

Agri-Food Traceability System Automatically Generated from Ethereum-Based Smart Contracts

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ABSTRACT

Transparency along the agri-food supply chain is becoming more and more sought for by both consumers and governments. Due to the inherent trust and unchangeability that this technology offers, it is being rapidly used to enable safe traceability for the management of the agri-food chain, provide information about a food product's provenance, and prevent food fraud. It is more difficult to create the appropriate smart contracts for these use cases than it is for those used in other disciplines, though. There have been a number of proposed management systems for the agri-food chain based on blockchain technology and smart contracts, however they are all ad hoc for a particular product or manufacturing process and challenging to generalise. In this work, we provide a novel method for

1.INTRODUCTION

Blockchain technology is a new distributed, decentralized and immutable ledger database that can assure immutability and integrity of data without the need of a third trusted party. This is one of the reasons for which strong expectations exist on this technology to solve problems in sectors in which several untrusted actors have to work together, such as in the case of the agri-food industry. Blockchain technology appeared for the first time in 2008 when one or more developers under the pseudonym Satoshi Nakamoto published a paper on a P2P electronic cash system [1] based on a digital currency called Bitcoin. This

quickly customising and composing generic Ethereum-based smart contracts created for the agri-food industrial domain. This method makes it possible to reuse code and modules, automate the process to reduce development periods, and maintain the security and reliability of the smart contracts. We want to create a system that operates roughly automatically by starting with the design of the real production process and automatically generating both the user interfaces to interact with them and the smart contracts to run the system. To demonstrate the effectiveness of our strategy, we also provide a case study on the production of honey. The approach's scope will initially be expanded to include other supply chains in future development; also, while Ethereum is now the platform in use.

currency is based on a blockchain and does not need any intermediaries or central authority to transfer money from one person to another person. A blockchain is a specific type of distributed database able to store data in a secure and immutable way, and simultaneously to create transparency of the data history. It is based on a technological protocol that enables data to be exchanged with third parties within the P2P network without the need for intermediaries, because participants interact anonymously with encrypted identities, through transactions. Each transaction must be validated by a community of users through a consensus process, and then recorded in the ledger by adding it to an immutable chain of blocks

holding the transactions stored in every network node. Many companies and startups are already adopting, and working on blockchain technology, trying to exploit the any advantages it promises, so we are experiencing a strong growth of ideas and applications.

Several research papers, like [2], [3], [4], [5], [6], just to cite a few, have shown that the use of the blockchain can advantageously help to achieve traceability, by storing data that are non-forgable, and with a certain date. Consequently, companies are trying to adopt this technology in various sectors by harnessing in particular its ability to get transparency in scenarios where numerous untrusted actors are involved. According to Galvez et al. [7] today more than ever, customers are demanding transparency, especially with food. People want to feel secure and to know how a product was farmed or manufactured, and which ingredients are involved in its production. In Europe, food legislation is particularly strict and the implementation of traceability systems are mandatory, but they are unable to fully guarantee consumers against fraud [8]. European Council formally adopted, on 13 June 2019, a new Regulation on the transparency and sustainability of the EU risk assessment in the food chain. According to European Commission and the European Food Safety Authority (EFSA) - a public agency that provides scientific advice and technical support for EU legislation - this new Regulation mainly revises the General Food Law Regulation that provides some procedures relating to food safety. It aims at increasing the transparency of the EU risk assessment in the food chain, maintaining a high level of safety [9]. The food labeling system cannot guarantee food safety and high quality. Therefore, traceability is a tool to assure food safety and quality as well as to achieve consumer condence [10].

In our opinion, innovative methods for traceability systems based on product identification are needed in order to ensure a high level of food safety and fully guarantee consumers against fraud. For these reasons, blockchain is gaining increasing popularity as a technology to enable traceability in a certified and immutable way in the agri-food sector, helping to avoid fraud and counterfeiting by creating an auditable record of the journey from the farm to the fork behind all physical components of the food products.

Some companies have launched pilot or proof of concept projects to implement blockchain technology in a wide range of sectors, but at present many limitations still have to be considered and addressed. Most of the published works concerning the application of blockchain technologies, for example in supply chain management, reported no detailed information about the technical implementation, and there are still few practical uses of blockchain technology. Research on blockchain in many different application areas is going through an exploratory phase, and supply chain management is one of the main areas of interest to be studied in terms of the benefits that would be obtained on the traceability system, such as facilitating food safety and fraud prevention. Clearly, there is a need for structured methods to facilitate and make more efficient the development of applications based on blockchain technology for the management of the traceability of the agri-food supply chain.

2.LITERATURE SURVEY

2.1 A review on blockchain smart contracts in the agri-food industry: Current state, application challenges and future trends

Xiangzhen Peng , Zhiyao Zhao , Xiaoyi Wang , Haisheng Li , Jiping Xu , Xin Zhang

Abstract

With the continuous development of the new crown epidemic and the outbreak of the Russian-Ukrainian war, the world is facing a serious food crisis, especially the agri-food (agricultural and food) crisis. The research of blockchain smart contracts in the agri-food industry has attracted great attention. To judge its trend, this research adopts the methods of bibliometric analysis and content analysis to conduct a comprehensive review and content analysis of the blockchain smart contract research in this industry. A general framework for blockchain smart contract research applied to the agri-food industry is proposed. Firstly, 78 relevant literatures were screened from 6 databases including the web of science and the Derwent Innovations Index for this review. Bibliometrics analyzes previous research from five dimensions, including publication year, document type and publication journal, country, author, and keywords. Secondly, the content analysis identified 4 issues, such as agri-food data storage, agri-food information management and control, agri-food data traceability, and agri-food data rights confirmation. Thirdly, the general framework provides a general research method for blockchain smart contracts. Finally, the advantages, challenges and development trends of blockchain smart contract research in the agri-food industry are discussed. This paper makes a qualitative and quantitative analysis of blockchain smart contracts in the agri-food industry, and clarifies the research status, challenges and development trends. We provide a common framework that contributes to the body of knowledge that will facilitate greater strategic adoption and use of blockchain smart contracts in the agri-food industry.

2.2 Improving Agricultural Product Traceability Using Blockchain

Madiha Shahzad, Academic Editor and Kashif Kashif, Academic Editor

Abstract:

Most traditional agricultural traceability systems are centralized, which could result in the low reliability of traceability results, enterprise privacy data leakage vulnerabilities, and the generation of information islands. To solve the above problems, we propose a trusted agricultural product traceability system based on the Ethereum blockchain in this paper. We designed a dual storage model of “Blockchain+IPFS (Inter SPlanetary File System)” to reduce the storage pressure of the blockchain and realize efficient information queries. Additionally, we propose a data privacy protection solution based on some cryptographic primitives and the Merkle Tree that can avoid enterprise privacy and sensitive data leakage. Furthermore, we implemented the proposed system using the Ethereum blockchain platform and provided the cost, performance, and security analysis, as well as compared it with the existing solutions. The results showed that the proposed system is both efficient and feasible and can meet the practical application requirements.

3.PROPOSED SYSTEM

To sum up, we suggest a novel method for easily customising and composing general Ethereum-based smart contracts (SCs) created for the agri-food industrial domain. This method automates the process to reduce development time while maintaining security and trustworthiness. For the agri-food industrial domain, this is the first attempt that we are aware of to create a semi-automatic configurable system that supports the whole class of supply chains.

How ever the methodology is designated to the agri-food space, it very well may be effortlessly reached out to numerous different sorts of supply chains, where an item, a help, or a shipment is conveyed by gathering and dealing with parts, or potentially goes through various kinds of changes and state changes.

_ The review and advancement of an expanded and worked on broad portrayal of food creation explicitly designated to handle recognizability frameworks utilizing blockchain innovation;

_ The creation of a set of modules that can be easily configured to generate a system for tracking real agri-food supply chains, including general SCs and UI applications;

Additionally, the SCs were examined for gas-saving and security;

_ The improvement of an organized way, beginning from the meaning of the food creation process through predefined tables, to design these modules and to effortlessly produce the last framework likewise by engineers with just restricted information on blockchain innovation;

_ The creation of a novel case study, honey production, to demonstrate the method's effectiveness.

3.1 IMPLEMENTATION

3.1.1 USER

Buys the target good from Retailers. S/he is usually not provided with an address. Users Buying agri products and the services from warehouse who sell agri products online and performs the following operations My Profile, Search Agri Products, Create Account, My Account Details, View All Purchased Agri Products.

3.1.2 WAREHOUSE

Warehouse have sought to sell their products to people who surf online. Before

people buy anything online, get to know the seller people need to know their contact details for a reputable business should make this information easy to find. And also track the product details of customer mostly like, number of users view the product or purchase the product. A reputable business should also have good customer feedback - friends, family or other customers rate them highly and perform some operations like Add Products, View All Agri Products, View Purchased Products.

Warehouse receives, stores, and sends goods. It is able to take ownership of the tokens associated with the target good, or simply to register their storage, leaving the ownership to the original one.

3.1.3 ADMIN

Administers the software system by managing and controlling the reading and writing access to the system by other actors and their permissions. This is a role present in most business process management systems.

Admin will authorize users and Warehouse seller and performs the following operations such as View All Users and Authorize, Add Category, View All Agri Products Categories, View All Agri Products, View All Agri Products By Blockchain, View All Purchased Agri Products By Blockchain, View All Agri Products Price Results, View All Purchased Agri Products Price Results.

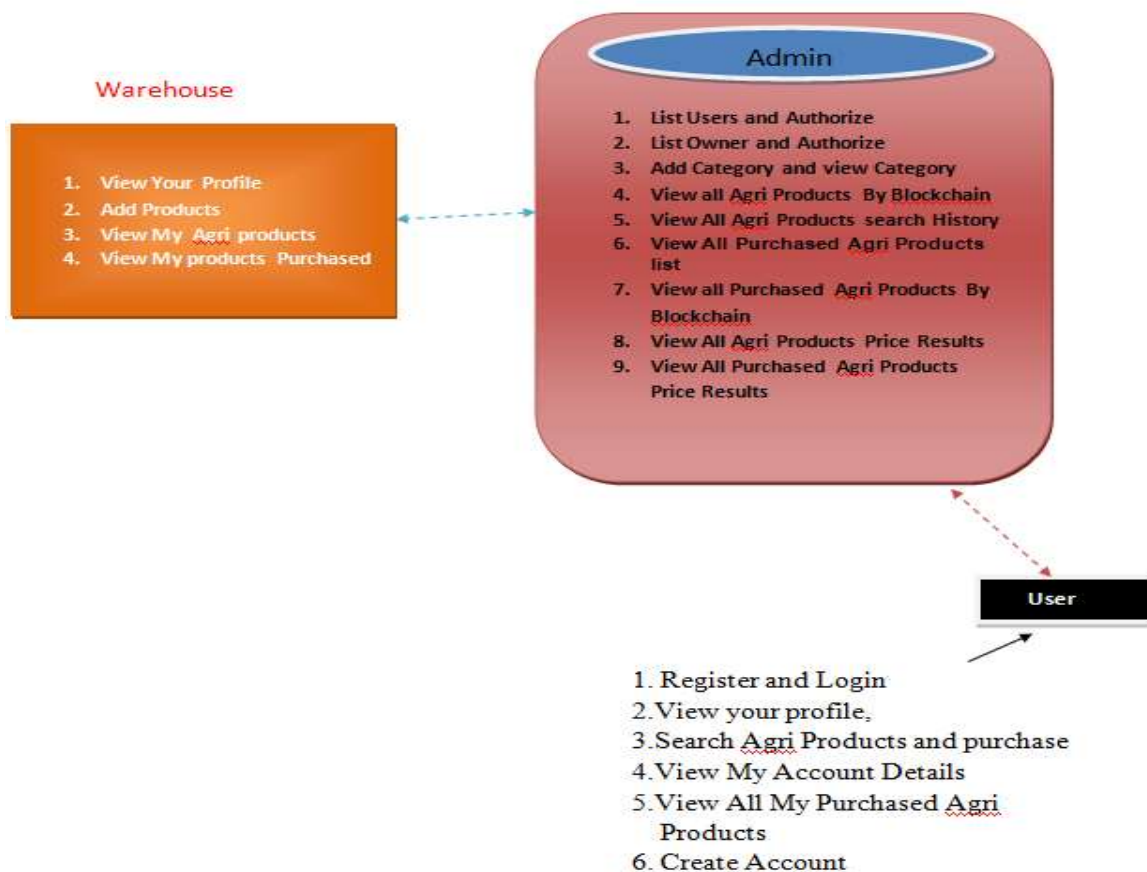


Fig 1: Architecture

4.RESULTS AND DISCUSSION

| Entity | Data storage | Description |
|------------|--|--|
| Apiary | Blockchain, Producer's server | Registration of a production area, and related beehives. It can include photos, maps, and other documents, which are kept on a dedicated server. The recording of this data takes place during the system initialization phase before it enters operations. New data can be added, or data can be modified, at a later time. The blockchain holds links to the data, as well as their hash digest. |
| Honeycomb | Blockchain, possibly Producer's server | Registration of a specific set of honeycombs, harvested from the beehives. It is associated with events that document its harvesting, and which may include pdf files, photos, and other documents, which are kept on a dedicated server. |
| Honey | Blockchain, possibly Producer's or Retailer's server | Registration of a specific batch of honey, extracted from the honeycombs. It is associated with events that document its processing, and which may include pdf files, photos, and other documents, which are kept on a dedicated server. |
| Honey jars | Blockchain, possibly Producer's server | Registration of a batch of packaged honey, in which all jars have the same QR code on the label, allowing product tracing. Here we deal with jars, but in principle, they might be also drums or buckets. |

Table 1: RESULTS AND DISCUSSION

Actors:

| ID | Name of Actor |
|-----|-------------------|
| BEK | Beekeeper |
| APC | Apiary Consortium |
| PRC | Processor |
| CRT | Certifier |
| RET | Retailer |

Producers:

| Name | Description | Products | Enabled Actors |
|--------------------|-----------------------------|-------------------------------|----------------|
| Miele Monte Arcosu | Apiary firm founded in 1949 | AP1;AP2;HCB;HON;J250;J500;HBK | BEK |
| Miele di Sardegna | Honey producer | HON;J250;J500;HBK | PRC |
| Mielizia | Honey retailer | J250;J500;HBK | RET |

Productive resources and Products:

| ID | Name | Description | Quantity | Unit of Measure | Enabled Actors |
|------|--------------------------|--|----------|-----------------|----------------|
| AP1 | Apiary in Place Salighes | Apiary with 85 beehives | 85 | units | BEK |
| AP2 | Apiary in Place Perdixi | Apiary with 145 beehives close to eucalyptus trees | 145 | units | BEK |
| HCB | Honeycombs | Lot of honeycombs | | units | BEK |
| HON | Honey | Batch of honey | | Kg. | PRC |
| J250 | Jars of Honey | Lot of jars of honey (250 gr.) | | units | PRC, RET |
| J500 | Jars of Honey | Lot of jars of honey (500 gr.) | | units | PRC, RET |
| HBK | Buckets of Honey | Bucket of honey (10 Kg.) | | units | PRC, RET |

Fig 2: Productive resources and Products

Figure 2 depicts the information contained in these files for actors, producers, and resources (Productive Resources and Products), for three producers: a beekeeper (Miele Monte Arcosu), a company that packages and distributes honey (Miele di Sardegna), and a retailer of honey (Mielizia). The beekeeper's two apiaries, several intermediate products (honeycombs and raw honey), and finished goods (honey buckets and jars) are the

resources that are discussed. Only apiaries have a set number of beehives, which is determined at system initialization and can be altered using a particular function of the Product SC that is called by the owner of the apiary. Under the restrictions listed in Section III-A4, "Transformation events," the quantities of other goods are determined by the events that give rise to them

5.CONCLUSION

These days, purchasers overall need to be certain that the food they eat is protected and can be dependably followed back to its starting place to give confirmation that what they are purchasing is real and sound. As a result, they are willing to pay for the intangible benefits of secure traceability and country of origin labeling and are demanding the highest levels of food safety throughout the supply chain. Traceability systems are regarded as essential for preventing food supply chain fraud and ensuring a food product's safety. It is fundamental to further develop the ongoing detectability frameworks, as deceitful makers could take advantage of the holes in the frameworks for their

potential benefit and to the disservice of buyers.

Implementing a traceability system in which independent third parties can identify themselves and certify the accuracy of data pertaining to the origin and quality of products is made possible by integrating systems based on blockchain technology and smart contracts with the Internet of Things. Along these lines, the client can be guaranteed of the honesty of the detailed data with a serious level of certainty.

In this specific situation, we proposed a framework empowering engineers to rapidly and easily foster detectability frameworks in the agri-food space, without the need to get a handle on in everything

about details of SC improvement, which is plainly unique in relation to traditional programming advancement. In order to accomplish this, we developed a system that was able to automatically generate both the tracing system's UI and the SCs, and we accurately represented the problem domain, which was found to be suitable for such an approach.

Our methodology begins from the portrayal of the store network to be followed with regards to entertainers, makers, assets and items, occasions, and information. This portrayal is provided utilizing with a bunch of calculation sheet pages, which is a device exceptionally simple to utilize likewise by individuals master in the space, however not in software engineering. The SCs and HTML5 pages that can interact with them and provide the dApp's user interface are generated from these pages, which have been converted to.csv les.

This technique can be utilized at each hub of the inventory network and can catch basic occasions, which are accordingly recorded permanently. Likewise, the entertainers who enrolled the occasions can be related to an exceptionally serious level of sureness. In this way, instead of being created solely by the producer, as is the case with traditional systems, certification for each step of the production process can be audited by reputable third parties, providing a much higher level of confidence in the accuracy of product information.

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