RESEARCH & INNOVATION DIVISION
IJIST

A Sustainable Growth MetaMask Consulting Application for Agriculture Sector Using Ethereum and Blockchain Technology

Adnan Ashraf, Anroop Kumar, Madeha Memon
Department of Computer Systems Engineering (Mehran university of engineering and technology), CloudEvol (United States of America)
***Correspondence:** Madeha Memon madeha.memon04@gamil.com

Citation | Ashraf. A, Kumar. A, Memon. M, "A Sustainable Growth MetaMask Consulting Application for Agriculture Sector Using Ethereum and Blockchain Technology", IJIST, Vol. 6 Issue. 2 pp 582-592, June 2024
DOI | https://doi.org/10.33411/ijist/202462582592
Received | April 15, 2024 **Revised |** May 18, 2024 **Accepted |** May 22, 2024 **Published |** June 03, 2024.

Pakistan's economy depends heavily on the agricultural sector, yet a large number of farmers encounter financial constraints, including debt, loan repayment, a lack of loan security, and crowdfunding scams, which are the primary reasons for converting their lands into real estate. Crowdfunding for agriculture on the blockchain will cut out the middlemen and connect customers and producers directly. Blockchain technology provides a way to share a database or ledger that will guarantee an unalterable and consistent version of the truth even amongst untrustworthy players. Therefore, this study establishes a peer-to-peer network and a marketplace where community members can fund agricultural endeavors in exchange for food items. The novelty of this research is that the blockchain-based crowdfunding system for agriculture that enable investors to connect with farmers consistently and directly. The methodology includes the integration of AI-powered consultation tool, like ChatGPT into a web application to increase its efficacy. With the use of this instrument, enables farmers to solve issues pertaining to saline lands and obtain information regarding land productivity. This tool provides farmers quick, accurate, and easily available information to assist them in making better decisions. Therefore, this research aims to provide a comprehensive approach to aid impoverished farmers, encourage agricultural expansion, and ensure equitable profit sharing among all parties involved. Through the integration of blockchain technology, cooperative investment, and AI-powered consulting, this study aims to promote the agriculture sector's sustainable growth.

Keywords: Ethereum; MetaMask; Blockchain; ChatGPT; Metaverse.

Introduction:

Agriculture has evolved greatly from its initial times of cultivating for survival to meeting the food demands of the world's growing population. However, in the twenty-first century, this industry continues to face pressing difficulties. One of the main concerns is economic disparities prevalent within the farming community. Many farmers, particularly those in developing nations, encounter challenges in assessing the necessary capital and technology required to enhance their productivity and quality of life. Conversely, investors often overlook the agriculture sector due to perceived risks and obstacles, opting instead for other investment opportunities. These challenges faced by farmers are further compounded by environmental factors such soil deterioration, water scarcity, and climate change [1][2]. Blockchain is a leading technology which is undertaken to facilitate farmers.

The primary benefit of crowdfunding is its ability to rapidly increase the necessary number of plutocrats. This is facilitated by widespread use of social media and the Internet nowadays, enabling the design creators to quickly connect with the public. Additionally, many designers have chosen to use crowdfunding to finance their projects due to potential challenges in obtaining funding from banks or traditional investors, often associated with lengthy repayment periods [3][4]. Moving on to blockchain technology, its fundamental components are blocks and transactions. A block is a collection of data that records a transaction together with other relevant parameters like the correct order, creation timestamp, etc. A transaction is the action that the party initiates [5][6][7].

Smart contracts are one of the blockchain's most alluring characteristics. They represent an executable legal document that operates within a blockchain environment, carries out, and enforces the conditions of a contract. It is used to automatically carry out the agreements as soon as the predetermined requirements are met. They can be deployed on various blockchain platforms such as Ethereum, NXT, and Bitcoin, offering capabilities like asset balance tracking, data storage, and programmable logic. By leveraging the blockchain network, stakeholders can create and manage contracts securely and transparently [8][9][10].

Literature Review:

Agricultural Crowdfunding Through Blockchain study focuses on the use of the private blockchain Hyperledger for crowdfunding linked to agriculture in India Institute of Technology Roorkee, providing direct financial assistance and enhanced transparency to lessen the financial strain and associated difficulties faced by farmers [11]. A smart group of researchers has contributed to the field of Blockchain and smart contract for IoT enabled smart agriculture. The integration of blockchain, smart contracts, and IoT in smart agriculture improves data management, traceability, and automation, leading to more efficient and transparent agricultural practices with enhanced food safety and real-time monitoring [12][13].

Table 1: Enumeration of Pakistani crowdfunding sites in operation**.**

No.	Name	Niche	Blockchain Usage
1	Seed out	Donations	No
2	Transparent Hands	Health Care	No
3	Care Foundation	Education	No
4	Patari	Entertainment	No
5	Edhi Foundation	Charity org	No

Furthermore, researchers have explored the utilization of ChatGPT in the digital era: focusing on perspectives regarding chatbot implementation. The study presents the application of ChatGPT and its investigation in education for providing support and workload reduction. However, concerns about accuracy and privacy underscore the importance of careful implementation of these technologies [14]. The study finds that salaam-based crowdfunding serves as a feasible Shariah-biddable investment platform, potentially benefitting both implicit investors and growers or entrepreneurs in financing agricultural activities in Afghanistan

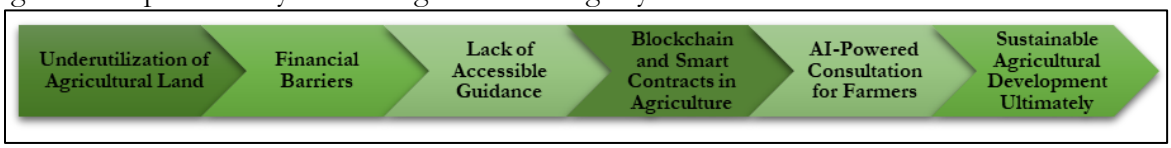
[15][16]. The study utilized Decentralized Peer to Peer Networks in order to explore blockchain adoption in the agri-food supply chain, revealing key drivers like traceability and safety. The study underscores the importance of post-adoption guidelines and policymaking, providing a basis for future research and strategic initiatives in this field. [17][18][19][20][21].

Critical Analysis from Literature Review:

In this section we have discussed and reviewed all the projects related to Crowdfunding using blockchain, but our unique focus is on establishing an agri-estate. In this initiative, we aim to connect multiple investors with farmers, ensuring equitable profit distribution between the two parties. Additionally, we plan to provide consultancy services through a chatbot. There is currently no existing startup or organization addressing this specific issue, highlighting the innovative nature of our project.

Research Problem:

The agricultural sector in Pakistan faces a complex dilemma characterized by extensive unused agricultural land, financial limitations that hinder land cultivation, and a lack of customized guidance for addressing various agricultural challenges, including land salinity. The main research problem focuses on the novel work to effectively utilize and develop Pakistan's agricultural potential by addressing the following key issues:



Objectives:

- To investigate the causes of agricultural land underutilization and address financial barriers in agriculture.
- To evaluate the viability of blockchain and smart contracts that foster sustainable agricultural development.
- To design and develop web-based platform offering Smart Contracts for agriculturists interested in FinTech and crowdfunding.

Sustainable Development Goals (SDG):

SDG-8: Decent Work & Economic Growth:

SDG 9: Industry, Innovation, and Infrastructure:

The project holds immense significance for both small-scale farmers and job seekers alike, as it is strategically designed to propel economic growth within the agricultural sector. By focusing on the needs of small-scale farmers, the initiative aims to empower them with resources, knowledge, and technology that can enhance productivity and yield. It not only secures sustainable income for the farmers but contributes to the overall economic development of the community. Furthermore, the project creates a ripple effect by generating employment opportunities for job seekers within the agricultural value chain.

Furthermore, the project spearheads innovation and infrastructure enhancement in the agricultural sector through the integration of cutting-edge technologies such as blockchain and smart contracts. By leveraging these technological advancements, the initiative aims to revolutionize traditional agricultural practices, offering farmers streamlined processes and increased efficiency.

Research Methodology:

Using the Ethereum blockchain, users developed and contributed to crowdfunding campaigns through the system, which is a decentralized application (dApp). The back-end server of the system runs on NodeJS, while the front-end user interface runs on ReactJs. Solidity is a programming language created specifically for Ethereum, and it is used to write smart contracts that control the logic and regulations of the system. Figure 1 shows the configuration of the system and interaction of its various components.

Materials and Methods:

Using solc, a Solidity compiler package for NodeJS, the smart contracts are compiled into Application Binary Interface (ABI) code in JSON format. Next, an instance of the Web3 provider library, a tool that facilitates connectivity with the Ethereum network, is created using the ABI code. The tools and technologies that were used included React JS, Node JS MetaMask, Solidity, SQL, OpenAI, Figma and VS Code.

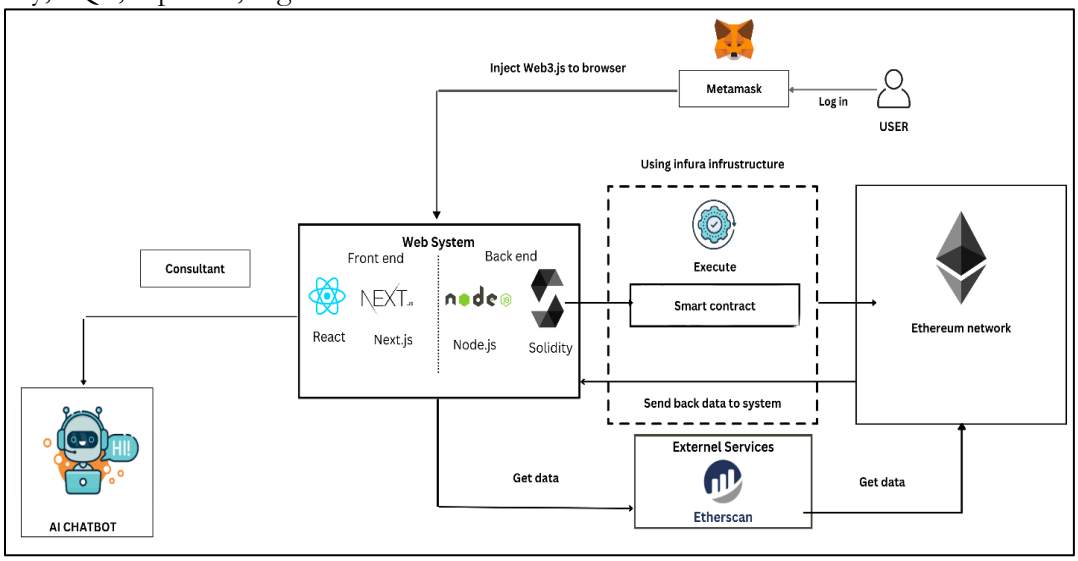


Figure 1: Research Methodology

The system connected to the Ethereum network via Infura, a service that offers remote access to Ethereum nodes, rather than a local node. To utilize the system, users must first set up a cryptocurrency wallet called MetaMask. This wallet is a browser extension that enables users to communicate with dApps and send and receive Ether, the native currency of Ethereum. Once an account has been created in MetaMask, users can add Ether from external sources to their wallet. Users can begin using the system as soon as they have some Ether in their wallet because MetaMask has inserted a Web3 instance inside the browser. By defining the project's aim, length, and description, users can establish campaigns. Ether can be contributed by other users to the campaigns they enjoy. To demonstrate how they intend to use the money generated for their initiative; the campaign manager may also create requests. The requests must be granted by most contributors before the Ether is distributed to the vendors or beneficiaries. The system, currently in its prototype stage, is connected to the Ethereum network through Infura infrastructure. However, it does not yet utilize the main Ethereum network for actual value exchange and transactions as in Figure 2.

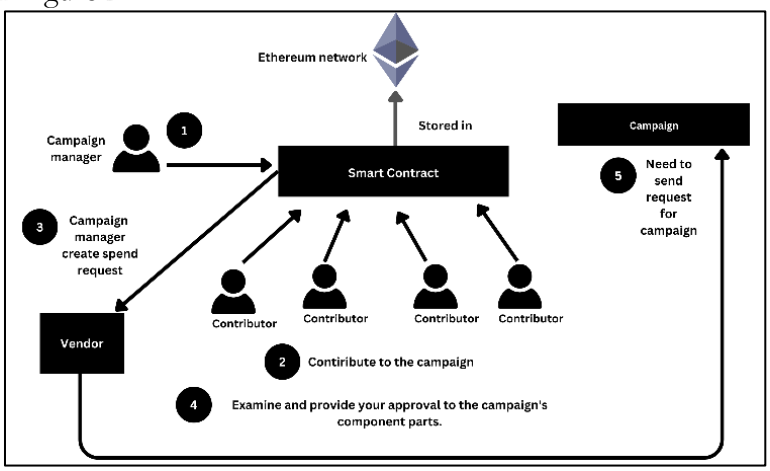


Figure 2: Ether flow in the proposed Blockchain model

Rather, it makes use of a test net, which is a network that imitates the primary network but tests it using fictitious Ether. One of the official test nets supported by Ethereum, the Rinke by network is a proof-of-authority blockchain. Since the Rinke by network is being used, ether must be requested from the Rinke by Test Faucet at 1. Ether cannot be mined by resolving cryptographic riddles. Ether scan API is a service that offers data and statistics about the e by a campaign manager. The manager must provide campaign details and may also post a comprehensive proposal to convince donors. Every transaction is documented in the blockchain and accessible to all users on the Ether scan website as represented in Figure 3.

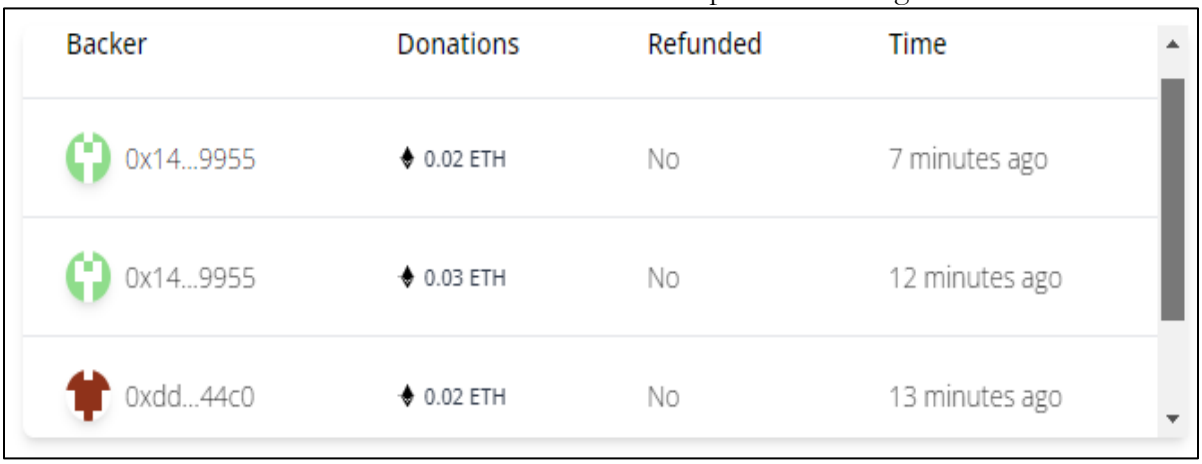


Figure 3: Documentation of Ethereum Trades

Creating a Chatbot with GPT Integration:

The methodology for creating a chatbot with GPT integration using React involved a systematic approach. It began with defining the chatbot's objectives and features, then moves on to selecting the technology stack, designing a user-friendly interface, and handling user input effectively. Authors developed the chatbot's logic and integrated a GPT-based AI API, ensuring reliable error handling, context management, and personalization. Implement a feedback system for continuous improvement, prioritize security and privacy, and deploy the chatbot on a server or cloud platform. This iterative process requires continuous monitoring of user interactions and feedback, as well as staying updated with advancements in AI to deliver a responsive, secure, and user-centric Chatbot as shown in Figure 4.

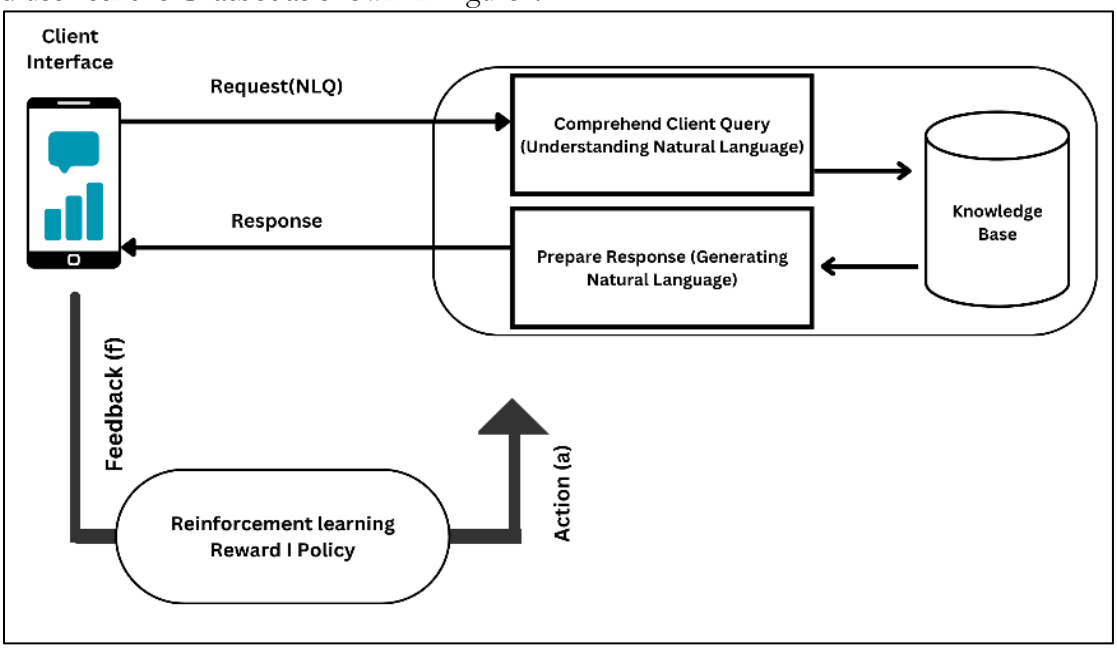


Figure 4: Architecture of AI Chatbot

The Chatbot is designed to function as a farming expert, offering advice on improving land productivity by suggesting appropriate crops, guiding on proper irrigation, and offering tips to enhance overall farm output. It also assists investors by recommending profitable crops to maximize returns.

An activity diagram was employed to depict the sequence of actions involved in a user logging into the application and delineated the outcomes in the event of a successful login. After successfully logging in, the user obtains two options. The first option is to use the virtual Chatbot to resolve issues related to land. The second option is for the user to initiate a campaign where they can share all the details regarding the crop for which they need investment. The details are received by potential investors, and if they find the campaign feasible, they may choose to invest in it. Otherwise, they can exit the campaign. The figure 6 shows when a farmer shares their investment campaign on the blockchain network, the campaign will be received by the investor. If it seems feasible to the investor, the investment can be proceeded; otherwise, they have the option to discontinue.

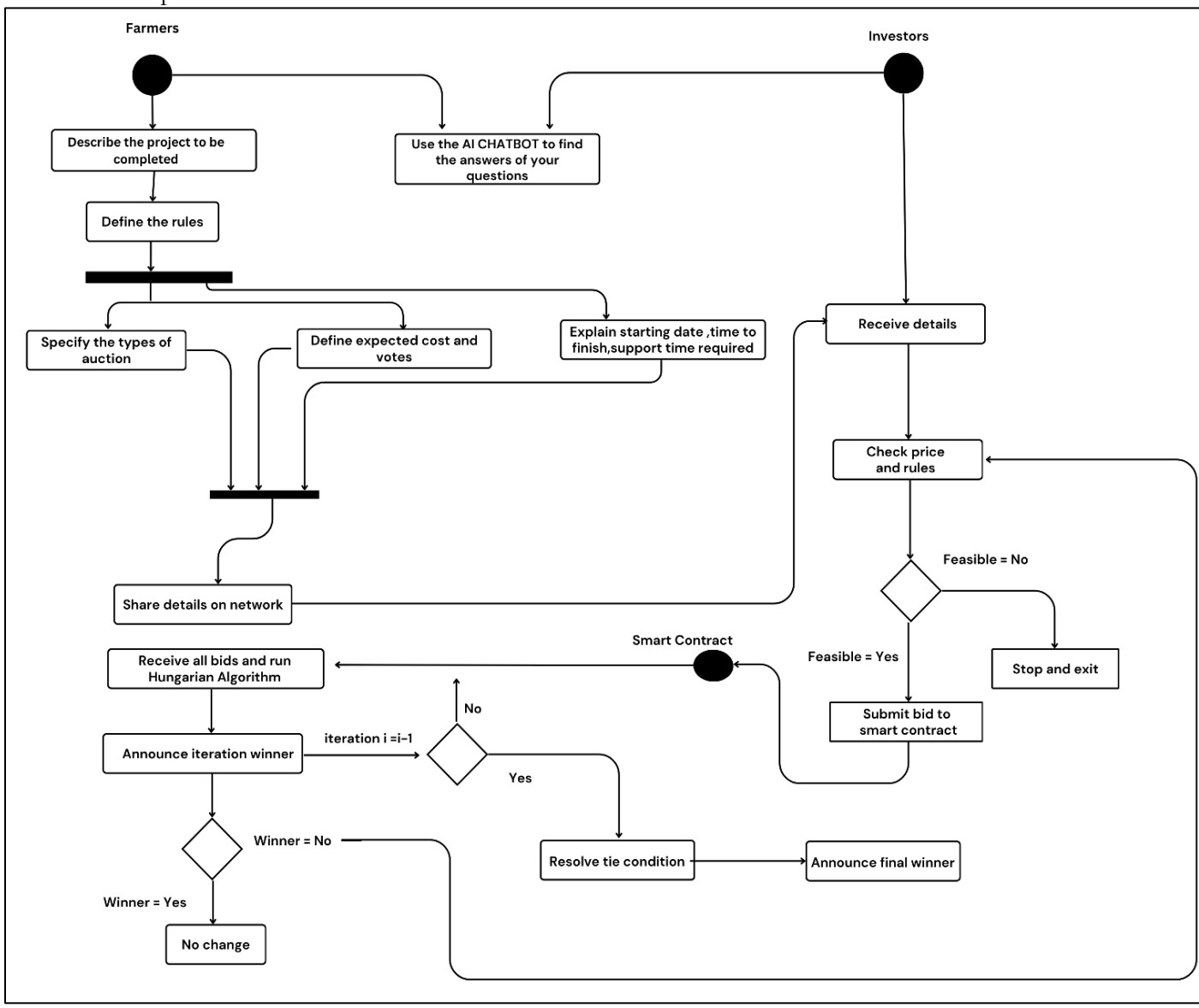


Figure 5: Activity Diagram

User Interface of Agri-Blockchain:

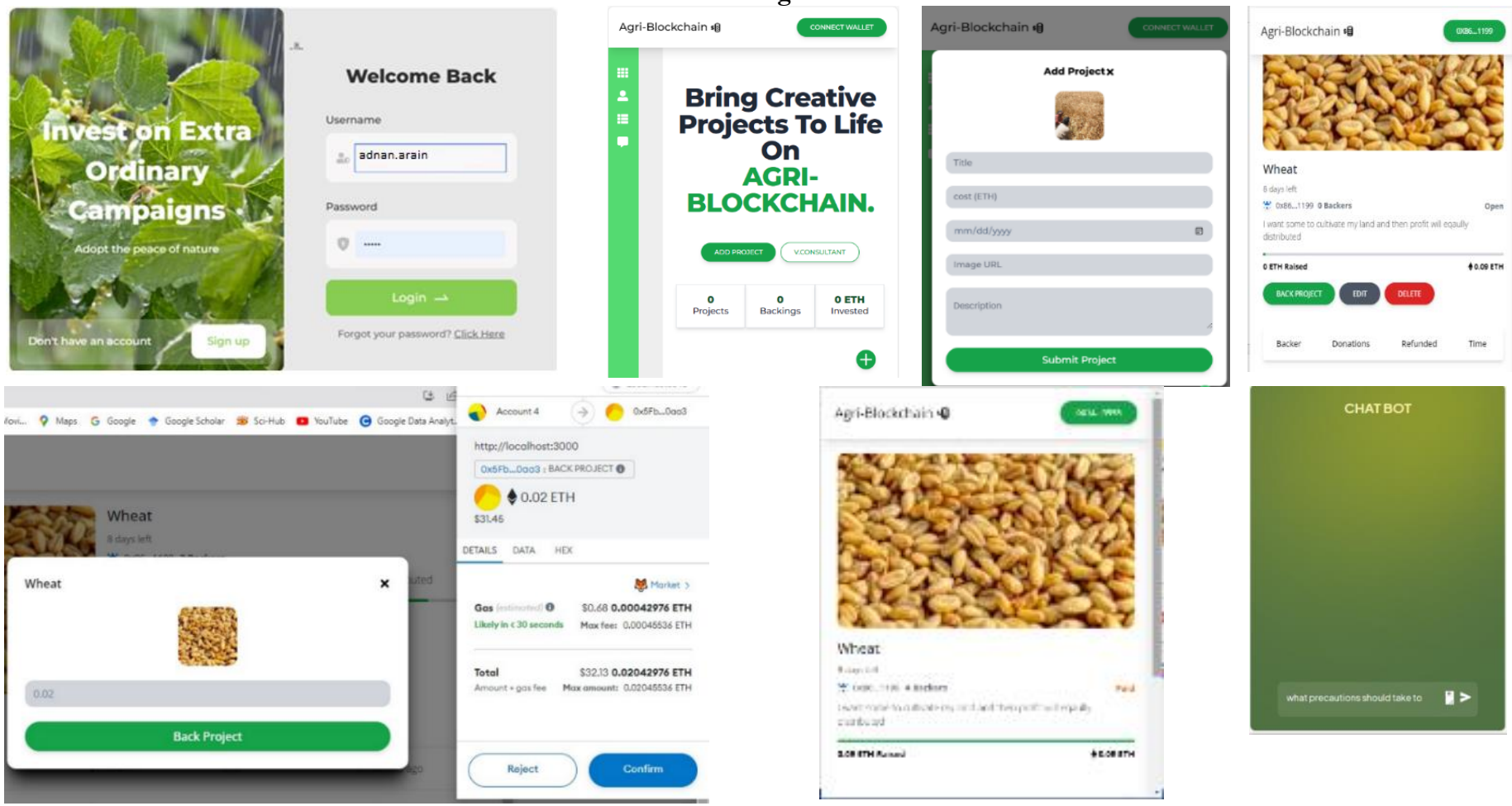


Figure 6: User Interface of Agri-Blockchain

Testing of MetaMask Consulting Application:

Test Runs Overview

	Overall Average	RUN #6	RUN #5	RUN #4	RUN #3	RUN #2	RUN #1
Max. Virtual Users:	11.33	10 ↘	12 ↗	12 ↗	10 ↘	12 ↗	12 ↗
Test Duration:	49 s	1 min, 19 s ↗	33 s ↘	33 s ↘	1 min, 22 s ↗	34 s ↘	33 s ↘
Average Response Time [ms]:	2742.17	7022 ↗	332 ↘	469 ↘	7215 ↗	993 ↘	422 ↘
Total Errors:	21.67	120 ↗	0 ↘	0 ↘	10 ↘	0 ↘	0 ↘
Total Hits:	403.33	300 ↘	500 ↗	460 ↗	300 ↘	380 ↘	480 ↗
Hits per Second:	10.38	3.80 ↘	15.15 ↗	13.94 ↗	3.66 ↘	11.18 ↗	14.55 ↗

Average Response Times

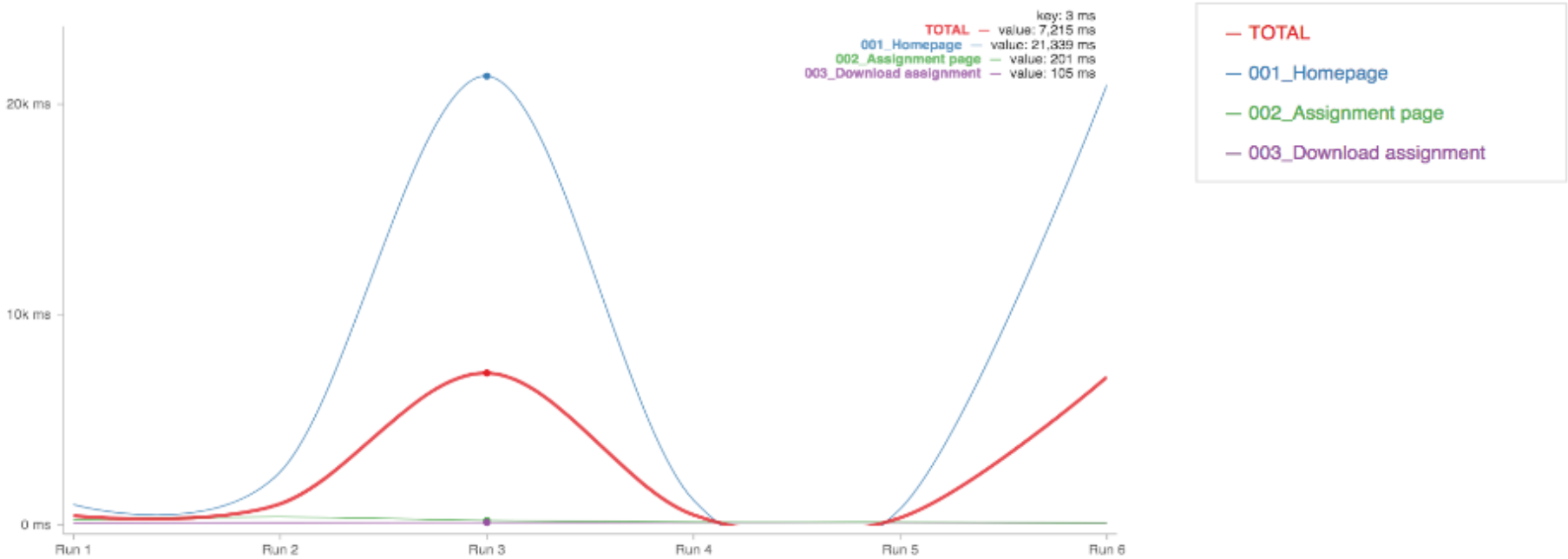


Figure 7: Average Response Time of Testing

Various software testing approaches were undertaken to check the response time of the application including user testing, performance testing, unit testing and load testing represented in Figure 8 investigated using Test Management Tool. In this testing methodology maximum number of virtual users were employed to check the user and load per second. Thus, the efficiency of the performance measures of the test were incorporated without any errors.

Conclusion:

The discussion extends beyond crowdfunding to address the broader challenges in agriculture. Economic disparities within the farming community and environmental factors such as soil deterioration and climate change pose significant hurdles. The proposed solution integrates blockchain technology and AI-driven consulting services, offering a progressive approach to bridging the financial gap between investors and farmers. This holistic strategy aims to bring about fair and sustainable agriculture, addressing the evolving needs of the industry and contributing to both rural and global food security. It includes by creating a chatbot with GPT integration using React involved a systematic approach, defining the chatbot's objectives and features, then moves on to selecting the technology stack, designing a user-friendly interface, and handling user input effectively. In essence, the discourse emphasizes the transformative potential of combining innovative technologies with economic strategies and knowledge exchange to shape the future of crowdfunding, agriculture, and beyond. It underscores the importance of ongoing research and development to create solutions that are responsive to the dynamic challenges faced by various industries in our rapidly evolving world. It is our achievement in blockchain-based crowdfunding platform technologies where special concentration was given to user-friendly design, understandable instructional materials, and attentive customer service to guarantee a flawless experience for both farmers and investors. During the beta testing, the UI supported our customers with instructional resources and tutorials. Random user feedback sessions have been there in place. Additionally, we have focused on using ChatGPT's API to its fullest potential so that our chatbot can give farmers and investors quick and reliable information. Chatbot is being trained as we need voluminous conversations with ChatGPT to serve it better. The indirect feedback during beta-testing seems satisfying the responses as random LIKES (clicks) are observed. Furthermore, optimization parameter of testing was performed for improving the performance of application.

Using React, a methodical strategy was used to create a chatbot with GPT integration. First, the goals and features of the chatbot were defined. Next, the technology stack was chosen, an intuitive user interface was created, and user input was efficiently handled. The authors implemented a GPT-based AI API into the chatbot's logic to guarantee dependable error handling, context management, and customization. Prioritize security and privacy, put in place a feedback system for ongoing development, and host the chatbot on a server or cloud platform. First, the goals and features of the chatbot were defined. Next, the technology stack was chosen, an intuitive user interface was created, and user input was efficiently handled. Additionally, comparing our model with other existing models i.e. Supply Chain Traceability in which every stage of the agricultural supply chain may be transparently and irrevocably documented using smart contracts built on Ethereum. However, our agriculture blockchain uses various asserts technologies including growers, retailers, and customers to follow the produce's path from farm to table, guaranteeing its authenticity and quality. Moreover, in Decentralized market model only farmers and consumers can interact directly through blockchain-based decentralized markets that are enabled by Ethereum smart contracts, cutting out middlemen and transaction fees. However, our model connects with various marketplaces and give consumers access to recent production that is acquired locally while also enabling farmers to get fair pricing for their goods.

References:

[1] L. Bader, J. C. Burger, R. Matzutt, and K. Wehrle, "Smart Contract-Based Car Insurance Policies," 2018 IEEE Globecom Work. GC Wkshps 2018 - Proc., Jul. 2018, doi:

10.1109/GLOCOMW.2018.8644136.

[2] D. Puthal, N. Malik, S. P. Mohanty, E. Kougianos, and C. Yang, "The Blockchain as a Decentralized Security Framework [Future Directions]," IEEE Consum. Electron. Mag., vol. 7, no. 2, pp. 18–21, Mar. 2018, doi: 10.1109/MCE.2017.2776459.

[3] D. Reich and C. Pearson, "Irrigation Outreach in Afghanistan: Exposure to Afghan Water Security Challenges," J. Contemp. Water Res. Educ., vol. 149, no. 1, pp. 33–40, Dec. 2012, doi: 10.1111/J.1936-704X.2012.03125.X.

[4] Z. Zheng, S. Xie, H. Dai, X. Chen, and H. Wang, "An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends," Proc. - 2017 IEEE 6th Int. Congr. Big Data, BigData Congr. 2017, pp. 557–564, Sep. 2017, doi: 10.1109/BIGDATACONGRESS.2017.85.

[5] A. Kosba, A. Miller, E. Shi, Z. Wen, and C. Papamanthou, "Hawk: The Blockchain Model of Cryptography and Privacy-Preserving Smart Contracts," Proc. - 2016 IEEE Symp. Secur. Privacy, SP 2016, pp. 839–858, Aug. 2016, doi: 10.1109/SP.2016.55.

[6] V. Hassija, V. Chamola, D. N. G. Krishna, and M. Guizani, "A Distributed Framework for Energy Trading between UAVs and Charging Stations for Critical Applications," IEEE Trans. Veh. Technol., vol. 69, no. 5, pp. 5391–5402, May 2020, doi: 10.1109/TVT.2020.2977036.

[7] T. Hong, "Accelerating the Application of Blockchain in the Field of Agricultural Products E - commerce in China," pp. 18–20, 2016.

[8] A. Angrish, B. Craver, M. Hasan, and B. Starly, "A Case Study for Blockchain in Manufacturing: 'FabRec': A Prototype for Peer-to-Peer Network of Manufacturing Nodes," Procedia Manuf., vol. 26, pp. 1180–1192, Jan. 2018, doi: 10.1016/J.PROMFG.2018.07.154.

[9] O. Posegga, M. P. Zylka, and K. Fischbach, "Collective dynamics of crowdfunding networks," Proc. Annu. Hawaii Int. Conf. Syst. Sci., vol. 2015-March, pp. 3258–3267, Mar. 2015, doi: 10.1109/HICSS.2015.394.

[10] A. H. Kelechi, N. F. Abdullah, R. Nordin, and M. Ismail, "SMART: Coordinated double-sided seal bid multiunit first price auction mechanism for cloud-based TVWS secondary spectrum market," IEEE Access, vol. 5, pp. 25958–25971, Nov. 2017, doi: 10.1109/ACCESS.2017.2768964.

[11] "International Roaming Services Optimization Using Private Blockchain and Smart Contracts." Accessed: May 22, 2024. [Online]. Available: https://www.warse.org/IJATCSE/static/pdf/file/ijatcse32832019.pdf

[12] J. Hörisch and I. Tenner, "How environmental and social orientations influence the funding success of investment-based crowdfunding: The mediating role of the number of funders and the average funding amount," Technol. Forecast. Soc. Change, vol. 161, p. 120311, Dec. 2020, doi: 10.1016/J.TECHFORE.2020.120311.

[13] S. Kleinert, C. Volkmann, and M. Grünhagen, "Third-party signals in equity crowdfunding: the role of prior financing," Small Bus. Econ., vol. 54, no. 1, pp. 341–365, Jan. 2020, doi: 10.1007/S11187-018-0125-2/FIGURES/3.

[14] Z. Wang, Z. Feng, and P. Zhang, "An iterative hungarian algorithm based coordinated spectrum sensing strategy," IEEE Commun. Lett., vol. 15, no. 1, pp. 49–51, Jan. 2011, doi: 10.1109/LCOMM.2010.111910.101806.

[15] A. Alimoglu and C. Ozturan, "Design of a smart contract based autonomous organization for sustainable software," Proc. - 13th IEEE Int. Conf. eScience, eScience 2017, pp. 471–476, Nov. 2017, doi: 10.1109/ESCIENCE.2017.76.

[16] "Computer-Assisted Framework for Automatic Detection of Structural Hand Deformities." Accessed: May 22, 2024. [Online]. Available: http://jonuns.com/index.php/journal/article/view/826

[17] A. Mahmood, J. Luffarelli, and M. Mukesh, "What's in a logo? The impact of complex visual cues in equity crowdfunding," J. Bus. Ventur., vol. 34, no. 1, pp. 41–62, Jan. 2019, doi: 10.1016/J.JBUSVENT.2018.09.006.

[18] A. A. Yavuz, A. Mudgerikar, A. Singla, I. Papapanagiotou, and E. Bertino, "Real-Time Digital Signatures for Time-Critical Networks," IEEE Trans. Inf. Forensics Secur., vol. 12, no. 11, pp. 2627–2639, Nov. 2017, doi: 10.1109/TIFS.2017.2716911.

[19] M. Memon, B. Lalwani, M. Rathi, Y. Memon, and K. Fatima, "A Framework for Automatic Blood Group Identification and Notification Alert System," Sir Syed Univ. Res. J. Eng. Technol., vol. 13, no. 2, pp. 74–84, Dec. 2023, doi: 10.33317/SSURJ.578.

[20] K. Li, H. Li, H. Hou, K. Li, and Y. Chen, "Proof of Vote: A High-Performance Consensus Protocol Based on Vote Mechanism & Consortium Blockchain," Proc. - 2017 IEEE 19th Intl Conf. High Perform. Comput. Commun. HPCC 2017, 2017 IEEE 15th Intl Conf. Smart City, SmartCity 2017 2017 IEEE 3rd Intl Conf. Data Sci. Syst. DSS 2017, vol. 2018-January, pp. 466–473, Jul. 2017, doi: 10.1109/HPCC-SMARTCITY-DSS.2017.61.

[21] Khan, D., Jung, L.T. and Hashmani, M.A., 2021. Systematic literature review of challenges in blockchain scalability. *Applied Sciences*, *11*(20), p.9372.