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A blockchain based solution to improve loyalty program with NFT in agribusiness

Hossein Hosseinalibeiki¹ , Mohammad Zaree²

¹DISA-MIS Department, University of Salerno, Fisciano 84084, Italy.

²Law Department, University of Salerno, Fisciano 84084, Italy.

Correspondence to: Dr. Hossein Hosseinalibeiki, DISA-MIS Department, University of Salerno, Aula Dei Consigli DISA MIS, Secondo Piano Invariante D1, Università Di Salerno 84084, Italy. E-mail: hhosseinalibeiki@unisa.it

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Abstract

This paper presents the design and preliminary development a new model based on blockchain for improving brand loyalty in agribusiness by customer reward. Using facilities of Ethereum Network and solidity programing, we have created an Agri non-fungible token (NFT) according to ERC-721 protocol that is most widely used protocol for creating NFTs on Ethereum. One of the main advantages of ERC-721 is its flexibility, as it allows developers to define custom metadata for each NFT and customize the attributes. The interaction between Ethereum nodes and the user is established via the frontend, which is developed in Nodejs and connects to the Ethereum network. In previous works on loyalty systems, blockchain-based solutions were proposed that resemble the system developed in this study but there are significant differences between our work and other related works such as: the use of NFT and personalization for customers, the adoption of a new version of Solidity, as well as the adoption of the metadata feature for using media to encourage and assist customer brand awareness and repurchase. We tried to provide a safe and transparent way to use NFTs in the way of increasing brand loyalty in agricultural businesses. Due to characters of NFTs as uniqueness and personalization, customers in a loyalty cycle prefer to shop more in order to earn more AgriNFT, causing retailer to sell more items and manufacturers to generate more goods.

Keywords: Agribusiness, agriculture, blockchain, NFT, non-fungible token, loyalty, brand loyalty

INTRODUCTION

Manufacturers looking for a way to improve brand loyalty among consumers usually apply traditional



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techniques such as: A loyalty program typically issues a card to its members, which may be referred to as a loyalty card, rewards card, point's card, advantage card, or club card. This card serves to identify the cardholder as a member of the loyalty program^[1]. With the advancement of technologies and emerging new technologies, traditional ways are replaced by modern approaches that leverage on personalization of experiences. The implementation of personalization strategies is of utmost importance for businesses as it enables them to establish a distinctive and captivating customer experience, thereby resulting in a surge in customer allegiance and preservation. The implementation of personalization as a business strategy is aimed at achieving a competitive edge by effectively acquiring knowledge about customers, aligning their preferences with available products and services, and providing tailored solutions to meet their unique needs. The implementation of personalization can be advantageous for customers, as it can effectively mitigate disorientation by directing their attention towards options that align with their specific requirements^[2]. The objective of personalization is to enhance customer satisfaction by improving the quality of decisions made, ultimately leading to the development of customer loyalty. When implemented with careful consideration, personalized marketing has the potential to enhance customer value by expanding the scope of the customer relationship^[3]. Personalization refers to the systematic modification of a system with the aim of enhancing its personal relevance^[4]. As an emerging technology, blockchain can enable new forms of personalization through smart contracts that trigger personalized offers or discounts based on specific customer actions or behaviors, creating a seamless and personalized customer experience.

Blockchain has been used in customer loyalty programs, where it is seen as a strong contender for the job of living up to the heightened expectations of loyalty program users while simultaneously improving the system's level of dependability. According to KPMG, One effective approach for introducing tokenization to consumers is by integrating blockchain technology into existing loyalty programs. The company conducted a survey that found 82% of consumers are willing to use tokens as part of the membership of an existing loyalty program, while 81% of respondents stated they would trust the use of tokens more readily if they are already loyalty program participants. This indicates that there is a high level of trust and acceptance among consumers towards tokenization when it is integrated with established loyalty programs. By leveraging this existing trust and loyalty, businesses can effectively introduce tokenization and create a more engaging and rewarding experience for their customers^[5].

In 2015 Kolod, Steffen indicated in agribusiness participation in a customer reward program is associated with increased loyalty, improved financial KPIs, and deeper insights into the client base^[6].

The field of personalized marketing has been characterized by six major themes, as identified in a study that reviewed 383 publications. These themes include personalized suggestion, personalized connection, the customization-privacy paradox, personalized marketing, personalization idea and discourse in marketing, and consumer insights in customized marketing. The study concludes by proposing potential avenues for future research that center on emerging technologies such as artificial intelligence, big data, blockchain technology, the internet of things, and wearables to facilitate customized experiences across both digital and physical channels^[7].

According to various research studies, the efficacy of a loyalty program can be attributed to five distinct components.

1. Cash value of redemption rewards (cash value): tokens are a digital cash value that is determined by the supply and demand of any commodity and is used to store the Blockchain's transaction records. Buyers will do all financial transactions without available cash in a few decades^[8].
2. The range of choice of these rewards (redemption choice): companies that use blockchain technologies

for loyalty networks minimize constraints and inefficiencies while improving the consumer experience with safe and rapid redemption choices^[9].

3. The aspirational value of rewards (aspirational value): there is a rising societal and economic interest in digital assets. The defining characteristics of this new phenomenon are rapid price spikes and considerable volatility^[10].

4. The perceived likelihood of achieving rewards (relevance): the more people that adopt a particular digital asset or tokens, the more likely it is to increase in value and provide rewards to investors. This is because a larger user base increases demand for the currency, which can drive up the price. Users, instead, as in traditional equity finance, may come in early because they expect the token to appreciate in value and reward their investment^[11].

5. The scheme's ease of use (convenience): cryptocurrencies are decentralized, meaning that they are not controlled by any central authority. This can provide greater security and privacy compared to traditional forms of payment, as well as reduce the risk of censorship and interference. Cryptocurrency transactions can often be processed at a lower cost compared to traditional forms of payment, such as credit card transactions. This can be a significant convenience for users who need to send or receive payments frequently. This study examines five key factors of cryptocurrencies, security, bookkeeping and convenience, namely profitability and anonymity^[12].

Non-Fungible Tokens (NFTs) visible a promising prospect within the realm of digital design, as they have emerged specifically to facilitate the secure ownership of digital assets, with certification provided by the Blockchain^[13].

NFT reward is a better degree of security is offered by its uniqueness since it is more difficult to forge or tamper with rewards from loyalty programs. NFTs on the blockchain provide evidence of validity and ownership. There are no questions about who owns something since it is cryptographically protected and verified on the blockchain. Participants may securely redeem awards since they are safeguarded and their ownership is verified.

The Ethereum blockchain is utilized to record transactions related to NFTs, including but not limited to reward issuance, redemption, or transfer. The Ethereum blockchain cryptographically secures the ownership of NFTs, thereby guaranteeing that the rewards can only be accessed and utilized by the legitimate owner. The maintenance of interoperability guarantees the continuity of customer rewards, allowing them to be tracked and utilized across various loyalty programs or platforms.

NFTs in Agribusinesses loyalty programs might provide unique benefits and opportunities.

(1) Agribusinesses demand supply chain transparency and traceability. NFT loyalty programs may reward sustainable and ethical agricultural supporters.

(2) Agribusinesses may issue NFTs for goods from sustainable or ethical farms. This encourages buyers to buy ecologically and socially responsible items.

(3) Agriculture enterprises might provide distinct NFT benefits for agricultural experiences. Farm tours, harvesting, and sustainable farming seminars are examples.

(4) NFTs from local farms encourage buyers to support their communities and economy.

(5) NFTs possess the capability to authenticate agricultural products, thereby guaranteeing their authenticity and provenance. The distinct identifiers embedded within NFTs serve to validate the origins of the associated organic products and ensure adherence to predetermined standards or certifications. The inclusion of this authentication feature facilitates customers in making well-informed decisions and strengthens their allegiance to brands that prioritize the values of genuineness and product integrity.

Through the implementation of the Agri NFT brand loyalty program, agribusinesses have the potential to realize a range of advantages, including heightened levels of customer engagement, greater brand loyalty, the ability to make data-informed decisions, a competitive edge, expanded marketing prospects, and improved sustainability measures.

This study aims to examine the technical viability of integrating NFTs into customer loyalty programs through the analysis of personalized strategies. The utilization of personalization attributes inherent in NFTs holds the promise of elevating levels of customer contentment, augmenting the worth of decisions taken, and ultimately fostering the cultivation of patronage. In the realm of Agribusiness, it is common practice to utilize customer actions or behaviors on NFT as a basis for generating tailored offers or discounts. Specifically, five unique aspects contribute to the success of a loyalty program. These aspects are cash value, redemption options, aspirational value, relevance, and convenience. This paper examines the potential features of NFT technology to improve each of these components and suggests potential directions. The results that were achieved in this paper provide insights into how technical features of non-fungible tokens may be taken advantage of to create more engaging and rewarding customer experiences and promote customer loyalty in the context of loyalty programs.

Comparison with related works

There is a significant amount of literature on blockchain technology, which has emerged as a transformative technology across many industries including agriculture, and the application of this technology to loyalty programs.

The main findings of the article suggest that using NFTs and smart contracts can improve transparency and sustainable conscientious consumer behavior in the Agri-Food Supply Chain. Overall, the use of NFTs and smart contracts in the Agri-Food Supply Chain can improve transparency and trustworthiness^[14].

The article discusses the use of NFTs for rewarding students in education. It highlights that NFTs can be used to establish recognition levels and incentivize students to receive NFT recognition rewards. By automatically processing transaction information and using smart contract technology, educational institutions can reward students with NFTs based on their achievements or progress. This gamification process can enhance student motivation and engagement. However, the article does not provide specific results or findings regarding the effectiveness or impact of using NFTs for rewarding in education^[15].

The article suggests that using NFTs in marketing can positively impact brand loyalty. The study found that consumers perceive benefits in owning branded NFTs, such as the potential for appreciation over time and the ability to earn from selling NFTs. Additionally, the research indicates that social comparison tendencies can influence consumers' responses to NFT marketing. Individuals who are more prone to social comparison are more likely to perceive branded NFTs as exclusive and valuable, leading to more positive experiential evaluations, increased willingness to purchase branded NFTs, and ultimately, enhanced brand loyalty. The study emphasizes the importance of considering psychological motivations, such as social comparison and perceived financial values, when crafting NFT marketing campaigns to entice consumers and build loyalty^[16].

Bext360 employs artificial intelligence and Blockchain technology to eliminate intermediaries from the coffee supply chain, thereby facilitating discernible enhancements for regional producers. Artificial intelligence (AI) devices are utilized to evaluate the quality and provenance of coffee beans. Subsequently, the corresponding data is uploaded onto the Blockchain, thereby tokenizing the coffee. This process enables

prompt payments to be made to the producers. The coffee, which has undergone a certification process to ensure its quality, is subsequently monitored via Bext360's Software-as-a-Service (SaaS) platform during its entire journey^[17].

Tinlake is a platform that facilitates the provision of loans to stakeholders, including farmers, processors, marketers, and handlers. These loans are secured against non-fungible assets, such as financial documents, invoices, or agreements with buyers. The recently generated asset is depicted on the blockchain in the form of a NFT. The utilization of stable coins, such as DAI, which is a token pegged to the US dollar, allows producers to obtain loans. The aforementioned feature facilitates prompt lending through smart contracts and endorses a novel open-source resolution for the financial progression in supply chains^[17].

However, to achieve widespread adoption of blockchain technology in agriculture, it is necessary to overcome technical and regulatory challenges^[18]. NFTs can be a valuable blockchain application for representing digital asset ownership in agribusiness and have the potential to enhance supply chain transparency and traceability^[19]. Moreover, customer reward programs and other loyalty programs have been shown to be effective in increasing customer retention and the concept of loyalty within the retail sector^[20]. Overall, the integration of blockchain technology and other innovative applications has the potential to transform the agriculture and food industry by increasing efficiency, transparency, and sustainability.

As regards loyalty programs, blockchain technology presents several applications. In^[21], a blockchain-based loyalty system termed BCOIP for issuing and redeeming reward points was presented. This system connects a number of enterprises into a consortium and produces electronic reward points that are easier to acquire and able to circulate throughout the consortium. This project focuses on implementing brand loyalty using Ethereum smart contracts^[22]. Proposes the use of blockchain technology in the implementation of a loyalty program. The proposed loyalty program using blockchain involves the creation of a smart contract that defines the rules of the program and enables automated execution. The program uses a token system where customers can earn tokens for their loyalty and use them to redeem rewards.

NFTs, which were created specifically to govern the ownership of digital assets in a safe way verified by the Blockchain, provide a fantastic potential for the field of digital design^[23].

We found that most of the proposed loyalty programs use fungible tokens. However, it is possible that tokens will not give consumers the feeling of a customized personalization experience. It's possible for customers to have the impression that they are nothing more than a number in a rewards program, rather than being respected and acknowledged for their distinct brand devotion, but by using features of NFT we can improve the personalization experience for customers.

NFTs are a type of digital asset that is often built on blockchain technology, which is the same technology that powers cryptocurrencies like Bitcoin and Ethereum. However, NFTs are not considered cryptocurrencies themselves. Cryptocurrencies are digital currencies that are designed to be used as a medium of exchange, while NFTs are unique digital assets that represent ownership of a specific digital asset. In other words, cryptocurrencies are fungible, meaning that each unit is interchangeable with another unit of the same value. NFTs, on the other hand, are non-fungible, meaning that each one is unique and cannot be replaced or exchanged for another NFT with the same value. NFTs are aesthetically beautiful, hyper-interactive, and make intuitive sense to consumers. Hence, NFTs may serve as entry points for Web adoption as technology becomes more affordable and more people are attracted to the domain^[24,25].

NFTs can't be split up because they represent a single asset with its own set of features. In particular, one of the main benefits of using NFT in the loyalty program is that it makes it easy to accurately represent and track unique points. This one-of-a-kind token standard and smart contracts for customizable items are safe from theft, loss, and other types of fraud. By using a system of non-transferable tokens instead of paper documents, NFT loyalty program development makes it possible to track the user's points, eliminating the possibility of fraud and eliminating a common source of loyalty program failure. Large investors and company builders are drawn to NFT because of the safety and openness it promises in a decentralized setting. In this article we proposed a model based on NFT model for Improving brand loyalty by customer reward based on blockchain and NFT in agribusiness.

Given the advantages of NFT, the model we present in this paper has the following three distinctive features compared with related works:

- (1) It can be included in discounts or bonuses for buyers, and producers can add a behind-the-scenes of production, diverse product photos, or any other personalization for consumers as meta data.
- (2) It does not have to further dilute its token supply by giving away high yields to stakes.
- (3) With our model, each company's NFTs might have the same or a different value, allowing us to create distinct redemption values.

The model

Figure 1 shows the model proposed to improve brand loyalty in customer experiences. The model foresees the following steps to enhance loyalty brands:

- (1) Retailers record consumer personal information (it can be unnecessary) and Ethereum wallet address in a Customer Relationship Management (CRM) system.
- (2) Producers makes NFTs in the Ethereum network and retain their NFTs in producer wallet address.
- (3,4) Transfer NFT between consumer and producer will record in a Database (such as BigchainDB, explained in the following).
- (5) As well as consumer can sell their NFT on the secondary market.

The model utilizes the Ethereum Network to create NFTs that can be used as part of a loyalty system. The NFTs can be produced by the loyalty system initiator and provided to consumers. Consumers have the option to either sell the NFTs on the secondary market or keep them in the loyalty system to redeem them for various products.

To obtain an NFT, consumers provide their information to the CRM system when making a purchase from a retailer or supplier. This information may include a unique Ethereum wallet address, which is essential for receiving the NFT. Ethereum wallets are software programs that allow users to store, manage, and interact with Ethereum and other tokens on the Ethereum network. These wallets offer a unique public key that can be used to transfer and receive tokens.

In AgriNFT with using NFT features possess the capability to authenticate agricultural products, thereby guaranteeing their authenticity and provenance. The distinct identifiers embedded within NFTs serve to validate the origins of the associated organic products and ensure adherence to predetermined standards or certifications. The inclusion of this authentication feature facilitates customers in making well-informed decisions and strengthens their allegiance to brands that prioritize the values of genuineness and product integrity.

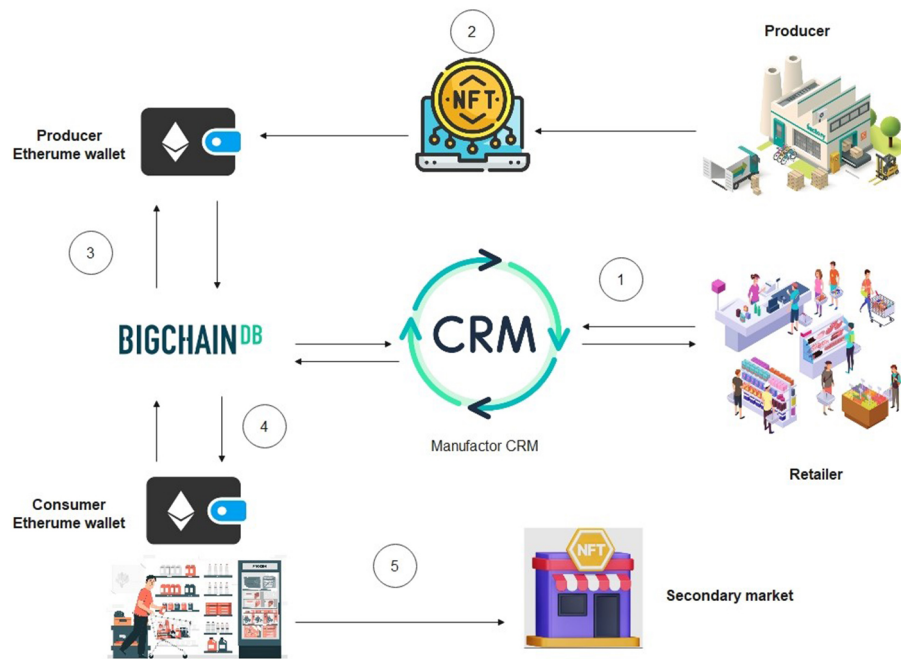


Figure 1. Proposed model for improving brand loyalty according to NFT. CRM: Customer relationship management; NFT: non-fungible token.

In our proposed model personalization plays a crucial role in the Agri NFT model to enhance customer satisfaction and loyalty. By leveraging customer data and activities (such as CRM data and loyalty points), personalized NFTs can be generated for customers. These personalized NFTs can offer unique benefits or experiences tailored to individual preferences and behaviors. By providing customized rewards and experiences, the model deepens the connection between the brand and customers, fostering loyalty and satisfaction.

There are various types of Ethereum wallets, including desktop, mobile, online, and hardware wallets, each with its own security, accessibility, and convenience benefits and drawbacks. Some popular Ethereum wallets are MyEtherWallet, MetaMask, Ledger Nano S, and Trezor. When choosing an Ethereum wallet, it is crucial to consider factors such as security, usability, and interoperability with other Ethereum-based apps and services. Instead of carrying multiple loyalty cards from different companies, consumers can use their Ethereum wallet address to receive NFTs from each company.

Figure 2 shows that the members of the loyalty systems can have their own wallets, and they are able to store their non-financial tokens in the same wallet. It is clear from looking at the figure that the user was given a NFT by Agrinft as a reward for their efforts. Every NFT can have its own one-of-a-kind metadata, which consists of information about the manufacturer, product, and services that the customer needs to know. In the following section, we will take a deeper look at metadata and will show how we can use that for improving brand loyalty.

In our model, we employ BigchainDB for a portion of the CRM database, particularly for NFT ownership and redemption. This may be useful for the manufacturer when they want to redeem the NFT or transfer it to another customer. Likewise, BigchainDB may be used to keep on the blockchain a record of NFT ownership, transactions, and redemptions. This allows for the safe and transparent tracking of the

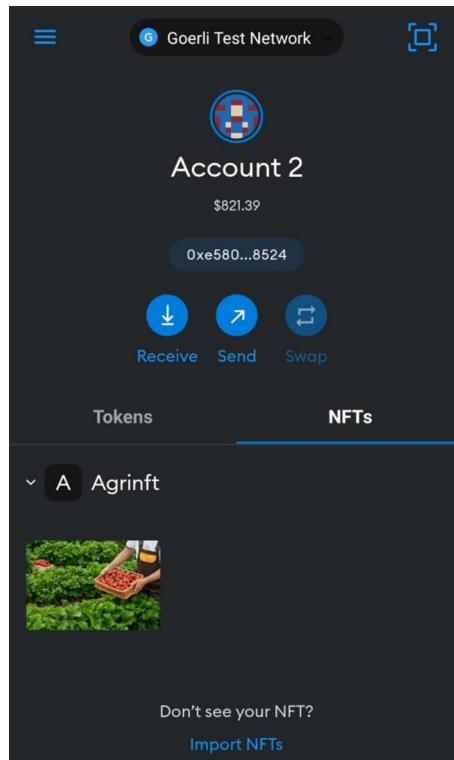


Figure 2. Metamask Ethereum wallet. NFT: Non-fungible token.

ownership and transfer of NFT awards, as well as their redemption. BigchainDB exhibits characteristics similar to those of a blockchain database due to its ability to handle large amounts of data, minimal delay, robust query capabilities, decentralized governance, unalterable data storage, and asset facilitation. BigchainDB facilitates the creation of blockchain-based proofs-of-concept, platforms, and applications for various industries and use cases by utilizing a blockchain database. It is a tool that is available to both developers and businesses^[26].

METHODS

Enrollment: Customers first need to enroll in the loyalty program in CRM system by retailer. During the enrollment process, customers provide their basic information and consent to participate in the loyalty program.

Transaction activities: upon enrollment, clients commence the accumulation of Agri NFTs via their transactional undertakings. The aforementioned activities encompass procuring agricultural commodities, availing farming-related services, or taking part in agribusiness gatherings. The loyalty program monitors the aforementioned activities and dispenses Agri NFTs as incentives in accordance with predetermined regulations and standards.

Reward calculation: The loyalty scheme ascertains the quantity of Agri NFTs obtained by patrons through the consideration of variables such as transactional value, frequency of interaction, or targeted promotional activities. As an illustration, a consumer may acquire a specific quantity of Agri NFTs in exchange for each dollar expended on agricultural commodities or participation in agricultural seminars.

Agri NFT issuance: Upon earning the Agri NFTs, they are subsequently issued to the customer’s digital wallet that is linked to their loyalty program account. NFTs are created through the process of minting on the Ethereum blockchain, thereby endowing them with distinctive characteristics and ensuring their resistance to tampering. Every Agri NFT symbolizes a distinct incentive or advantage that can be subsequently exchanged by the consumer.

Tracking and transparency: The loyalty program tracks and records the issuance of Agri NFTs on the Ethereum blockchain, ensuring transparency and traceability. Customers can view their Agri NFTs in their digital wallet and verify their ownership and authenticity through the blockchain.

Redemption options: Customers have various options for redeeming their Agri NFTs. These options can include exchanging the NFTs for discounts on future purchases, accessing exclusive agribusiness content or events, participating in special promotions, or even using the NFTs to gain voting rights in certain agribusiness decisions. The redemption options depend on the specific rewards and benefits associated with each Agri NFT.

NFT transferability: In some cases, customers may have the option to transfer or trade their Agri NFTs with other participants in the loyalty program or even with external NFT marketplaces. This transferability provides additional flexibility and value to customers, allowing them to utilize their rewards in a way that best suits their preferences.

The loyalty program’s mechanism of acquiring Agri NFTs serves as a motivating factor for customers to actively participate in agribusiness activities, fosters customer loyalty, and acknowledges their engagement through rewards. The utilization of NFT technology and the Ethereum blockchain by the program guarantees the authenticity, safety, and distinctiveness of customer incentives, thereby augmenting the customer experience holistically.

To clarify the mechanism of our proposed model in Figure 1, Figure 3 shows a sequence diagram showing the function calls and events considered, and Figure 4 shows the prototype and mechanism of Agrinfnt.

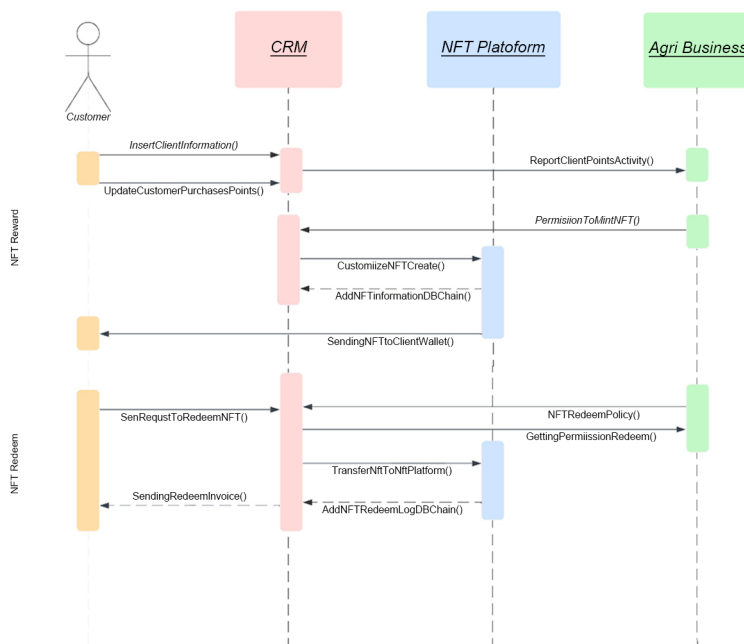


Figure 3. Sequence diagram showing the function calls and events considering. CRM: Customer relationship management; NFT: non-fungible token.

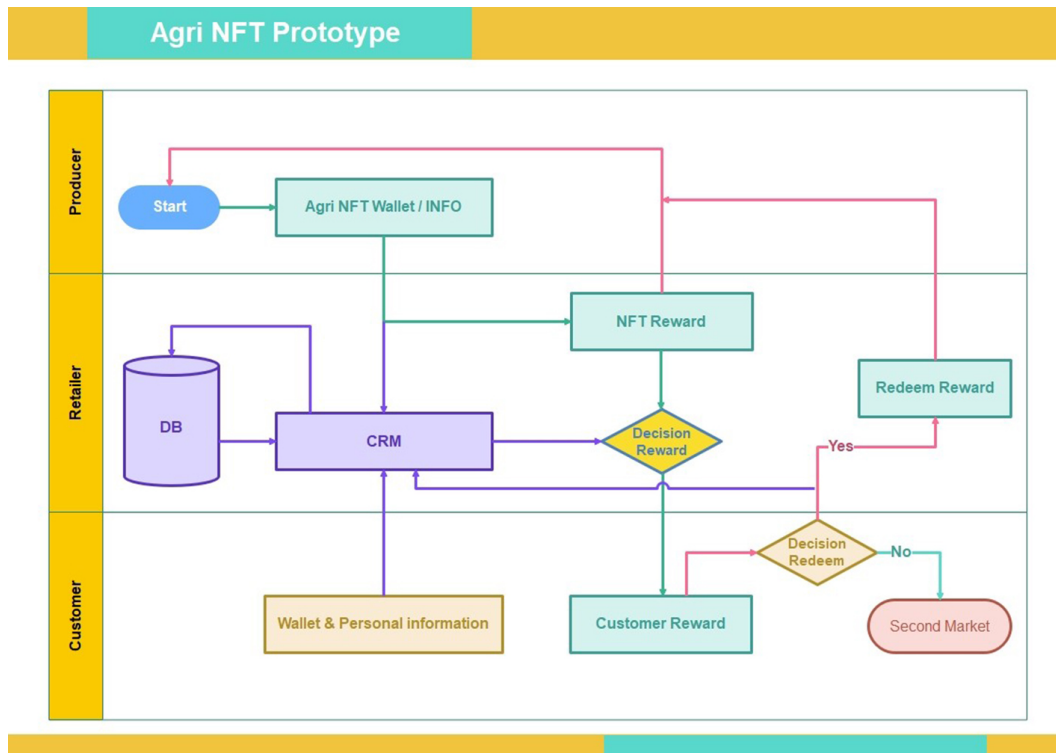


Figure 4. Agrifnt prototype and mechanism. CRM: Customer relationship management; NFT: non-fungible token.

RESULTS

A preliminary implementation

The preceding section expounded on the model’s implementation in a preliminary prototype aimed at assessing the benefits associated with the integration of blockchain and NFTs.

Ethereum is a blockchain-based platform that supports the creation and use of NFTs through several different protocols:

- ERC-721 is the most widely used protocol for creating NFTs on Ethereum. This protocol allows for the creation of unique, one-of-a-kind tokens that can represent anything from digital art to collectibles. One of the main advantages of ERC-721 is its flexibility, as it allows developers to define custom metadata for each NFT and customize its attributes.
- ERC-1155: ERC-1155 is a newer protocol that allows for the creation of both fungible and non-fungible tokens on the same contract. This means that developers can create collections of NFTs with different attributes and properties, as well as fungible tokens that can be used for rewards or other purposes. One of the main advantages of ERC-1155 is its efficiency, as it reduces gas costs and improves scalability.
- ERC-998: ERC-998 is a protocol that allows for the creation of “composable” NFTs, which can be combined with other NFTs or fungible tokens to create new, more complex assets. This protocol enables developers to create more dynamic and interactive experiences for users, such as games or virtual worlds. One of the main advantages of ERC-998 is its flexibility, as it allows for the creation of complex and customizable asset structures.

· ERC-20: ERC-20 is a protocol that is primarily used for creating fungible tokens, but it can also be used for creating NFTs that represent fractional ownership of a particular asset or collection. This can be useful for creating investment opportunities or other financial instruments. One of the main advantages of ERC-20 is its interoperability, as it can be easily integrated with other Ethereum-based protocols and applications.

· We are choosing ERC-721 for implementing this project, This NFT is written by solidity ^0.8.17 programming language for creating and managing NFTs.

Also, we are using OpenZeppelin, which is a library of reusable smart contract components for building decentralized applications (dApps) on the Ethereum blockchain. The library provides a set of secure and audited smart contracts that developers can use as building blocks to create their own dApps.

The OpenZeppelin library includes contracts for token standards such as ERC20 (fungible tokens), ERC721 (non-fungible tokens), and ERC777 (improved fungible tokens), as well as contracts for access control, ownership, payment splitting, and other common dApp functionalities. The library is open source and can be used by anyone to build and deploy smart contracts on the Ethereum blockchain.

The OpenZeppelin library is widely used by developers and has a strong community of contributors who help to maintain and improve the codebase. The library is also frequently audited by security experts to ensure that the contracts are secure and free from vulnerabilities.

In general, the OpenZeppelin library constitutes a significant asset for developers seeking to construct dependable and impregnable dApps on the Ethereum blockchain. It has emerged as a crucial instrument in the Ethereum developer community. OpenZeppelin is a leading provider of cybersecurity technology and services in the field of cryptocurrency. Numerous widely used DeFi and NFT projects hold it in high regard and depend on it^[27].

The utilization of Solidity and ERC 721 in the development of smart contracts on the Ethereum blockchain will now be analyzed. Let us proceed with a detailed examination of the code:

[Figure 5](#) provides the specification of the required Solidity version for the contract. Additionally, the code incorporates essential contracts from the OpenZeppelin library, such as ERC721URIStorage, Counters, and Ownable.

As you can see in the [Figure 6](#), Declared as deriving from Ownable and ERC721URIStorage, the Agrinft contract. To maintain NFT token IDs, it also makes use of the Counters library. The constructor specifies the ERC721 token's name ("Agrinft") and symbol ("NFT") as well as the contract's initialization parameters.

The contract owner may mint fresh NFTs by using the mintNFT function in [Figure 7](#). It requires two parameters: the URI (metadata URI) of the token and the address of the receiver. The function sets the recipient's token URI, increases the token ID, and creates a new token for them. The ID of the just created NFT is then returned.

The metadata JSON in an NFT is a file containing information about the token that enables us to personalize loyalty programs, such as its name, symbol, description, and image [[Figure 8](#)]. This metadata is stored on the blockchain as a URI (Uniform Resource Identifier), which is essentially a link to the JSON file.

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.17;

import "@openzeppelin/contracts/token/ERC721/extensions/ERC721URIStorage.sol"
import "@openzeppelin/contracts/utils/Counters.sol";
import "@openzeppelin/contracts/access/Ownable.sol";
```

Figure 5. Necessary OpenZeppelin libraries.

```
contract Agrinft is ERC721URIStorage, Ownable {
    using Counters for Counters.Counter;
    Counters.Counter private _tokenIds;

    constructor() ERC721("Agrinft", "NFT") {}
```

Figure 6. Agrinft Contract.

```
function mintNFT(address recipient, string memory tokenURI)
    public
    onlyOwner
    returns (uint256)
{
    _tokenIds.increment();

    uint256 newItemId = _tokenIds.current();
    _mint(recipient, newItemId);
    _setTokenURI(newItemId, tokenURI);

    return newItemId;
}
```

Figure 7. MintNFT. NFT: Non-fungible token.

```
1  {
2      "attributes": [ {
3          "trait_type": "Product",
4          "value": "Strawberry Jam"
5      }, {
6          "trait_type": "Producer",
7          "value": "AgriBusiness company"
8      } ],
9      "description": "NFT for Brand loyalty",
10     "image": "https://gateway.pinata.cloud/ipfs/QmPQc3muETvCRk3jLTbbZipn8qtukDz4wf9Cui2RnyuB6",
11     "name": "Hossein Hosseinlibei"
12 }
```

Figure 8. Meta data for NFT. NFT: Non-fungible token.

The metadata JSON file follows a standardized format that is defined by the ERC-721 and ERC-1155 token standards. The format includes several fields that describe the NFT including (see Figures 3-8 for an examples):

- attributes: an array of attributes that describe the NFT, including a “Product” trait with the value “Strawberry Jam” and a “Producer” trait with the value “AgriBusiness company”.
- description: a description of the NFT.
- image: a link to the image that represents the NFT.
- name: the name of the NFT.

The metadata JSON file allows NFTs to be displayed and traded on marketplaces and other platforms in a standardized way. When someone buys or views an NFT, the platform retrieves the metadata from the blockchain using the token's URI and uses that information to display the NFT in a user-friendly way.

Overall, the metadata JSON is an important part of the NFT standard and provides a way for NFTs to be easily displayed, traded, and understood by users and applications alike.

We compiled NFT with using Deploy.js. The script typically contains code that initializes a web3 provider, compiles the smart contract code, and deploys the contract to the blockchain. This is a script written in JavaScript that uses the ethers.js library to deploy a smart contract named Agrinft to a blockchain network.

In summary, this script deploys an instance of the Agrinft smart contract to a blockchain network using the ethers.js library.

The NFT is shown in Etherscan in [Figure 9](#). Etherscan is a blockchain explorer that enables users to see and search for Ethereum blockchain transactions and data. Although it is mostly used for monitoring transactions involving Ether (ETH) and other ERC-20 tokens, users may also examine transactions using NFTs generated on the Ethereum network. Etherscan allows users to view the transactions related to the creation, ownership, and transfer of NFTs, including their ownership history and current owner. Users may track the value and ownership of their NFTs, watch market trends, and verify the validity and ownership of NFTs they are interested in purchasing or selling by using Etherscan to observe NFT transactions^[28].

DISCUSSION

Our model has the main objective of providing benefits to the suppliers, and consumers. Throughout the preliminary prototype implementation, the producer generates the NFT and distributes NFT to consumer that buy their products them. When clients buy goods or services, retailer record their data in CRM system. This feature enables users to use their earned incentives as they like. So, the user may utilize the collected NFT to pay for future purchases.

According to our research, the majority of loyalty programs make use of fungible tokens. On the other hand, tokens might not give customers the impression that they are taking part in a personalized experience. It's easy for consumers to have the sense that they're nothing more than a number in a rewards program, rather than being appreciated and acknowledged for their unique brand loyalty. This isn't the case, but it might give customers the wrong impression.

(1) Our research solution can provide visual interaction between agribusiness and consumers. This feature allow producer with taking professional photo of production line, visual images of the farms, behind the sense of producing, natural and fresh ingredients, and mint these pictures in their NFT and rewarding attractive NFT to loyal consumers. This strategy helps agribusiness demonstrate trustworthiness and competitive advantages about their products.

(2) Our model creates an opportunity for agribusiness to integrate their CRM strategy with the proposed Mint NFT, which is not mentioned in other works. This feature evolves their CRM toward increasing brand loyalty through personalized customer reward.it helps agribusiness to provide personalized reward for consumer such as special NFT with creative photo for congratulating birthday and membership anniversaries or appreciating their loyalty to their brand. This feature makes a good scene for consumers, increasing their motivation to repurchase products.

(3) In other works that provide the fungible tokens in loyalty programs, there are significant gaps such as:

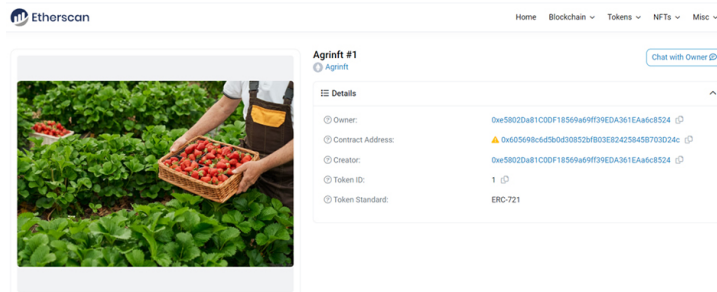


Figure 9. Agrifnt in Etherscan.

There is also a lack of personalization of fungible tokens.

All fungible tokens have the same value, which can limit the creativity of the branding team, but in each NFT, the branding and marketing team can determine the value of the NFT during the redemption process.

(4) Different types of loyalty programs that use fungible tokens require significant investment and burn tokens to maintain token value in secondary market, whereas NFT can sell and buy with a unique price in secondary market by consumer and this feature encourages them to participate in loyalty programs.

Overall, our model gives to agribusiness a new perspective so that they can use the feature of personalization and visual environment of NFT for improving and reinforcement brand loyalty.

By implementing a loyalty program with Agri NFT rewards, retailers can drive customer engagement and incentivize repeat purchases. When customers earn Agri NFTs through their transactions, they are motivated to continue buying from the retailer to accumulate more rewards. This increased customer loyalty and repeat business can lead to higher sales volumes for retailers, positively impacting their revenue and bottom line.

Agri NFTs (Non-Fungible Tokens) developed utilizing the ERC-721 protocol have a number of individualized and customizable characteristics and properties that add to their value and distinctiveness.

(1) Metadata: This metadata may contain crop kind, agricultural techniques, location, yield, farming practices, certifications, and other features. One of the important part of NFT loyalty system focuses on using metadata to provide detailed information on the goods, services, or experiences connected to the brand including in-depth explanations, specs, use guidelines, and customer feedback. Our goal is to provide consumers with a distinctive, atmosphere about products to improve awareness, which deepens their bond with the brand and ultimately promotes advocacy and long-term loyalty.

(2) Imagery: Agri NFTs may include photos or drawings of agricultural assets. These photos may be edited to showcase the asset's unique aspects, such as the crop's development, traits, or agricultural location. Visual components may boost Agri NFT appeal.

(3) Token Name and Description: An Agri NFT's name and description might reflect its unique qualities or stories. Designers may highlight the NFT's unique traits, history, and other relevant information.

Ensuring quality assurance is a vital aspect within the realm of agriculture, necessitating strict adherence to rigorous standards. NFTs have the potential to establish a connection with quality control procedures and certifications. As an example, a NFT linked to an organic product has the capacity to authenticate its compliance with organic standards. This feature offers a transparent and verifiable documentation of compliance with established quality standards, instilling confidence in customers and strengthening their commitment to the brand.

The use of NFTs has the potential to facilitate the provision of authenticated data on the whole trajectory of a product, spanning from its origin at the farm to its ultimate destination on the table. This capacity holds promise in the restoration and fortification of consumer confidence in the supply chain. When customers possess a high level of trust in the reliability and transparency of the supply chain, they are inclined to exhibit brand loyalty towards companies that use blockchain and NFT technologies.

NFTs has the potential to serve as a mechanism for incentivizing and promoting ecologically and socially acceptable behaviors within the realm of agriculture. As an example, tokens may be allocated to goods that are manufactured using sustainable and environmentally conscious practices or procured from nearby agricultural enterprises, so fostering conscientious and sustainable patterns of consumption.

Loyalty programs within the agricultural sector often center on the provision of discounts or prizes as incentives for customers to make recurring purchases. NFTs have the potential to develop novel and captivating loyalty programs. For example, patrons have the opportunity to acquire NFT-based “badges” or collectible tokens as a reward for endorsing certain farming methodologies or engaging in transactions during designated periods. The aforementioned tokens possess the capacity to be exchanged for distinctive merchandise or experiences, therefore establishing a novel degree of client involvement and allegiance.

NFTs have the potential to contribute to the enforcement of both local and international legislation pertaining to goods. By establishing a connection between the pertinent regulatory data and NFTs, agriculture enterprises may expeditiously showcase adherence to regulations and instill customer confidence in the safety and excellence of their merchandise.

The integration of NFTs inside loyalty programs in the agricultural sector presents a potentially advantageous resolution to the unique issues faced by the industry. They enhance trust, transparency, and sustainability while reconfiguring loyalty programs to actively involve customers in novel and stimulating manners. Through the use of blockchain and NFT technology, agricultural enterprises have the potential to effectively tackle the distinct challenges present in the sector. Moreover, this technological integration may foster enhanced brand loyalty and customer trust, therefore contributing to the development of a more sustainable and competitive agribusiness environment.

These features contribute to enhancing brand loyalty in agribusiness includes of:

- (1) Unique Brand Identity: Uniqueness helps buyers remember them. When people associate a brand with a unique NFT, customers become more loyal.
- (2) Transparency and Traceability: Agri NFTs may provide clear and traceable information about the agricultural assets they represent.
- (3) Storytelling and Consumer Engagement: In order to offer tales about agricultural practices, environmental stewardship, community impact, or cultural history, brands may make use of unique information and visual components.
- (4) Pecial perks and prizes: Agri NFTs may be created to provide holders of NFTs special perks and prizes.

Minting and transmitting NFTs need more gas than simpler transactions. To estimate gas costs for an agribusiness loyalty program, the following factors should be considered:

- (1) Frequency and Complexity of Transactions: determining gas expenses for farm businesses requires determining typical workload and transaction frequency.
- (2) Smart Contract Design: Gas prices depend on the loyalty program’s smart contracts design.

Blockchain developers or specialists may assess the needs and design of an agricultural company loyalty program to estimate gas prices more accurately. They may assist estimate gas expenditures by optimizing gas prices and simulating gas use depending on workload.

There are solutions may help improve transaction speed, network congestion, and gas prices for program consists of:

Layer 2 Scaling Solutions: Sidechains may improve Ethereum transaction velocity and reduce network congestion. Off-chain processing allows transactions while protecting the Ethereum network.

Gas Optimization: Gas costs may be reduced by optimizing loyalty program smart contracts and transaction logic for gas. This requires careful code assessment, minimization of unnecessary calculations or storage, and transaction parameter improvement.

Off-Peak Processing: Off-peak transactions reduce network congestion and gas costs. Enterprises may cut transaction processing time and costs by strategically scheduling loyalty program activity during low network demand. This strategy reduces traffic congestion's impact on end-users.

The ERC721 token has been selected for implementation in the current project due to its established effectiveness and widespread adoption. However, for the commercial version, we recommend the utilization of ERC-1155 due to its potential advantages for these reasons:

- (1) Batch Transfers: ERC-1155 batch transfers might reduce network congestion and gas expenditures by 90%. ERC-721 requires transactions for each NFT, which slows down and increases gas costs. Ethereum transactions need gas expenses.
- (2) Transaction Security: ERC-1155's transfer security feature provides hassle-free transactions and token recovery by the issuer. Asset security comprises recording a token's lifespan from minting to burning.

The adoption of a new Solidity version and leveraging metadata for media contribute to the effectiveness and uniqueness of a blockchain-based model by providing enhanced functionality, compatibility, expanded metadata capabilities, customizability, personalization, and improved discoverability.

As technical note, we try to provide you with insights on how the use of Agri NFT in brand loyalty programs can contribute to the broader field of blockchain applications in improving customer loyalty and engagement. Businesses can improve customer experience and brand loyalty by offering individualized digital incentives using blockchain technology and NFTs. Agri NFTs enable consumers to own their incentives. NFTs are unique digital assets clients may accumulate, trade, and redeem for special rewards.

Personalization, Blockchain-based loyalty programs may collect consumer activity and preference data. Using blockchain and NFTs might enable data-driven personalization, enabling firms to adjust their services and marketing tactics to specific consumers.

CONCLUSION

Today, companies are trying to increase the level of brand loyalty by increasing the trust of customers in their brand. In this direction, especially in agribusiness, offering rewards is one of the ways to increase brand loyalty but with the increasing development of emerging technologies such as blockchain, solutions can be provided so that customers can receive their rewards in a completely safe and transparent

environment. NFTs have been rapidly expanding, personalize and being used by business owners since their introduction. In this article, we tried to provide a safe and transparent way to use NFTs in the way of increasing brand loyalty in agricultural businesses. Today, brands try to increase the level of brand loyalty by increasing the trust of customers in their brand.

This research reinterprets loyalty programs using NFT. The suggested system includes a maker of NFT to validate purchases and awards, merchants or service providers to provide these NFT to consumers, and loyalty system users, who are customers. The maker may mint NFT or hire a separate NFT manufacturer (minter).

The deployed system operates on the Ethereum blockchain and NFT were developed using the Solidity programming language. The interaction between Ethereum nodes and the user is established via the frontend, which is developed in Nodejs and connects to the Ethereum network using Deploy.js. Also we are using Pinata for storing media in IPFS.

The utilization of Node.js for frontend development is of significant importance in facilitating the establishment of communication between Ethereum nodes and users. This technology facilitates the development of interfaces that are easy for users to navigate, allows for seamless integration with Ethereum wallets, manages user interactions, provides real-time updates, enables integration with backend systems, and supports the deployment and hosting of dApps. These capabilities facilitate the smooth incorporation of Ethereum functionality into the user experience, enabling users to engage with the blockchain.

Due to the expense of migrating and operating the NFT, our proposed system described in this research is presently unavailable on the main net and we used Goerli subtraction. Goerli is a cross-client Ethereum test network that is used for testing and experimentation purposes. It is one of several Ethereum test networks^[29]. If firms fund the suggested loyalty system, it may be migrated to the main network in the future. Because to the NFT's high flexibility, new features may be introduced in response to demands from businesses, and the structure can be expanded.

There is growing interest in exploring the potential of NFTs in brand loyalty in agribusiness and future work NFTs have the potential to revolutionize the way brands think about loyalty programs, product authenticity, limited edition merchandise, gamification, and future work. As consumers become more interested in digital ownership and unique experiences, brands will need to adapt and incorporate NFTs into their strategies to meet these expectations.

Integration with existing CRM systems can provide a holistic view of customer interactions, allowing businesses to streamline their customer management processes. Connecting the loyalty program with CRM systems enables better customer segmentation, personalized marketing campaigns, and more targeted loyalty rewards.

The future development and expansion of the system involve integrating with CRM systems, fostering interoperability, extending applicability to other industries, and leveraging technological advancements for a more robust and efficient loyalty experience.

There are scalability considerations or potential limitations in implementing your blockchain-based loyalty system on the Ethereum network includes of: Network Congestion, Transaction Throughput, NFT Storage Costs, User Experience, Environmental Impact.

Implementing a blockchain-based loyalty program can come with certain challenges and risks that need to be addressed. Additionally, there are regulatory and legal considerations related to the use of NFTs and blockchain technology in loyalty programs. Here are some potential challenges and ways to mitigate them, along with regulatory considerations:

User Adoption and Education: Educating clients about blockchain and NFTs is a difficulty. Clear explanations, tutorials, and assistance may aid people who are unfamiliar with these topics. UX design should be simple.

Technical Complexity: A blockchain-based loyalty scheme demands technical skills. It may need smart contracts, blockchain integration, and system security. Expert blockchain developers and consultants may assist with technical issues and implementation.

Scalability and Network Congestion: Scalability issues in blockchain networks like Ethereum may cause network congestion and slower transaction times during high use. Scalability solutions like layer 2 protocols, optimizing gas utilization, and keeping up with blockchain advancements may help.

Regulatory Compliance: NFT and blockchain loyalty schemes may be regulated. Consumer protection, data privacy, and loyalty program standards must be followed. Legal expertise with blockchain and loyalty program legislation may assist manage these complications.

Volatility and Liquidity: Digital assets like NFTs are volatile and illiquid. Setting explicit redemption processes and giving alternate incentives helps reduce market risk in loyalty program design.

Interoperability and Standards: Interoperability and standardization across blockchain networks and loyalty programs might be difficult. Interoperability industry efforts and standards organizations may reduce these problems and boost cooperation.

we propose some potential stakeholders who could implement such a solution: Agribusiness Companies , Agricultural Cooperatives, Farmers' Markets and Local Food Initiatives, Food Certification Organizations, Agricultural Technology Providers, It is imperative to acknowledge that the effective integration of a loyalty program based on Blockchain technology, incorporating NFTs, within the agribusiness sector necessitates meticulous evaluation of the distinct requirements, assets, and objectives of all parties involved. The establishment of a comprehensive and interoperable loyalty ecosystem can be facilitated through collaboration among various stakeholders.

This article focuses on technical note and using technical features for improving loyalty program with NFT. In future works conducting interviews between agricultural producers and consumers to assess the potential advantages and reception of the loyalty program, it is indeed a valuable approach.

Gathering feedback about using NFT features for improving brand loyalty in Agribusiness from both parties can provide insights into their perspectives, expectations, and potential adoption challenges. These interviews can help refine the loyalty program's design, ensure it aligns with the needs of both producers and consumers, and assess the level of interest and acceptance.

Through the utilization of interviews and surveys, the authors are able to acquire practical perspectives, recognize possible areas of difficulty, and authenticate the practicality and appeal of incorporating the loyalty program via NFTs within the agricultural sector.

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Authors' contributions

Idea, conceptualization and technical study, implementing, and interpretation, writing final manuscript (Introduction, Organizing Comparison with related works, The model, Mechanism, A preliminary implementation, Discussion, Conclusions and future works): Hosseinalibeiki H
Collaboration in collecting comparison with related works: Zaree M

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All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

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