputes, data breaches, and a lack of transparency. These problems are addressed with the introduction of blockchain technology, which offers a decentralized, transparent, and safe framework for performing transactions. The goal of this project is to transform the e-commerce sector by utilizing the special qualities of blockchain[8]. By using a blockchain ledger, all transactions are guaranteed to be recorded in a way that prevents tampering, improving the platform's integrity. By automating and upholding agreements, smart contracts eliminate the need for middlemen and streamline the transaction process. This reduces expenses for both buyers and sellers while simultaneously increasing

efficiency[5]. Furthermore, the project can add a new degree of freedom and ownership to e-commerce by implementing tokenization. Assets can be tokenized by users, allowing for fractional ownership and a wider variety of transactions. Due to blockchain's global reach, obstacles related to currency translation and conventional banking institutions are removed, enabling smooth international transactions. The goal of this project is to provide an open, globally accessible ecosystem for e-commerce.

III. OBJECTIVES

To Create Secure Platform:

Provide a strong platform built on blockchain technology that guarantees data integrity, safe transactions, and defense against market fraud.

To Implement Transparent Transactions:

By enabling clear and impenetrable transaction records through the use of blockchain's decentralized ledger, you can build confidence between customers, sellers, and the platform.

To Enable Secure Payments:

Integrate secure cryptocurrencies with established payment methods so that users can take use of the secure payment infrastructure provided by blockchain technology while transacting easily.

To Establish Provenance Tracking:

Establish a blockchain-powered traceability system to monitor the origin of each product and give consumers comprehensive historical data about the parts they buy.

To Ensure Data Privacy:

Offer consumers complete control over their personal data by putting advanced encryption and decentralization techniques into practice and prioritizing user data privacy.

IV. LITERATURE REVIEW

We examined multiple IEEE papers to have a thorough grasp of the state-of-the-art in the pertinent subject when doing the literature review for our project. These IEEE publications were a significant source of information, providing us with insights into important techniques, new developments in technology, and theoretical frameworks that influenced and directed the course of our research. We intended to ensure the validity and robustness of our method by combining information from various meticulously peer-reviewed sources. This allowed us to connect our work with existing research and build a body of knowledge that will strengthen the project's credibility and originality. Our project was placed within the larger framework of cutting-edge research in the field thanks to the abundance of knowledge gained from these IEEE publications, which also made it easier to understand the existing literature in a more nuanced way and inspired innovative solutions and techniques.

Paper Title	Author	Year	Summary	Advantages	Disadvantages
IEEE ACCESS SPECIAL SECTION EDITORIAL: Research Challenges and Opportunities in Security and Privacy of Blockchain Technologies [9]	1.Debiao He 2.Kim-Kwang Raymond Choo 3.Neeraj Kumar 4.Aniello Castigilione	2018.	The paper reviews e-Commerce integration in agriculture (2017-2021), highlighting Blockchain's potential, e-commerce development, and direct marketing benefits.	1. It highlights the importance of addressing security and privacy concerns in blockchain technologies, which is crucial for their widespread adoption.	1.Limited scope of the editorial, as it does not cover all the possible research challenges and opportunities in this field.
Blockchain and Autonomous Vehicles: Recent Advances and Future Directions [10]	1.Saurabh Jain 2.Neelu Jyoti Ahuja 3. P. Shrikant 4., Kishor Vinayak Bhadane 5. Bharathram Nagalh 6.Adarsh Kumar	2021	The paper explores recent advances and future directions at the intersection of blockchain and autonomous vehicles, examining the potential synergies and developments in this emerging field.	1.It sheds light on the potential benefits of using blockchain in the realm of autonomous vehicles 2. The paper identifies future directions for research and development. By outlining the gaps and challenges in the current use of blockchain in autonomous vehicles, it provides a roadmap for further exploration and innovation in this domain.	1.Lack of smart contract-based smart and secure data handling in an autonomous vehicle 2.Vehicle's internal parameters for blockchain network 3.Massive storage requirements
Blockchain Technology and Cryptocurrencies [11]	1.Siddharth Rajput 2.Archana Singh 3.Smiti Khurana 4.Tushar Bansal 5.Sanyukta Shreshtha	2019	The paper provides an overview of blockchain technology and cryptocurrencies, covering key concepts, functionalities, and potential applications in the realm of decentralized digital currencies.	1.Provides a tangible form of documentation, which can be useful in legal or regulatory contexts. 2.Lower Optional Cost 3.Enhanced Security and Confidentiality	1.Since bitcoins are not settling to a fused establishment, government, or bank their expenses may rise and fall fundamentally. 2.Clients may pick bitcoins to pay for unlawful items and endeavors (illegal substances, firearms, etc.) by methods for the

Table 1

					online dull web, as bitcoins can be harder to pursue.
A Privacy-Preserving E-Commerce System Based on the Blockchain Technology [12]	1.Yiming Jiang, 2.Chenxu Wang 3.Yawei Wang 4. Lang Gao	2019	The paper introduces a privacy-focused E-commerce model using private smart contracts and zero-knowledge proofs. It addresses privacy concerns by ensuring transactions without revealing personal data, employing blockchain, zk-SNARKs, and IoT measures.	1.Enhanced privacy 2.Transparency and trust 3.Efficient transactions	1.One drawback is the potential for slower transaction processing times. 2.complexity and lack of user-friendly interfaces.
A Reliable E-commerce Business Model Using Blockchain Based Product Grading System [13]	1.Ching-Nung Yang 2.Yi-Cheng Chen 3. Shih-Yu Chen 4. Song-Yu Wu	2019	The paper proposes a blockchain-based Product Grading System (BPGS) to address disputes over varying product quality perceptions in online shopping	1.Enhancing Trust and Data Security 2.Streamlining Supply Chain Management	1.Scalability is an issue. 2.Blockchain is not a Distributed Computing System
A Systematic Survey of e-Commerce Applications with Blockchain in Agro Sector [14]	1.Ashok Murugesan 2.Kumar Ramasamy 3.Aravind P 4. Bathri Narayanan V 5.Daniel Raja J	2021	It explores the integration of blockchain technology in e-commerce platforms specific to agriculture, highlighting trends, challenges, and potential benefits within this domain.	1.The use of blockchain technology can enhance transparency and traceability in the agro sector 2.Can provide a secure and immutable record of transactions, ensuring the authenticity of products and reducing the risk of fraud.	1.The implementation of blockchain technology requires a significant investment in infrastructure and training.
The Diversity Layout of E-commerce Applications Based on	1.Yi Liu 2. Chuanchang Liu	2018	The paper underscores the significance of mobile e-commerce	1.It allows for greater customization and	1.The fragmentation of the Android ecosystem. 2.Android has various

Table 2

Android [15]	3.Zhiyuan Su		apps in the mobile Internet era, focusing on the necessity for diverse and flexible homepage layouts.	personalization. 2.Android provides a wide range of options for designing layouts, allowing developers to create unique and visually appealing interfaces. This can help to enhance the user	different versions and making application compatible for every version is a difficult task
Towards Formal Modeling and Analysis of UPI Protocols [16]	1.Sreekanth Malladi	2021	The paper explores UPI (Unified Payments Interface), a mobile payment framework connecting customers and merchants. It addresses reported vulnerabilities by proposing the modeling of UPI protocols as conventional cryptographic protocols.	1.It sheds light on UPI framework. 2.It Models UPI with conventional cryptographic protocol to test for security breaches	1.Informal Weakness Discovery 2.Simplification of Protocols - this could lead to abstraction from real world complexities 3.Unconventional Features - It suggests changes in unconventional features which may affect correctness/effectiveness .
Developing an E-Commerce Website [25]	1.Syed Emdad Ullah 2.Tania Alauddin 3. Hasan U. Zaman	2016	The paper addresses the disparity between e-commerce and brick-and-mortar businesses, outlining challenges and solutions for e-commerce website development	1.Provides practical insights into the process of developing an e-commerce website.	1.May lack in-depth technical details or advanced strategies for experienced developers.

Table 3

V. LIMITATIONS OF EXISTING SYSTEM

Centralized Control:

Conventional e-commerce sites are usually controlled by one organization, making them centralized. This centralization may result in possible power abuse and a lack of transparency.

Trust and Transparency:

Consumers frequently lack knowledge about the legitimacy of products and the production chain. Misleading product information and worries about fake items can undermine trust.

Payment Disputes and Chargebacks:

In traditional e-commerce, chargebacks and payment disputes are frequent occurrences that cause friction between customers and sellers. The process of resolution takes a lot of time.

Data Security and Privacy:

Since user data is stored centrally, traditional e-commerce platforms are more susceptible to privacy issues and data breaches.

International Transactions and Currency Conversion:

Conventional e-commerce platforms could have difficulties facilitating smooth international transactions, such as problems with cross-border payments and currency conversion.

High Transaction Costs:

Transaction fees are frequently levied by conventional payment gateways and financial intermediaries, particularly for international transactions. This results in increased expenses for both buyers and sellers.

VI. PROBLEM STATEMENT

" Creating a safe and transparent marketplace where you can buy, sell and reliably track authentic products and promote business survival and growth."

VII. IMPLEMENTATION

- Created Smart Contracts.
- Created Data
- Uploaded data (with images) in Pinata.
- Deployed Smart Contracts on Blockchain.
- Created Navbar section of User Interface (Front End) using React JS.
- Integrated MetaMask with the User Interface (Front End) of the website.
- Added Accounts to the MetaMask Wallet.
- Used Ether JS to create connection between User Interface (Front End) to Blockchain.

VIII. SYSTEM ARCHITECTURE

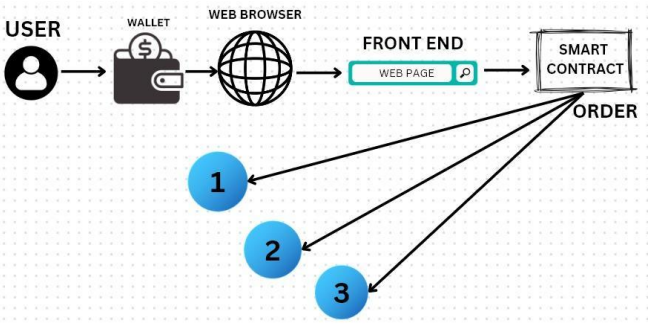

Fig.1 Smart Contracts

In the above diagram the user will connect his wallet to the website that we have created for our e commerce store Then through the web browser and with the help of the user friendly UI the user can purchase any product using ether As this is being carried out the smart contracts will handle the transaction that is meant to be executed over the block chain Taking care of the order and all the details of the product the smart contracts will then act upon the blockchain to do so.[23]

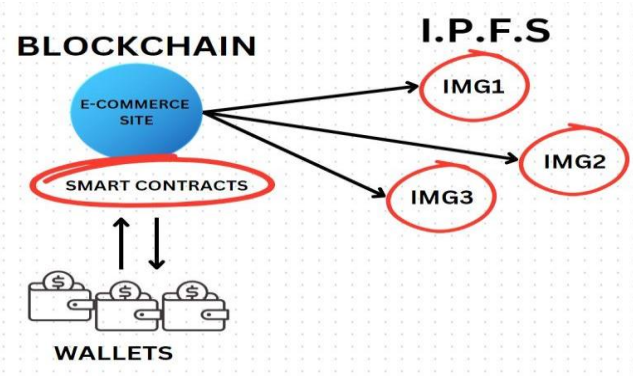

Fig.2 IPFS (Inter Planetary File System)

INTER PLANETARY FILES SYSTEMS is like a backend of the block chain that helps store files and pictures in the blockchain and we use this to obtain the pictures on our front end to display for the users to make it easy for them to get a discrete view of the product.[13]

IX. Software Used

Vs Code

Microsoft created Visual Studio Code (VS Code), a cross-platform, lightweight source code editor. It supports numerous programming languages, offers smart code completion, integrates Git for version control, includes an integrated terminal, and is highly customizable through extensions. VS Code is widely used for its speed, versatility, and a large community contributing to its ongoing development. It will be used for front-end design.

Pinata

Pinata is a cloud-based service that simplifies and accelerates the development of decentralized applications (DApps) on blockchain networks, particularly for the Inter Planetary File System (IPFS). It offers tools and services for managing, pinning, and distributing content on IPFS, making it easier for developers to handle the storage and retrieval of data within decentralized applications. Pinata simplifies the process of interacting with IPFS, providing developers with an efficient solution for managing and sharing data in a decentralized and distributed manner. It will be used for IPFS(Inter Planetary File System)

Ethereum

Ethereum is a decentralized blockchain platform that makes it possible to create and run decentralized apps (DApps) and smart contracts. The name of its native cryptocurrency is Ether (ETH). Ethereum's key features include a Turing-complete scripting language for smart contracts, a decentralized virtual machine (EVM) to execute these contracts, and a consensus mechanism called Proof of Stake (PoS) that is transitioning from Proof of Work (PoW). Ethereum aims to provide a global, open-source platform for building decentralized applications, fostering innovation in the blockchain space. It is using etherium blockchain for online payment purposes.[20]

X. Results

```
Account #0: 0xf39Fd6e51aad88F6F4ce6aB8827279cffFb92266 (10000 ETH)
Private Key: 0xac0974bec39a17e36ba4a6b4d238ff944bacb478cbed5efcae784d7bf4f2ff80

Account #1: 0x70997970C51812dc3A010C7d01b50e0d17dc79C8 (10000 ETH)
Private Key: 0x59c6995e998f97a5a0044966f0945389dc9e86dae88c7a8412f4603b6b78690d

Account #2: 0x3C44CdDdB6a900fa2b585dd299e03d12FA4293BC (10000 ETH)
Private Key: 0x5de4111afa1a4b94908f83103eb1f1706367c2e68ca870fc3fb9a804cdab365a
```

Fig 10.1 Result 1
Shows dummy accounts for smart contracts

The project is currently using the Hardhat framework with Solidity and JavaScript coding languages.[24]We created Smart Contracts for the product listing section. We also used Pinata for storing the data (images) onto IPFS(Inter Planetary File System) which will be required to display data on front-end.[22]

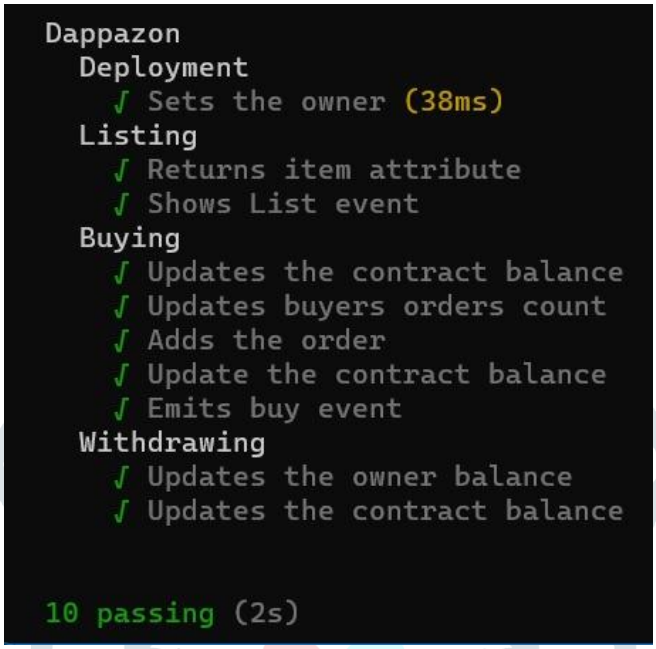

Fig.10.2 Result 2

Shows deployment of smart contracts

Initially we studied the basics of Solidity language. Using Solidity we programmed the Smart Contracts and we also used JavaScript for programming .This is the output of Smart Contracts on Cmd. The Hardhat deploys the Solidity and JavaScript files using Mocha framework and Chai libraries.[23]

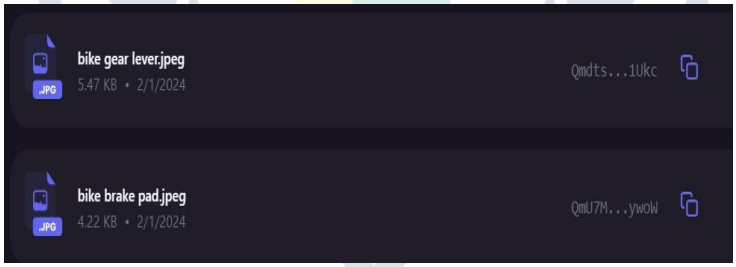

Fig. 10.3 Result

Shows the images stored in IPFS using Pinata

Since the blockchain does not display images directly we will be using Pinata database. This is the output we obtained after we uploaded data using Pinata onto IPFS(Inter Planetary File System).This data will be further displayed on the front-end of the website. This is a separate database used to upload images onto blockchain.

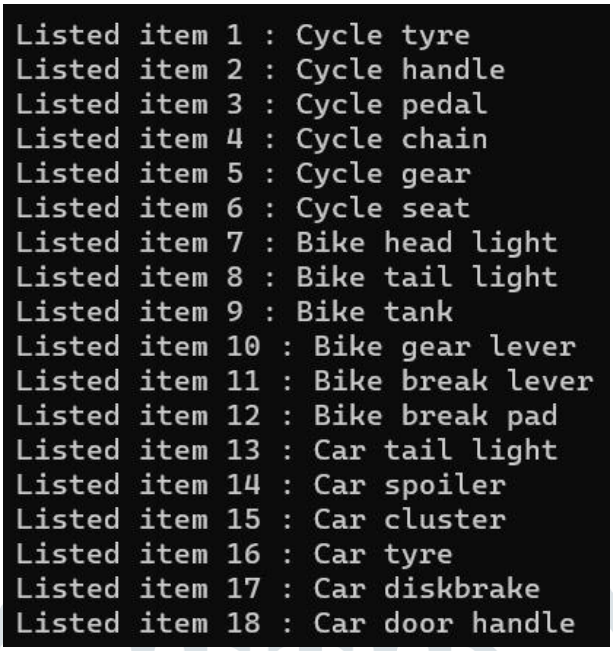

Fig 10.4 Result 4
Shows the items listed and stored on blockchain

We focused on creating smart contracts that would form the backbone of our decentralized application. We meticulously crafted these contracts, defining the rules and logic that govern the interactions and transactions on the blockchain. Utilizing Solidity, a programming language specifically designed for smart contracts, we ensured the reliability and security of the underlying code.

To manage the storage and accessibility of our data, we chose Pinata as our decentralized data storage solution. This platform allowed us to efficiently upload and store data, including images, in a decentralized manner. Pinata's robust infrastructure ensured data integrity, providing a reliable foundation for our decentralized application.

Once the smart contracts and data were ready, the next step involved deploying the smart contracts onto the blockchain. Leveraging platforms like Hardhat, we initiated the deployment process, making our smart contracts operational and accessible to users on the decentralized network. This step marked a pivotal moment in the project, as it brought the conceptualized rules and functions to life on the blockchain.

Fig 10.5 Result 5
Shows the blocks in which all the data is stored

Fig 10.6 Result 6
Shows listing of products

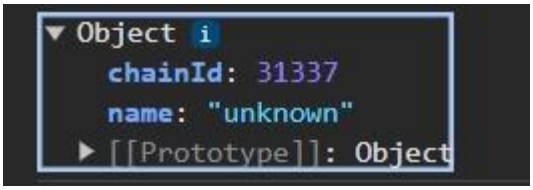

Fig 10.7 Result
Shows connection of back-end to front-end

Moving on to the frontend development, we used React JS to craft the Navbar section of our user interface. React JS, known for its efficiency in building dynamic and responsive interfaces, enabled us to create a seamless navigation experience for users within our decentralized application. The Navbar served as an intuitive gateway, enhancing the overall user interaction with our platform.

To bridge the gap between our user interface and the blockchain, we seamlessly integrated MetaMask, a popular cryptocurrency wallet and gateway. This integration provided a secure and user-friendly means for users to interact with our decentralized application. Accounts were added to the MetaMask wallet, empowering users with a personalized space to manage their digital assets and engage with blockchain-based functionalities.

In order to establish a robust connection between the frontend and the blockchain, we employed Ether JS. This JavaScript library facilitated communication between the user interface and the deployed smart contracts on the blockchain. By using Ether JS, we ensured a smooth and efficient flow of information, enabling users to seamlessly interact with the decentralized application while maintaining the integrity of data and transactions on the blockchain.

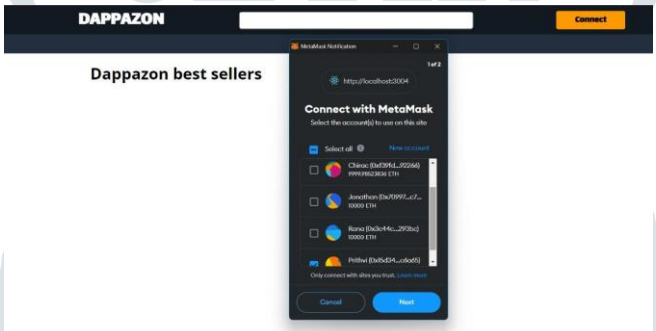

Fig 10.8 Result 8
Shows the User Interface connected to MetaMask

XI. Conclusion and Futurescope

In conclusion, our experiment on the "Blockchain-Based E-commerce Website" has been a significant journey marked by notable achievements and advancements in the realm of decentralized and secure online transactions. Over the course of this semester, we successfully conceptualized and implemented smart contracts, elevating the integrity and transparency of our e-commerce platform. The utilization of smart contracts not only streamlined the listing of products but also ensured a trustless environment for both buyers and sellers.[21]

A pivotal aspect of our project involved harnessing the power of Pinata to seamlessly integrate images into the Inter Planetary File System (IPFS). This strategic move not only enhanced the accessibility and durability of our data but also contributed to the overall decentralization of our e-commerce ecosystem.

Looking ahead, we are planning to facilitate the user interface (front end) of the website by adding more functionalities. We'll be pulling and displaying the data from IPFS on the user interface.

In summary, this semester has been instrumental in laying the foundation for our blockchain based e-commerce website. The incorporation of smart contracts, Pinata, and IPFS has positioned our project at the forefront of technological innovation in the e-commerce landscape. As we continue to evolve and refine our platform, the upcoming semester holds the promise of transforming our vision into a tangible, user-friendly reality.

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