International College of
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Digital Innovation & Financial Technology

ACADEMIC CONFERENCE

PROCEEDINGS

10 JUNE 2023	Saturday 08:30 AM

International College of Digital Innovation, Chiang Mai University

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Book of Full Paper of Digital Innovation and Financial Technology 2023-1
Conference 10th June 2022 at International College Digital Innovation Chiangmai University
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International College Digital Innovation Chiangmai University

Introduction

The DIFT 2023-1 Conference is organized by International College Digital Innovation, Chiangmai University, International College Digital Innovation Building, Chiangmai, Thailand on 10th June 2020

The conference aims to bring together policy makers, researchers, and experts in the domain of policy making to share their ideas, experiences, and insights. We welcome experts, researchers and practitioners from academia, industries, research institutions, R&D enterprise services and governmental organizations to exchange innovative contributions around the topics.

All abstracts were reviewed by members of the DIFT 2023-1 Committee for rating and presentation content. Further details in accordance with the instructions of provided at: `https://icdi.cmu.ac.th/DIFT/2023-1/`

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Proceeding of the DIFT2023-1 International Conference
June 10th, 2023, Chiang Mai, Thailand

Blockchain Technology in Hospitality Industry

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Abstract

Researchers worldwide have witnessed a substantial increase in interest in blockchain technology and its far-reaching effects on the economy, society, and technology. This Research explores applications of blockchain technology in the hospitality industry and its potential to transform traditional practices by providing enhanced trust, security, and operational efficiency. The hospitality industry faces numerous challenges, including concerns over data privacy, security breaches, and intermediaries that increase costs and hinder uninterrupted transactions. This research aims to investigate how blockchain, as a decentralized and immutable ledger, can address these issues and revolutionize the way hospitality businesses operate.

The study employs a qualitative analysis, and a comprehensive literature review is conducted to examine the existing literature on blockchain technology and its applications within the hospitality sector. The review focuses on identifying key challenges faced by the industry and how blockchain can offer innovative solutions. Additionally, interviews with industry experts and its customers provide valuable insights into the practical implementation and potential benefits of blockchain technology for the technology.

This research adds to the current body of knowledge by providing insights into the precise ways in which blockchain technology can revolutionize the hospitality sector. The study presents suggestions for a new platform for implementing blockchain solutions within hospitality practices. Ultimately, the incorporation of blockchain technology in the hospitality industry has the capacity to optimize operations, increase transparency, and enhance customer satisfaction and experiences, ultimately fostering a more secure and efficient ecosystem.

KEYWORDS: Blockchain technology, Hospitality Industry, Customer Satisfaction, Platform

1 INTRODUCTION

The travel and tourism sector is one of the world's largest economic sectors. As of 2019, it was estimated that the travel and tourism sector made up a total of 10.3% of the global gross domestic product (GDP), supporting around 333 million jobs, or about one in ten globally (WTTC 2022). Although the global travel and tourism industry fell sharply due to the COVID-19 pandemic in 2020 and 2021, the World Travel and Tourism Council estimates that the sector is already growing once more as of 2022, adding 18.2 million jobs (WTTC 2022). Thus, despite a difficult few year, the travel and tourism sector is once more on the rise.

The hospitality industry is a large part of the travel and tourism sector, including accommodation, food and drink services, and event planning services at all levels (Reynolds et al. 2021). The hospitality sector is not entirely dependent on travel and tourism, as a significant number of customers for some services (particularly food and beverage and event planning)

are generated locally, but it has still been significantly affected by the economic downturn associated with the COVID-19 pandemic (Reynolds et al. 2021). Like the rest of the travel and tourism sector, hospitality is also once more on the rise. The hotel and resort (accommodation) industry is currently growing at a compound annual growth rate (CAGR) of 8.1%, and is projected to reach revenues of USD1.27 trillion by 2032 (Thoreson 2022). Other parts of the hospitality sector are also growing, and Thoreson (2022) states that many hospitality industries have returned to 2019 levels of revenue and profitability by late 2022. Thus, while the hospitality industry has been negatively affected in the last few years, it is expected to grow rapidly moving forward.

One of the most important aspects of the hospitality industry is that it is a service industry, meaning that it is providing individual experiences and services to consumers whose quality is judged somewhat subjectively (Reynolds et al. 2021). This makes customer satisfaction, which is a positive assessment of a service based on the extent to which customer expectations were met or exceeded, a critical aspect of competition in the industry (Oh et al. 2022). Traditionally, customer satisfaction in the hospitality industry has been driven by personalization and exceeding of expectations, for example through service improvisation and practices designed to promote customer delight (Secchi et al. 2019; Tai et al. 2021). Increasingly, the hospitality sector is turning to technologies to better understand customer satisfaction and provide services that create it (Tai et al. 2021; Oh et al. 2022). This study investigates one technology that has potential applications in hospitality: blockchain.

2 METHODOLOGY

There were two populations of interest in this study, which represent different perspectives on the use of blockchain technology in the hospitality industry. The first population of interest is hospitality managers and experts, who represent the perspective of the industry and its service providers. The second population of interest is customers of the hospitality industry, who have their own perspectives on customer satisfaction and the potential contribution of blockchain technology to their satisfaction within the industry.

Qualitative research uses purposeful sampling, in which participants are selected based on their membership in the population of interest, as well as known characteristics which make them suitable as participants (Ravitch and Carl 2019). Furthermore, the sample size is not dependent on the population size, as qualitative research does not use a representative sample (Taylor et al. 2016). Instead, sample sizes should be small enough for the researcher to be able to handle the data produced, but large enough to produce a range of theoretical and practical insights into the research questions (Taylor et al. 2016). A small qualitative study can have between five and ten participants to meet this goal (Ravitch and Carl 2019).

In this research, there were a total of six participants. The sample included two hospitality insiders, including one hotel manager and one restaurant manager. Both of these managers are active in the industry and currently manage large establishments. The sample also included four customers, who were selected to have a range of different preferences, viewpoints, and expectancies for the hospitality industry. There are more customers included than hospitality insiders because it is expected that hotel and restaurant managers will have more insight into the industry in its developments in blockchain technology than individual customers.

Therefore, to gain equivalent information from customers, it was necessary to include more customers in the sample.

3 LITERATURE REVIEW

How Blockchain Technology Integration can possibly help increase customer satisfaction in Hospitality Industry. Customer Satisfaction plays one of the important roles in the hospitality industry. As Le Na (2009) wrote that customer satisfaction and service quality measurement can benefit the company. It is that if a company gains a high level of service quality and customer satisfaction, it means that the company can enhance the loyalty of the customer, the market share is increasing, the return on investment is higher, and costs can be reduced.

According to the Cambridge dictionary, “Customer Satisfaction" is a measure of how happy customers feel when they do business with a company. It is a psychological concept that involves feeling pleasure from what one expects to get from the product or service his/her has (Na, 2009). Defining customer satisfaction into a word is not easy as satisfaction may vary for each person. It is possible that if a service was excellent to one customer, it might be low quality for another customer as the satisfaction level is judged by different customers (Sharma & Srivastava, 2018).

To increase customer satisfaction in the hospitality industry, Blockchain technology integration could be the method to use.

3.1 Blockchain Technology in Hospitality Industry

Tourism companies have introduced the use of the Blockchain to reserve and pay for various necessary bookings and other activities related to their customers’ trips (Rashideh, 2021). Additionally, blockchain technology and cryptocurrency payment are widely known as they can transform the way traditional tourism and hospitality businesses operate (Nuryyev et. al, 2020). Blockchain is more powerful in the hospitality business as several online travel agencies developed smart contracts and decentralized autonomous organizations (Pérez-Sánchez et. al, 2021). It has several uses in the lodging industry. These include revenue management, inventory control, guest history, and financial management (Willie, 2019). Moreover, the mechanisms of Blockchain have a positive impact on the loyalty program, as the asymmetric encryption platform allows companies to set parameters that favor customers who want to repeat the same experience in the same place (Pérez-Sánchez et. al, 2021).

3.2 Blockchain Use Cases in Hospitality Industry

There are various projects using blockchain technology in the hospitality industry such as TravelChain, WindingTree, and LockTrip. According to Polukhina et. al, the use of blockchain technology in tourism can be multifaceted, as several projects show. LockChain eliminates resellers, improves quality, and lowers costs; TravelChain provides an information base, helping travelers with the best deals and many useful budgeting tips; Winding Tree reduces costs and simplifies the selection process.

First, the TravelChain project; created a unique database of tourists where users can store personal data in encrypted form and the digital footprint like countries and places they visited

or their preferences in the open form. The integrated decentralized global registry, showing both global trends and the desires of each anonymous user, will allow any company to analyze market needs and make unique proposals according to the principles of the B2P system (Polukhinna et. al, 2019). In this way, companies save the advertising budget by selling directly to the customer. Users receive tokens for viewing offers and a personalized tour (Polukhinna et. al, 2019). According to Konstantinova, the advantage of using blockchain technology, it is a decentralized system which needs no intermediaries, and no commission. The highest quality and security of reservations are guaranteed, and the data itself is resistant to changes and unwanted manipulation. Second, Winding Tree; is the first public blockchain-based, an open-source marketplace for travel services. Its purpose is to make travel cheaper for travelers and suppliers such as travel agencies are to make them earn more. The project consists of sets of smart contracts which are developed on the Ethereum blockchain (Fehrer et. al, 2020). There is also a marketplace's cryptocurrency called Lif coins that the holder of the coin can participate in the further development of those contracts. Vendors, such as hotels, can post information about their room availability and prices to the blockchain, where travel agents can easily find them and then purchase that inventory and pay for it immediately, again using Lif. All interactions are designed to work without human intervention (Fehrer et. al, 2020).

In addition, Winding Tree incorporated is a private, non-profit company founded in Switzerland that operates a travel distribution network based on the Ethereum platform. They do not charge commissions to suppliers. The goal of the platform is to create a space where sellers can easily sell their inventory instantly with Lif (Krietemeyer, 2019). WindingTree has a process that eliminates high commission costs for additional intermediaries and since the system is based on blockchain technology, it can ensure that the operation is uninterrupted. Also, the project has already been implemented at Lufthansa Airlines and Dubai airport or even in the transport system of Japan and South Korea (Morozov, 2020). As a result of the WindingTree project, bookings and tracking can be done easily, securely and reliably, and all processes benefit from great transparency (Konstantinova, 2020).

Third, LockTrip; is a decentralized open-source booking system that has no commission. The company operates a booking platform without taking commissions, which is based on the Ethereum blockchain. The hotels can offer their rooms on the website 20% cheaper. Payment on the website is made via a cryptocurrency called LOK token (Krietemeyer, 2019). According to Amarouche who interviewed Petrova, Head of Business Development at LockTrip, the platform offers 0% commission services. Inconsequent, LockTrip does not make any profit as it aims to represent a foundational model for the travel industry that focuses on the most modern form of monetization which is "Freemium" just like google or Amazon. The platform aims to create a truly decentralized and shared rental ecosystem that will disrupt the booking website industry and replace ineffective sharing networks which attract more partners to involve not competitors. Petrova indicated that there are no other crypto projects currently competing with LockTrip. Instead, these customers can be provided with technology and expertise should they wish to migrate or improve their projects (Amarouche, 2019). In addition, the service offered by blockchain home-sharing platforms like LockTrip, advocate and support the adoption of blockchain in the industry. It comes with a positive conclusion that the results in the research can confirm that a decentralized business model is certainly growing and enticing with new solutions (Amarouche, 2019).

3.3 Comparing the use cases

The three use cases used in this research are TravelChain, WindingTree, and LockTrip. In addition, they are developed to be used in the hospitality industry differently.

Use Case I First, TravelChain, according to The three use cases used in this research are TravelChain, WindingTree, and LockTrip. In addition, they are developed to be used in the hospitality industry differently.

3.3.1 Use Case I First, TravelChain, according to `https://icobench.com/ico/travelchain` is a platform providing authentic smart data for businesses to know their clients better and helping travelers to get the best customer service. The idea of the platform is to collect users' profiles such as preferences, things they like to do, locations, or the way of living and traveling. Moreover, the users can limit what they want to share for the data and they will get travel tokens as a reward for sharing information. Then, those travel businesses will buy data of their potential customers. The advantage of the platform is that companies can buy accurate data and improve their services based on each individual and make each person's experience better. Making a platform like this needed a lot of time for collecting data on each traveller. The platform should provide more attractive rewards to motivate people to share information on the platform. As of now, the reward is the travel token (TT) which can be used on the platform (Bova, 2018).

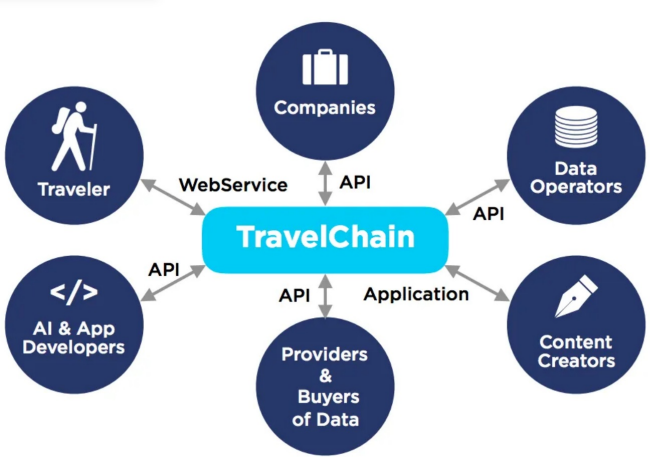

Figure 1: *TravelChain Diagram*

Use Case II Second, the platform WindingTree according to winding tree white paper, the platform offers a decentralized alternative to GDS and OTA distribution with a reduced cost of distribution (Izmaylov et. al.) The organization is developing a business-to-business platform where suppliers and sellers can connect on a single market (Beare, 2018). In addition, suppliers (hotels, airlines, etc.) will put availabilities and price information into the database and sellers (travel agencies) will have the ability to buy the inventory and pay for it on the platform (Izmaylov et. al.). Using blockchain technology, sellers can see transparency for price information and availabilities without any commissions added (Izmaylov et. al.). Moreover, the company is not charging suppliers for any distribution fees but there is a charge automatically

calculated by the blockchain at the time of the transaction to incentivize to miners which is minuscule (Izmaylov et. al.). It means that the company is building this platform to disrupt the online travel agency market which is normally charging commissions up to 15 to 20 percent per booking. However, the organization is aimed to build the technology by engineers for engineers and not for a user-facing interface for the marketplace (Beare, 2018).

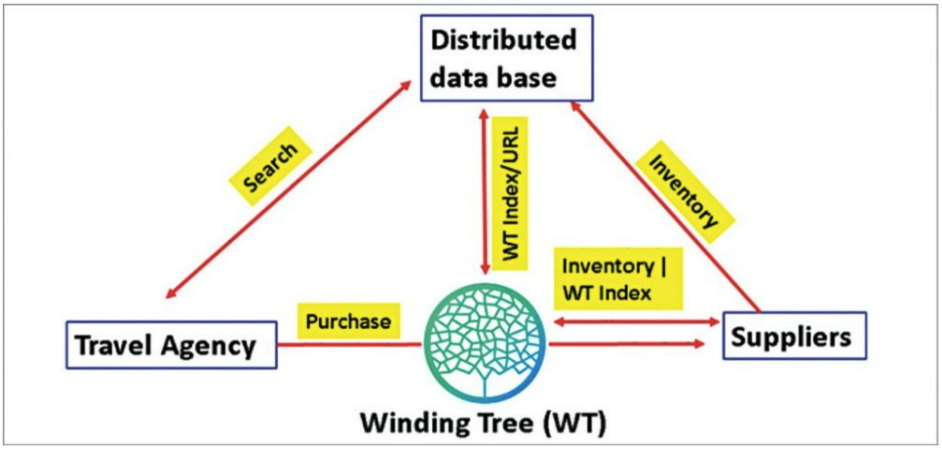

Figure 2: *WindingTree Diagram*

Use Case III Third, LockTrip as stated in the whitepaper on `www.locktrip.com`, it is the platform where hotels can set their prices and inventory in the platform. Then, people who want to book a hotel can search for the hotel's availability on their platform. The platform eliminates the need for price negotiation with middlemen or those online travel agencies. It helps cut out the middlemen who charge a large amount of commission. The platform also creates the environment for inventory which is open for everyone to see since it is on the blockchain. The platform works by using smart contracts with its utility token which is LOC. This LOC ledger is built on the Ethereum VM and is open source which is free for everyone to use (`www.locktrip.com`).

3.4 Suggestions on how a platform can be developed

As we see those three platforms mentioned are mainly focused on the pre-stay stage. They are not fully adopting blockchain in the hospitality industry as it could be as there are in-house periods and post-stay periods that blockchain can be used. A platform that customers can easily access like LockTrip would be a choice. This is to disrupt online travel agencies which cost hotels high commissions.

Creating a platform where it is easy for hotels to just update the price and availability without asking them to do it on a different platform. A ground-breaking blockchain platform that simplifies and streamlines the process of updating hotel prices and availability. It allows hotels to easily manage their rates and inventory without the hassle of using multiple platforms or relying on intermediaries. Using a decentralized ledger technology can help securely store and share data across the network, so there is no need for a central authority. It improves transparency and makes it really difficult for anyone to tamper with or commit fraud in the

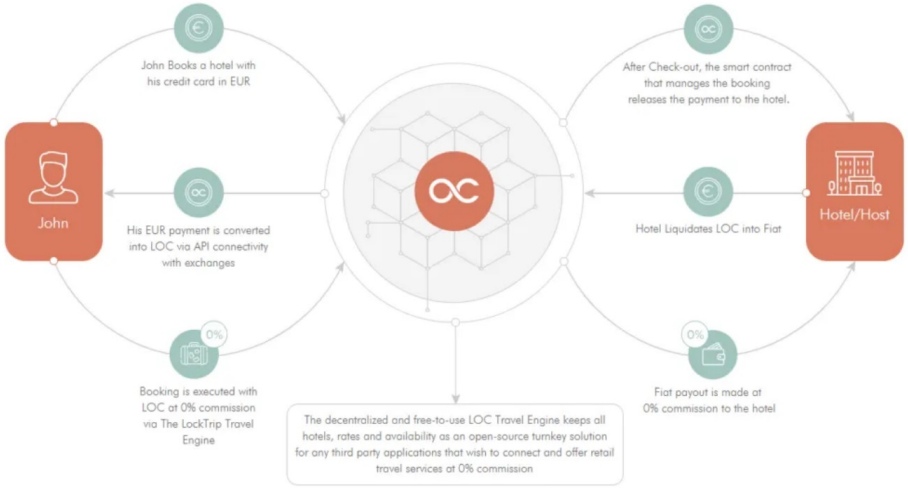

Figure 3: *LockTrip Diagram*

system. Also, a one-stop service platform for hotels is what is recommended to happen. The integration of a property management system (PMS) where properties can manage their properties since a customer inquires for a room until check out. Customers can search for and book a hotel on the platform where customers find the best price shown on the platform without commissions. Customers can fill in his/her information the hotel needs before checking in. Moreover, the blockchain can be adopted in luggage tracking (this could be done with airlines). Both customers and service providers can keep tracking on the system to prevent luggage loss.

Once they check out from the hotel, blockchain will be used to create more transparency in hotel reviews. The characteristic of blockchain that is eliminates the capability of deletion, therefore; all the comments and reviews will be organic. Furthermore, blockchain can be used in the loyalty management program as well. The proof of stake token will be granted as a loyalty point to customers. When they hold the token, they can also earn more. Also, the platform would be able to keep records of each customer's preferences to help customers get better experiences in the future. That also benefits the service providers since the service is matched with what customers want.

Apart from the above that the existing platforms already provided, this new suggested platform with blockchain technology could possibly do as follows;

First, use a blockchain-based system to securely store guest identities and personal information, improving check-in, data privacy, and protecting against identity theft and data breaches. Blockchain is a decentralized network that stores data across multiple nodes, making it difficult to tamper with. Each data entry is recorded as a block and linked together, creating an unchangeable chain of information. By storing guest identities and personal information on the blockchain, data integrity is ensured and unauthorized changes are prevented. More-

over, smart contracts are self-executing agreements stored on the blockchain that automate processes and enhance security. For instance, during check-in, a smart contract can validate guest identities, verify reservations, and update the blockchain with the necessary details. This streamlines the process and minimizes the chance of human errors. Also, blockchain systems can use strong identity verification methods, such as digital signatures, biometric authentication, or trusted identity providers. This ensures that only authorized individuals can access and modify their personal information, reducing the risk of identity theft.

Second, build smart contracts for booking and payments. This smart contract platform guarantees fairness, removes middlemen, and allows guests and hotels to make secure and immediate payments.

Third, for loyalty programs like to design a loyalty program using blockchain technology, enabling guests to earn and use points across various hotels and hospitality providers. By utilizing blockchain's decentralized approach, this program can overcome the limitations and restrictions of conventional loyalty programs, granting guests increased flexibility and a wider range of choices. Moreover, is to develop a loyalty and incentive program for guests using blockchain, where tokens are used to reward their stays and engagements. These tokens can be redeemed for future bookings, exclusive experiences, or even exchanged for other digital assets. This creates a valuable ecosystem within the hospitality industry, providing guests with additional benefits and opportunities.

Forth, design a reputation and review system on the blockchain, allowing guests to provide feedback and ratings directly. This decentralized system enhances transparency, eliminates biased or fake reviews, and empowers guests to make informed decisions when selecting accommodations.

Finally, without a trustworthy member of staff working in the industry is not fully fulfill the idea of security. Therefore, adding a system using blockchain to manage and verify the identities of staff members and service providers. This system will enhance security, prevent unauthorized access, and guarantee that only qualified individuals are employed in the hospitality industry.

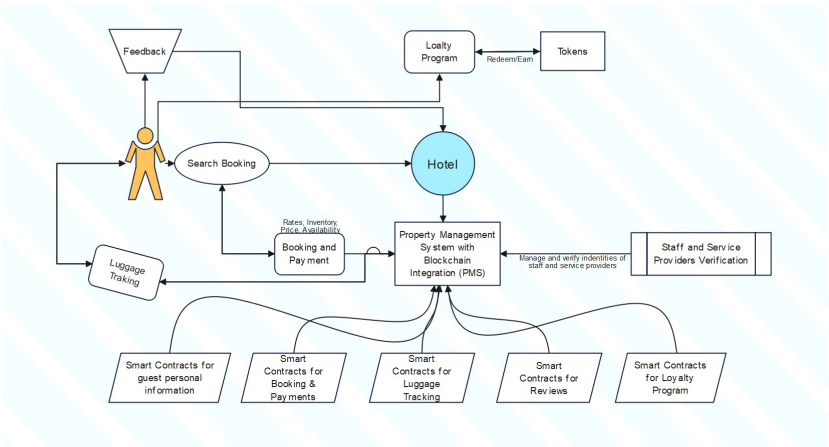

Figure 4: *Suggested Blockchain PMS for Hotel Industry*

4 CONCLUSION

In conclusion, blockchain technology has the potential to revolutionize the hospitality industry by addressing key challenges and improving customer satisfaction. Through its decentralized and transparent nature, blockchain has the capability to reduce operational costs, increase security, improve transparency, and empower customers with greater control over their personal data. The case studies of TravelChain, WindingTree, and LockTrip highlight the transformative power of blockchain in reimagining traditional business models.

The research methodology employed in this study, an approach of qualitative interviews provides a comprehensive understanding of blockchain adoption and its impact on customer satisfaction. The forthcoming findings and analysis chapter will study deeper into the subject, exploring a new platform identified by the author as highly suitable for the industry. This chapter will provide invaluable insights into the far-reaching implications for the hospitality sector.

In summary, blockchain technology has the potential to transform the hospitality industry and create a more efficient and customer-focused environment.

ACKNOWLEDGEMENTS

First of all, I would like to express my deepest gratitude to my advisor, Dr. Nathee Naktnasukanjn, for his invaluable guidance, support, patience, and encouragement throughout the entire research process. His proficiency, valuable input, and unwavering dedication to achieving excellence have played a crucial role in shaping this Research. I express my sincere gratitude to the participants of this study, whose willingness to share their experiences and perspectives has been invaluable in enhancing the findings of this research. I deeply appreciate their time and cooperation.

Finally, I would like to express my gratitude to the countless researchers and scholars who have made remarkable contributions to the field of blockchain and its use in the hospitality industry. Their pioneering efforts have laid the foundation for this study, inspiring and encouraging further investigation in this field.

This Research owes its existence to the collective efforts and contributions of all the individuals mentioned above.

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A Blockchain-based Framework to Connect Farmers and Market

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Abstract

The rising demand for ethical consumption, coupled with evolving food standards and regulations, has brought significant changes to the Food Supply Chain (FSC), particularly affecting small and medium farmers. This paper reviews how blockchain benefits farmers and companies operating in the food industry in terms of tokenization and traceability, then it explores the technical aspects of a blockchain-based system to suggest a conceptual framework for a food online application that connects farmers and consumers. The business idea and framework are expected not only to enable transparency and traceability but also to enhance regulatory compliance and farmers' presence in the FSC to achieve a sustainable and ethical food ecosystem.
KEYWORDS: blockchain, framework, food supply chain, ethical consumer, farmer

1 INTRODUCTION

Digitalization has had a significant impact on farmers, revolutionizing the way they work and transforming various aspects of the agricultural industry. Farmers now can easily access weather forecasts, market prices, crop data, and best farming practices which help them to optimize their farming techniques and increase productivity. IoT, robotics, and blockchain technologies are reported to be applied in many farms to automate tasks and optimize crop yield. However, most farmers, especially in rural areas have a limited approach to new farming technologies, food quality regulations, financial support, and increasing market demand. For example, in a case study review on rice products, traceability is lacking while other technologies like data analytics or IoT are "not yet economically viable for farmers" (Pichawadee Kittipanya-ngam & Kim Hua Tan, 2020).

The food market has been reshaped due to the acceleration of ethical consumption and e-commerce. There is an acceleration of niche markets focused on specific dietary preferences and values such as vegan, gluten-free, or organic food products. The e-commerce revolution also has changed the way people purchase, from traditional retail channels like markets to online platforms like websites or mobile applications. For online food delivery services, there is a transition from website to O2O (online to offline) and mobile application (A. Shankar et al., 2022).

By reviewing how the FSC and farmers can be affected by new consuming trends and food regulations, and how blockchain can be applied to bring significant benefit to the FSC and its participants, this paper wants to suggest a blockchain-based framework for a food online application that connects farmers and consumers, fostering enhanced traceability, regulation compliance, and active participation in its ecosystem.

2 THE RISING OF ETHICAL CONSUMERS

Ethical consumerism has not only reshaped consumer behavior, but also transformed the way food is produced, distributed, and purchased.

There is a growing inclination among consumers to inquire about not only the nutrition of the food but also the origins, the process, and the consequences it has on the environment and local communities. Up to 74% of people in a study noticed the labels showing information about animal welfare on egg, meat, and dairy products and they could pay higher money for those with trusted welfare certification (Spain et al., 2018). This has prompted farmers and food producers to adopt more sustainable practices, such as organic farming, fair trade certification, and animal welfare standards.

People are searching for products that align with their wellness needs, lifestyles, and values. According to NielsenIQ (Web-1), a well-known market research company, about 200 million consumers in the United States are following diet or health-related programs, actively seeking specific product characteristics such as keto-friendly snacks, gluten-free beer, or paraben-free makeup. Shoppers actively look for companies committed to sustainability with “clean-label" products, believing it aligns with their lifestyles. This has led to a diversification of food offerings and the emergence of specialized food products to these niche markets such as veganism, gluten-free, plant-based, low-carbohydrate, high-protein diets...

There is also an increasing demand for transparency in the FSC. With increasing awareness, consumers now are not only interested in knowing details such as the food’s origins, production methods, and processing conditions but they also want to know it immediately via the digital media. Consequently, food safety, traceability, and sustainability have emerged as vital concerns for stakeholders in the food chain. (Pichawadee Kittipanya-ngam & Kim Hua Tan, 2020). With this motivation, D. Bumblauskas et al. (2020) conducted a pilot of egg supply chain traceability in the Midwestern USA with positive result in consumer engagement. Customers can scan the QR code on the product and input data on the package to access traceability data such as farmer’s name and location, animal welfare information (Certified Humane, Free Range with Outdoor Access, No Antibiotics, 100% vegetarian Diet), sustainability information (100% Solar Power facilities, Restorative Soil Practices, Locally Produced Feed). Customers can also view the product story with information on collection, processing, and transportation from the farmer to the retailer.

3 FOOD STANDARDS AND REGULATIONS

Standards and regulations play a crucial role in ensuring the safety, quality, and sustainability of the food product and supply chain. They provide assurance to consumers, businesses, and regulatory bodies that certain criteria and requirements are met throughout the production, processing, and distribution processes.

Together with the rise of high standards from the customers, the FSC also has been put under pressure of various requirements from increasing food standards and regulations. For example, the egg supply chain mentioned above was implemented to automate the process from farm to table due to the requirement of the Food Safety Modernization Act (FSMA), which is issued by the United States Food and Drug Administration (FDA). The FDA’s Food

Traceability Final Rule (effective on 20 Jan 2026) establishes new recordkeeping requirements including key data elements and critical tracking events for food manufacturers, processors, packers, and holders of specific foods listed on the Food Traceability List. This rule will help to strengthen food safety by increasing the speed to identify and remove hidden contaminated food from the market (Web-2). Besides regulations on food traceability like FDA, there are other common standards such as ISO 22000: ISO 22000, Good Manufacturing Practices – GMP, Hazard Analysis and Critical Control Points (HACCP), Organic certification, Halal certification (compliance with the precepts of Islamic Law).

With the rise of ethical consumers, food products can have a higher value for promoting sustainable and environmentally friendly practices like Fair Trade certification or Animal welfare certifications. The Fair Trade promotes fair and ethical trading practices, particularly in products like coffee, cocoa, tea, and bananas. It ensures that farmers and workers receive fair prices, fair wages, and improved working conditions. Animal welfare certifications ensure that animals involved in food production are treated humanely. These certifications may cover various aspects, such as housing conditions, feed, handling practices, and transportation. Examples include Animal Welfare Approved (AWA), Certified Humane, and Global Animal Partnership (GAP) certifications. This trend is increasing not only in developed markets but also in developing countries like Vietnam. Tran et al. (2022) addressed that most Vietnamese customers are ready to pay more for food products with QR traceability or those with labels of VietGAP, EU, and USDA organic certifications.

These certifications and standards ensure that food products meet specific requirements for safety, quality, sustainability, and ethical considerations which help build trust between farmers, producers, and consumers. They can open opportunities for small and medium farmers to increase their product value and enter new markets, however, it's also a barrier for them to follow and adapt to the rapid changes of those requirements.

4 BLOCKCHAIN IN THE FOOD SUPPLY CHAIN

4.1 Blockchain for Tokenization

Blockchain technology is a distributed ledger system that facilitates secure and transparent transactions, eliminating the necessity for intermediaries. The concept of a distributed ledger system dated back to the early 1990s, but it was not until the publication of the Bitcoin white paper in 2008 by the pseudonym Satoshi Nakamoto that blockchain became widely known. Bitcoin is "a peer-to-peer electronic cash system", in which, a coin will be considered as a chain of digital signatures with double spending prevented by nonreversible timestamps through a peer-to-peer network using proof-of-work to record a public history of transactions (Web-3).

Known as technology under cryptocurrencies, blockchain evolved when it was introduced in Ethereum Whitepaper as a next-generation smart contract and decentralized application platform. Even though Bitcoin is the first digital currency, most of the cryptocurrencies and applications have been created based on the Ethereum protocol due to the above advantages. The advanced blockchain technology with accelerated development of cryptocurrencies and tokens issuance has opened new ways for startups to raise funds for their projects and businesses through tokenization via Initial Coin Offerings (ICO).

ICO is a crowdfunding mechanism using blockchain technology. According to Investopedia, a US investment dictionaries webpage, ICO "is a method of raising capital wherein companies sell investors a new digital token or cryptocurrency" (Web-4). Interested investors can buy an initial coin offering to receive a digital token issued by the company. This token can be redeemed for products or services that the company is provided (utility token) or represent a stake in the company or project and is expected to bring future profits (investment token). The transactions are recorded on blockchains and will be executed under smart contracts which helps to eliminate the need for intermediaries, hence reducing cost and ICO accessible to anyone.

ICO issuance in Thailand is subjected to Digital Assets Business Law in 2018. Which, the new issuance of a token to the public must be done by the ICO Portal that obtains a license from the SEC (The Securities and Exchange Commission, Thailand). The process normally takes more than 8 months, with 60 days for the SEC to consider issuing permission after the ICO business presents the White paper and 6 months for the company to offer the tokens sales via the ICO Portal (Web-5).

Today, there are more than 25,000 coins listed in 636 exchanges with a market cap of USD 1,132 billion (Web-6). The rapid growth of ICOs is due to the evolution of blockchain as mentioned above, which enable peer-to-peer transactions and automation via smart contract. With ICOs, Startups have the potential to secure funding at reduced expenses without compromising equity ownership (Martino et al., 2020), furthermore, with the token utilization function, it can create an ecosystem for investors, token users, and interest parties. In the context of FSC, it can be utilized by startups to approach financial support, create product tokenization and encourage participants, including farmers.

4.2 Blockchain for Transparency and Traceability

As said above, blockchain is not only a technology for cryptocurrencies but also has many applications in many other fields, including the food industry as it can offer a secure, distributed method to enable transactions among various untrusted parties (Creydt & Fischer, 2019).

Firstly, blockchain technology enhances transparency in FSC by immutable records of each transaction or event, such as production, processing, packaging, and distribution, providing a comprehensive and immutable audit trail. It allows participants to access the same information like origin, production methods, certifications, and quality of food products, reducing information asymmetry and allowing for greater trust and accountability. Blockchain's transparency and immutability make it difficult for malicious actors to alter or tamper with data. This helps in reducing fraud, counterfeiting, and mislabeling of food products. By creating traceable and transparent FSCs, businesses can cultivate stronger customer relationships, enhance efficiency, and mitigate the risks and costs associated with food recalls, fraud, and product loss. Simultaneously, consumers gain access to the information necessary to make informed decisions regarding the food they purchase and the companies they endorse (D. Bumblauskas, et al., 2020).

Secondly, blockchain with the power of smart contracts can improve the efficiency of the FSCs by automatically executing tasks based on predefined rules, streamlining the movement of goods, payments, and compliance checks. Smart contract implementation can help reduce

paperwork, eliminating manual tasks, errors, fraud, and further expenses (Creydt and Fischer, 2019). Moreover, blockchain's integration with other emerging technologies like the Internet of Things (IoT), Artificial Intelligence (AI), and Big Data analytics enables data-driven decision-making in the food industry.

Lastly, the transparency and efficiency of blockchain improve sustainability by recognizing and addressing data collected about environmental impacts, energy consumption, waste management, and resource allocation. Moreover, blockchain can facilitate the tracking and verification of sustainable farming practices, such as Organic, Fair trade, or Animal welfare certificates. By recording and verifying these certifications on the blockchain, stakeholders can ensure the credibility and integrity of sustainability claims. This transparency promotes trust among consumers and encourages businesses to adopt sustainable practices.

Blockchain can bring great benefit to farmers, as a part of the FSC, such as those farmers joined in Honeysuckle White Turkey of Cargill, a well-known meat producer. Customers could trace their turkeys back to the family farm, access information about the farm's location, view farm photos and read a personalized message from the farmer. This program serves to enhance the value of the product, foster trust, promote transparency within FSC, and instill customers with greater confidence in the food they buy and consume (Web-7).

Despite the potential benefits, some challenges have been addressed like scalability, privacy and data protection, limited existing infrastructure, and lack of expertise by small and medium businesses. On top of those, the cost and technical complexity of implementing and maintaining blockchain infrastructure can be barriers to adoption, especially for smaller participants in the FSC (A. Kamilaris, et al., 2019).

5 TECHNICAL ASPECTS FOR ENABLED BLOCKCHAIN

To set up a blockchain-based framework, the most critical question is "What are the Criteria for a FSC system built on blockchain?" Pichawadee Kittipanya-ngam and Kim Hua Tan (2020) introduced a framework for FSC digitalization that emphasizes five factors: (i) efficiency, (ii) transparency & traceability, (iii) environmental & social impacts, (iv) legal culpability, and (v) e-market/supply accessibility. The framework needs to define the value proposition while the enable factors come from technical abilities. In the detail of blockchain architecture design, D. Bumblauskas, et al. 2020 suggested important criteria in the use case of building a traceability egg supply chain as considerations, feasibility, operational compatibility, performance, privacy, assurance, and relevance to stakeholders. Guilain Leduc et al., 2021 with the idea to build a marketplace for farmers, has other criteria like consensus, social, and contract.

To answer the above questions, key elements of Blockchain have been reviewed including Consensus mechanism, Distributed ledger, and Smart contract. The consensus layer is one that greatly affects network performance (Guilain Leduc et al., 2021). Consensus mechanism ensures that all participants agree on the validity of transactions and data which helps maintain the integrity and accuracy of information recorded on the system. Consensus protocols in blockchain can be classified into three categories: permissionless (public), permissioned (private), and federated (consortium). Permissionless blockchains, exemplified by cryptocurrencies like Bitcoin and Ethereum, allow anyone to join, transact, and review the chain without specific identity requirements. Permissioned blockchains require authorization to access all or

parts of the blockchain, while federated blockchains combine aspects of both. Permissionless blockchains tend to be scalable and resilient but suffer from performance issues such as high latency, low throughput, and high energy consumption. Conversely, permissioned blockchains offer better performance but may have limited participants compared to cryptocurrencies. In the context of Food Supply Chains (FSCs), the proposed frameworks primarily utilize permissioned or private blockchains due to their suitability. The performance of consensus protocols depends on hardware factors like memory, processors, and the number of nodes, with the number of nodes impacting the security level. (Guilain Leduc et al., 2021).

The distributed ledger is utilized to record and share information about the movement of food products from farm to fork. Each participant in the supply chain, such as farmers, processors, distributors, and retailers, can contribute to the ledger, creating a transparent and shared record of transactions and data. Guilain Leduc et al., 2021 reported that Ethereum and Hyperledger Fabric are the most widely adopted solutions and raised the issue of the scalability that block generation frequency and block size can affect the system performance.

While most of the reviewed papers applied smart contracts to achieve traceability, tracking, and trading requirements, the paper showcased the Ethereum smart contract design among farmers, consumers, and deliverers in a proposed blockchain-based farming marketplace with detailed variables and algorithms.

In their review, Guilain Leduc et al. (2021) classified agreements among parties in the FSC into different categories, such as farmers and delivery company and vice versa, delivery company and Retailer, retailer, and customer which pertain to different contract terms. For example, the R2D (Retailer-to-Customer) agreement will involve contract terms related to sales time, price, and quality.

The other factors to enable a block-chain base system are security and authentication, front-end application, IoT sensors, and other hardware/software integration like data collection and analysis, ERP (Enterprise Resource Planning), CRM (Customer Relationship Management), AI In a FSC system, data is crucial to feed the blockchain system as in the below example of the egg supply chain (D. Bumblauskas, et al., 2020).

The criteria for an FSC system built on blockchain can vary depending on specific requirements and objectives. Besides utilizing the blockchain benefits like security, traceability, transparency, and effectiveness of consensus mechanism, distributed ledger, and smart contracts, an FSC system should focus on creating value and encouraging participation of related stakeholders, including consumers and farmers.

6 CONCEPTUAL FRAMEWORK DESIGN FOR ONLINE FOOD APPLICATION

6.1 Business idea

As discussed, ethical consumption has changed the FSC with the growing demand of consumers on food quality, origin, process, and the way they are purchased, which put pressure on the farmers, producers, retailers, and other relevant stakeholders. This paper wants to propose an online platform called "YumYum" which specialized in meal kit service with customized recipes for different dietary needs (e.g. vegan, low-carb, high protein...) and other seasonal products by cooperating with farmers. Customers can choose their preferred products on the website or mobile application, then the ready-to-cook meal kit or the products will be delivered

Table 1: *Data in an egg supply chain*

Locations	Time	Data sources	Data details
The farm	when eggs are collected	collectors, sensors	egg type, pickup time, temperature, location, humidity
The Packaging Facility	when eggs are packed	system operators, internal traceability software, processing hardware	collection location, time, farm name, temperature, humidity history, transit departures and arrivals processing and packaging time, egg type, certification data, batch quantity, best-by date, brand, color, product labels
Consumer engagement	customers scan the QR code and engage with the web application	website/mobile phone	number of users accessing the site, behavior, time spenton the site, visits per user

to customers. Customers can scan the QR code on the package delivered to see the origin of the meat/veggies, certificates of the farmers/sellers, date of packaging, delivery...and the recipes to cook the dish (Figure 1).

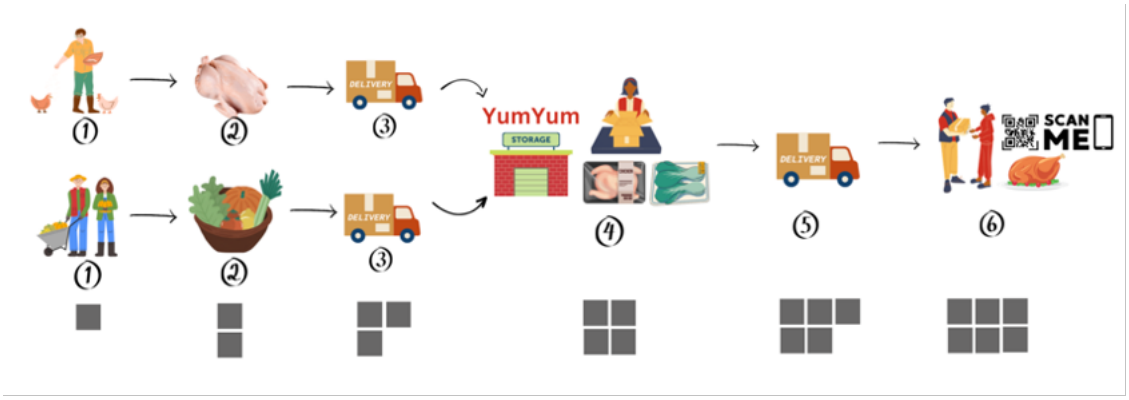

Figure 1: *YumYum supply chain flow*

Yumcoin will be the token of the business to encourage participation, loyalty, and usage of related stakeholders, including investors, app users, farmers, and other retailers/partners. Investors can exchange Yumcoin to fiat money and use the coin to buy products in the YumYum app or other YumYum partners. The users of the Yumyum app will get Yumcoin as an incentive for buying the products, sharing, reviewing, and joining other activities in the ecosystem (Figure 2).

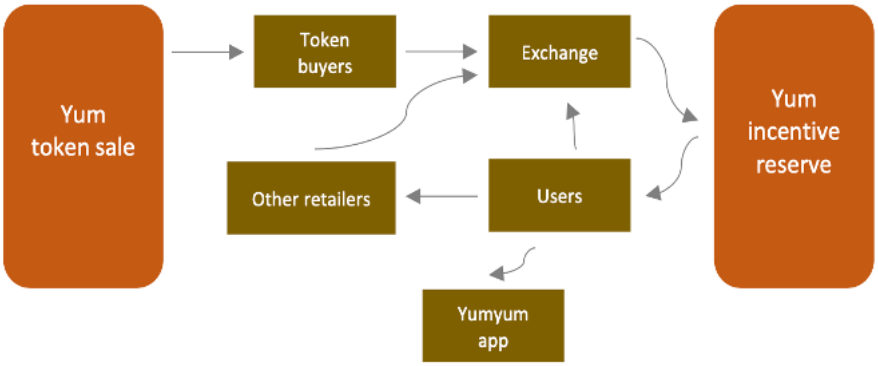

Figure 2: *Yumcoin economy*

6.2 A conceptual framework for YumYum application

In considering the above technical factors that affect a blockchain system, the paper suggested a framework built on the Ethereum blockchain to enable Yumcoin, smart contracts, and traceability in the FSC from farm to table. There will be three layers in the framework with the center being the ERP layer for the business operation management, the others are Blockchain and Front-end layers (Fig.3).

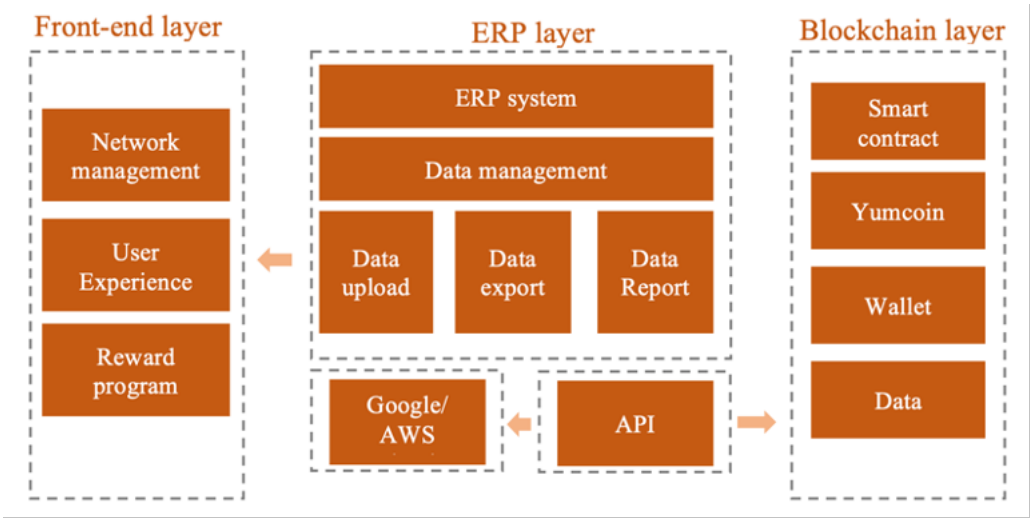

Figure 3: *YumYum conceptual framework*

The blockchain layer will be designed with concerns of feasibility, performance, and security to facilitate the data flows in blocks and smart contracts among participants. It also needs to connect with the exchanges, and cryptocurrency wallets to enable Yuncoin in the ecosystem. The Front-end layer is required to adopt the latest U/I (user interface), and U/X (user experience) designs to effectively engage with users (e.g. administrators, farmers, delivery partners, and customers...).

API is applied to connect the ERP system with the Blockchain layer and other software like Google/Amazon Web Service (AWS), IoT, CRM, or data analytics. The network is set up

on a private blockchain consensus mechanism, each participant must be verified and granted access by the network administrator before they can participate. Each participant is required to provide a digital identity to verify their identity on the network. This can be done using public key cryptography and digital signatures. Smart contracts are deployed to manage the various stages of the YumYum supply chain process.

7 CONCLUSION

This paper suggests a business idea for an online food application with a conceptual blockchain-based framework to connect farmers with the rapidly changing market demand, help them increase product value, and keep up with different food regulations for traceability, quality, and sustainable farming process. At the same time, it encourages the participation and engagement of farmers, customers, investors, and interested parties through token issuance and incentive. By leveraging blockchain technology, traceability, regulation compliance, and active participation are significantly enhanced, benefitting both farmers and consumers in the pursuit of a more sustainable and ethical food ecosystem. The future work includes further research about the market, customer segmentation, operation, and financial planning as well as detailed technical aspects to enable the project. The framework may benefit not only the food industry but for other products with similar directions.

ACKNOWLEDGEMENTS

The author would like to express sincere gratitude to Dr. Nathee Naktnasukanjn for his advice and encouragement during the process of writing the paper.

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