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# DAIRY LOGISTICS SUPPLY CHAIN USING BLOCKCHIAN TECHNOLOGY

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## ABSTRACT

With the rapid increase in global annual consumption of fluid cow milk worldwide, serious problems including food fraud, illegal production, foodborne illness, and food recalls have kept being critical, through great efforts have been made for dealing with those food safety problems. Blockchain technology, because of Bitcoin, is becoming a popular Front-age technology in finance, business, logistics, insurance, and many other fields. This paper uses blockchain technology to redesign a new Dairy Logistic Supply System. Decentralized, Security and Eco-society, these three unique advantages can provide an eco-system have completely solved the problems of traditional or central dairy supply systems. The new system guarantees to provide customers with fresh and safe dairy products at fair prices. Consensus and real-time transaction data and information will be stored in local blockchain adapted on the Ethereum platform and shared among involved participants. The Internet of things (IoT) lowers labor and decreases errors. The most important attribute is its smart contract with a crowdfunding function, which can provide customers a brand-new market platform that is collectively owned by all the participants who can observe the entire state of the market at any time. Our research offers a viable option to solve food safety problems in a decentralized, security, immutability, transparency manner.

Keywords: Blockchain, Dairy logistics, Food safety, Smart contract, Crowdfunding.

## 1. INTRODUCTION

Due to the Bitcoin, the blockchain technology, has been known by the public since 2008. Compared with traditional networks, Blockchain is a distributed peer-to-peer network, each node can directly interact with other nodes without a trusted third party involved (Nakamoto, 2008; Duan et al., 2020). Its applications have been successfully introduced into the logistics supply system, voting mechanism, medical area, and financial market (Duan et al., 2020; Yiannas, 2018; Vadgama, et al., 2021). A blockchain-based ledger is elucidated as "a decentralized, security, and eco-society ledger used to permanently keep the digital records of transactions".

Unlike other traditional transactions that need to be processed and verified by central architectures or trusted third parties, decentralization can minimize intermediate waiting time and operating costs. Using the blockchain-based ledger, all users can more efficiently communicate with the other participants within the network, which speeds up the process of transactions. Information asymmetry and information fraud is the major reason to delay the transaction flow, to break trust among collaborations, to increase consuming time of products recall, and to hurt customers' confidence (Nakamoto, 2008; Duan et al., 2020; Yiannas, 2018; Wan, Huang et al., 2020; Casino et al., 2019). To avoid these issues, information sharing is regarded as one practical approach. A decentralized environment makes fair and transparent information sharing become possible. All users have the equal power to make decisions and the equal right to access all information and transactions shared among the network anytime (Duan et al., 2020; Rejeb et al., 2020). Decentralization promotes more accurate, timely information sharing, removes information inequality and builds up more trust.

In addition to information sharing, blockchain technology also ensures the originality and authenticity of all recorded information (Duan et al., 2020). With cryptographic hash algorithms, any data will be written onto a special hash and be stored in the blockchain. If any values, for example to add one space or delete one comma, got altered, the whole hash value would be totally different. Therefore, it's easy for every participant to detect the altered behaviors even one single point of failure (Duan et al., 2020; Yiannas, 2018). Hacking behaviors can only happen when at least 51% of users are replaced, which leads to one complicated blockchain network with a large number of users is very safe (Nakamoto, 2008; Duan et al., 2020).

In blockchain's decentralized network, any exchange of information, every single transaction needs to be verified by the rest of the users and then stored in one block permanently (Duan et al., 2020; Wan et al., 2020; Rejeb et al., 2020). Each user has a full copy of all transaction data that fed into the blockchain network, all transactions and data information are shared equality to each user, meanwhile, each user has the responsibility to remain the information secure and unchanged (Yiannas, 2018; Casino et al., 2018). This consensus and distributed data storage are able to prevent the usual problems in a centralized network including fraud or alteration, and more eliminate the risk of the whole centralized system failed if one single point breakdowns (Gandhi et al., 2021). Each new block is related to a prior block, the rest blocks will be broken down due to one block failed. All users can quickly and easily notice the breakdowns from the data tampering or hack behaviors. The consensus and distributed data storage guarantee transparency and immutability of information sharing to all participants within the blockchain network, which makes it more secure and has a lower probability of being hacked.

Smart contract is an account governed by code and stored on a blockchain that runs when predetermined conditions and service terms are fulfilled (Duan et al., 2020; Wan et al., 2020; IBM, 2021; Ashari, 2020). Smart contract wipes out the need for a centralized organization or trusted third party, the code will self-execute to manage, verify and store the real-time information, and more the code allows automatically flow of work and provoke the next action when the conditions are met (Wan et al., 2020; IBM, 2021; Ashari, 2020). All participants do not need to pay for the extra fee and time for any intermediary intervention. The transactions data, account balance, and capital flow stored in smart contract is transparent and visible to all participants, like theft, fraud and tampering these behaviors have no possibility to happen since smart contracts based on the agreement of all partners. The implement of smart contract can significantly speed up the transaction, reduce unnecessary cost, protect the benefit of a wild range of stakeholders, and build more trust among the participants and ecosystems (Duan et al., 2020; Yiannas, 2018).

Crowdfunding provides a practical and fast method to collect cash for innovative project ideas and emergency assistance (Ashari, 2020; Alexandria, 2021). The past 2020 has caused a lot of challenging economic times worldwide due to Covid-19 plague, many organizations like Oxford, European Institute of Innovation and Technology (EIT) were raising funding to help local governments to deal with economic and medical problems. In general, a trusted intermediary is needed to manage the planning, broadcasting, raising funds, running project, tracking funds and other complete actions. However, crowdfunding supported with smart contract can eliminate the waiting time and extra charge fee from the intermediary. Crowdfunding can be automatically delivered to start the project when the money meets the unchanged protocol and rules including necessary financial requirements and other prerequisites. Every donates can track the capital flow, funding balance and process of the projects on a consensus, transparency, and shared data information (Alexandria, 2021). Autonomy and self-execute properties reduce the intermedia charge and energy resources wastes, lead to a rapid activation, information sharing achieving a trust relationship among trustless individuals.

Internet of things, or IoT, is an intelligent, reliable, and high-speed information collecting and sharing network that connects billions of physical devices including RFID (Radio-Frequency Identification), Barcode, GPS (Global Positioning system), WSN (Wireless sensor network), etc. (Duan et al., 2020; Ranger, 2021). Blockchain system linked with IoT technology can enhance security and accuracy of automatically captured real-time information which improves transaction efficiency information transparency, supply chain traceability, enable the rapid identification of the products origination, movement and qualities (Duan et al., 2020; Wan et al., 2020; Rejeb et al., 2020).

Blockchain is a multilateral resource value model that serves the electronic ecology which including all those functions. Immediate recalling action and reduction of consumers' concerns will reduce food loss and waste globally. A safe, adequate food, trust, healthy and eco society is every human being's desire. No single company, regardless of size, can achieve all of these features alone. Blockchain provides a fair, visibility, trust, eco-society for all human beings. Everyone can work together to minimize duplication efforts, unnecessary cost, processing time, and to promote more effective and interoperable solutions for a better life, a better world, and better earth.

The purpose of this research is to develop an eco-system using blockchain technology to improve dairy food and other food safety. It is decentralized, efficient, traceable, versatile, practical. The running of smart contracts supports a more trust, and efficient high-quality dairy supply system. The implement of crowdfunding function provides customers more choice and right to direct the customization and diversify dairy market. Equal and transparent

information sharing enhances the trust among all participants. More visible and authentic tracking data will eliminate the fear of customers and build up their confidence in dairy and other food products.

We set up the following four specific aims:

- I. Decentralized and Consensus data storage.
- II. Real-time and Efficient traceability.
- III. All information is open to customers
- IV. Safer dairy logistics supply chain

Successful completion of these specific aims was expected to establish a framework for a practical solution to solve the current dairy food safety problems including illegal production, fraud milk, food illness and food recall.

## 2. CURRENT DAIRY FOOD SYSTEM

Food is essential to support the function, growth, and development of the human body, hence, to ensure food safety is to ensure the basic human right (Fung et al., 2018)). A rapidly increasing and complex global food supply system starts from origins to consumers is coming with a series of continuous and daunting challenges in the form of food fraud, illegal production, foodborne illness, and food recall (dlesBlockchain, 2021). World Health Organization stated that. Microbial agents, chemicals, and other contaminations are the major hazards in unsafe food, which can cause over 200 diseases like diarrhea, cramps, typhoid, etc. (Duan et al., 2020; Fung et al., 2021; Food Safety, 2021). Every year, there were 600 million people fall ill after eating contaminated food in the world, over 420,000 people included 125,000 children die annually due to foodborne diseases (Food Safety, 2021).

## Dairy Food safety problems

Milk, a highly nutritious food, contains proteins, vitamins, minerals, carbohydrates, and other various essential components (Tan, 2020). Around the world, over 6 billion people are consuming it and its products, 150 million households are engaged in milk production (Dairy production and products: Processing, 2021). However, milk is required to be handled carefully because it's an excellent medium for the growth of microorganisms. Short shelf-life and greater perishability make the current dairy food supply system face more safety problems and challenges during processing, handling, and transportation (Kamath, 2018; Dairy production and products: Processing, 2021). Milk-related scandals have not waned from this earth. In 2005, contaminated baby milk resulted in 146 children's illnesses in France (Hamaide, 2021). In 2008, fraud milk caused over 300,000 victims included 54,000 babies in China (Chinese milk scandal, 2021). In 2013, Fonterra, a global dairy nutrition company, recalled 1000 tons of contaminated whey and related products across 7 countries (Fonterra recall, 2021). In 2019, Walmart, an American multinational retail company, recalled 23,388 containers contaminated infant formula globally (Levenson, 2021).

The slow and complicated transaction information track system suffered from identifying and verify the origin of dairy products and transport information by shifting from hundreds or even thousands of documents (Yiannas, 2018; Dujak, Sajter, 2019). Complex and diverse dairy food process-range from pasteurization to product labeling, and globalization markets make tracking more difficult (Duan et al., 2020). The increase of scandals of dairy food and the lack of information sharing has hurt customer's confidence in the products they got from the different retails. Recalls and customers' concerns of contaminated dairy products have brought about 29 million tons of dairy products were lost or wasted in Europe, \$27 billion in dairy products waste in the United States (Food loss and waste facts, 2021).

All these serious food safety problems have already impacted customers' trust, company's brand, human health, social economy, and our ecosystem. There is a pressing need for the development of an efficient and traceability food supply system.

## **Current solutions for food safety problems**

The global food traceability market size was valued at \$14 billion by 2019 and is expected to reach \$22.274 billion by 2025 (Fung et al., 2021). Most of the research and related work efforts over the past several decades focused on three approaches to achieve a better food supply system.

## Traditional food supply system

In a traditional food supply system, all transaction data is stored disparately. Figure 1 shown that product information visibility is only one step ahead and one step behind (Yiannas, 2018), each stakeholder in this supply system must work with the next one in the system to identify the provenance of the product. Traditionally, the transaction information is largely stored on paper or digital methods (Duan et al., 2020; Yiannas, 2018). Each participant in this system cannot communicate efficiently with others due to the disparate and multiples transaction information. During a foodborne outbreak, one by one checking from hundreds or even thousands of documents will heavily extend the time for identifying the problems (Yiannas, 2018). And customers who want to purchase this product only get the information from the product package, the information that the producers want to tell you. Because of this pathetic traceability capability, Walmart, famous American multinational retail company, still needed to spend at least 6 days, 18hours, 14 mins to track the original grower of a package of sliced mango a few years ago (Yiannas, 2018).



# Centralized Service System

A lot of modern companies like Sysco, Blue Apron, Hello Fresh, are utilizing the centralized service system. A centralized supply chain must follow the central power's governance rules and mechanism (Rejeb et al., 2020), all transaction information must be depended on the central organization to collect, check, maintain (Duan et al., 2020). For example, Blue Apron, one new meal's ingredients delivery service company, will provide customers the different recipes based on the seasonal food every week. Blue Apron will buy all ingredients in the recipes from their trusted local grocery stores, and then deliver them to the customers on time after repacking (Figure 2). Each meal service has a higher price-range from \$7.49 to \$9.99 for each customer (Blue Apron, 2021). All the transaction data, ingredient's quality, customers' account information is stored and controlled by the 'Blue Apron', this central power. The customers have only shared the limited information provided from Blue Apron's website and the ingredients' package. For a centralized service system, inequality power enhances the more limited information sharing, all sensitive transaction information and customers' privacy would be at risk if the central organization got hacked.



Figure 2: Blue Apron service system

#### Food supply system with IBM Hyperledger

In 2016, Walmart began to cooperate with IBM, the newly introduced Hyperledger technology has provided an efficient and secure digital tracking system for Walmart (Figure 3). With this new tracking system, the time needed to trace mangoes' provenance from 7 days dropped to 2.2 seconds (Duan et al., 2020; Yiannas, 2018; Kamath, 2018). Walmart controls the whole supply data on the network and has the power to determine the sharing of data elements. Nowadays, customers will not only be satisfied with purchasing the food to feed their stomach, but customers will wonder whether the products they purchased have as same quality, safety, and nutrition as described. According to current market situation, customers obviously still do not have enough confidence in Walmart's new Hyperledger technology because of limited information sharing.



Figure 3: Walmart track mangoes system with IBM Hyperledger

For the current existed supply system, disparate and complicated one by one traditional inefficient tracking system could not provide immediate and accurate gangrened tracking information, it's not practical to ensure the food especially the fresh argi products and dairy food safety. Although a centralized service system can query transaction information in time and make better and quick responses for foodborne problems compared with the traditional ones, inequality information sharing will provide the chances for fraud and other immoral behaviors. A centralized system may put all transaction data and customers' privacy information at risk if the system got hacked. Walmart's mango tracking system with Hyperledger provided product visibility from farm to store, the database stored in the blockchain is authentic and efficient for major participants, especially for Walmart. However, the limited information shared with customers is still a challenger to solve customers' fear of food safety problems.

## 3. RESEARCH DESIGN

We design a brand-new dairy supply system which will provide customers with fresh, organic dairy products at fair prices. It is decentralized and the data is open to everyone in a real-time.

#### 3.1 Create customize dairy supply chain

Smart contract is the future of crowdfunding. For traditional crowdfunding, contributors must pay for the intermediary fee and processing time, and worse, contributors do not know that whether the inventors put their money into some actual and feasible activities. The possibility of fraud issues will increase contributors' fear. However, contributing the money to a crowdfunding campaign supported by smart contract is secured and only after the campaign is successful (so when the agreement meets the predetermined conditions) the funds are given to the creators for concept realization. In case the concept fails to meet its objective-the funds will be automatically given back to the contributors immediately without third-party's time waste and extra money charged.

This new crowdfunding idea supports a more customize, diversify high-quality dairy supply system. For example, building up a new dairy supply chain needs a lot of money and not every enterprise wants to take this risk. But a crowdfunding application enables that more mid-class families living in Arlington, VA (a second headquarter of Amazon) donate a small amount of money to make a new organic goat milk supply chain become successful. Enterprises will be so willing to provide their sources to build up this new diary supply chain after they see so huge customers' demand and especially enough funding support. I-We believe that customers will be the future's major productivity leaders.

## **3.2 Record dairy logistics supply data**

Blockchain technology works with IoT will make all the participants can easily track whether the store temperature meets the required store temperature and date conditions during the whole supply chain. Like the process shown in Figure 4, milk must be finished transporting, checking, processing, and going to the store after milking at below 40 Fahrenheit within 48 hours. To make the dairy food reliable and safer, the real-time data will get recorded when sensors scanning with FRID on the milk cooling tanks, milk transport trucks, QR code and expiration date on the products package. Each block contains a Unix timestamp which will make global participants involved in this system can check and get the actual timestamp. The decentralized attribute allows each one involving the system to enter and attach the necessary information and certifications. Real-time and efficient track and trace capability makes recalling action become more effective and improves dairy food safety.



Figure 4: Record dairy logistics supply data using Blockchain

This proposed idea will be adapted to the Ethereum platform. The token wallet, MetaMask, makes participants worldwide make instant, easy payments with Ether is possible. A decentralized application was built with the Next.JS framework allows each participant can enter and attach some necessary information and certifications like farm needs to provide an FDA Dairy farm inspection report, dairy transportation company needs to provide FDA-approved inhibition test result and certificate of shippers. At the same time, IoT will record milking, transporting,

processing, distributing participants' transportation data for each participant and finally be stored into the Ganache local blockchain (Figure 5). All predetermined conditions including special service requirements, payment details and other agreements needed to be written into Smart contract (Figure 6).



Figure 6: Predetermined conditions for different participants

## **3.3 Local Blockchain Network**

Unlike Bitcoin, this dairy logistics supply system will be going to use a local blockchain, Ganache, instead of a public test one for the development purpose. This dairy supply system is more economic and environment friendly because less CPU space and electricity running is needed. All participants involved in this system have the same responsibility to check and maintain the data and transaction due to this system is governed by them rather than the single entity.

## 3.4 All information is open to Customers

As an import role in the food supply system, customers have the right to know whether the food they purchased is still in good quality, matches the products' description, meets the food safety requirements, or an organic food. After scanning the QR code and entering the expiry date on the product's package, customers can access the permission part of the blockchain record with a special App. More visible and authentic tracking data and information can reduce customers' fear to some extent. Reduction of the total food wasted in the world will contribute to the less squandering of resources including water, land, energy, labor, and capital.

## 4. **RESULTS**

## 4.1 Records of Dairy Logistics Data

Code in Smart contract will determine how this contract behaviors, how it handles the money. Set up different Smart contract according to each participant's special service conditions, payment details and agreements.

#### Smart contract for each participant

As shown from Figure 7 to Figure 11, we set up different smart contract to achieve different functions for each participant.

Farm Contract														
Variables						Functions								
manager		address	address of the person who	is managing and creating cord	nanaging and creating the farm Consti					constructor function that record the manager's account address, his working farm name. the farm address and some inspection certification id				
farm_name		string	the farm of this m	anager is working at			createRecord	Cal	led by the manager, the p	roduce reco IOT techno	rd is entering into the system with			
farm_addres	s	string	the addres	s of this farm			orderinfor	Calle	d by the manager to ente	r the proces	sor's order information into system			
certification_	id	string	FDA inspectio	on certification id			checkRegister	Call	ed when each departmen	t's checker r	needs to register to check whether			
department_na	ime	string	the department of the c	hecker is responsible with		approveBecord			Called by the regis	tered check	ers to approve a record			
work_id	work_id string		the id to iden	tify the checker		approvence or a			Called by the	manager a	nd finaliza record			
checkersCou	checkersCount uint		the number of tota	I registered checkers			InalizeRecord	Called by the manager and finalize record						
checkers	checkers mapping		list of addresses for every worker who is registered to be a checker				finalizeOrder	finalize the order in case the misunderstanding or double produce						
records	records		List of produce records	that are created with IOT			createShipping	System						
orders	orders		the list of the order the fa	irm got from the processo	rs		finalizeShipping	Call	Called by the manager, after getting the successful delivery information, the manager will finalized this shipping and she the money to the shipper					
shippings	shippings		the list of the shipping info	rmation the manager crea	ted		getSummay	C	Only view the number of orders, records, manager address, and other information, this function is used for user interface					
Record struct				Order struct					Shipping struct					
temperature	uint	the temp	erature of operation	order_company	string		the name of processor		shipping_product	string	the product name needs to be sh	ipped		
milking_date	string	the	a date to milk	order_product	string	th	e name of the product name	,	shipping_address	string	the name of shipping compar	ıy		
product_name	string	the farm may	produce milk, goat milk	order_amount uint		the product amount of product			shipping_amount	uint	the total amount needs to be shi	pped		
milking_amount	uint	the amou	unt of milk products	total_payment	uint	t the total payment for this order		r shipping_date		string	the date of products are shipped			
barn_number	string	the place of cow stay		expect_delivery_date string		the date is expected to delivery			expect_delivery_date	uint	the date of products should be delive to the processor			
cows_id	string	the RFID on cow, it helps to track the health situation of cow		complete	bool	· •	Whether this order is finished	shipping_fee		uint	the shipping fee			
cooling_tank	string	the cooling tank to store the milk						recipient		address	s the shipping company, who will get t money			
complete	complete bool Whether		the record is done						complete	bool	Whether the shipping is don	0		
approvals	mapping	track which chee	ker has approve the order						-					
approvalCount	uint	track the num	ber of approval checkers											

Figure 7: The variables and functions for Farm Smart Contract

			Transportati	on Cor	ntra	act				
oxt	Variables				[	Transport stru	ct			
	manager	address	address of the person who is managing and creati record	ng the	ſ	temperature	uint	the temperature of operation		
	shipper_name	string	the transportation of this manager is working a	ıt		shipping_date	string	the date to start transport		
	shipper_address	string	the address of this farm			delivery_date	string	the date to successful delivery to pro	cessor	
	certification_id string		certification of shipper			shipping_product	string	the name of the product to transport		
	checker_position string		which position this checker is responsible			shipping_amount	uint	the total amount to transport		
	checker_id	string the checker's working id				driver_id	string	the working id of the truck driver		
	checkers	mapping	list of addresses for every worker who is registered to be a checker			truck_license string		the license of transport truck		
	checkersCount	uint	the number of total registered checkers			complete bool		Whether the order is done		
	transports	Transport[]	List of transport records that are created with IC	т		approvals	mapping	track which checker has approve the order		
	records	Record[]	the list of the sender's (farm) shipping information	ion		approvalCount	uint	track the number of approval cheo	ber of approval checkers	
[	Functions				[	Order struct	]			
	transportation	Constructor function the shipper name, the sh	t record the manager's account address, his working ipper address and some inspection certification_id		ſ	sender_company	string	the name of sender(farm)		
	createTransport	Called by the manager,	the transport record is entering into the system with IOT technology	1		transport_product	string	the name of the transport product name		
	orderinfor	Called by the manager	o enter this shipping's order information into system			product_amount	uint	the product amount needs to be transport		
	checkerRegister	Called when each department's checker needs to register to check whether the record information is correct and match the order and approve it				receiver_company	string	the name of receiver's company (processor)		
	approvalTransport	Called by the registered checkers to approve a transport				transport_payment	uint	the total payment for this transport		
	finalizeTransport	Called by	the manager and finalize this transport			expect_delivery_date	e string	the date is expected to delivery		
	getSummay	Only view the numbe information	er of orders, records, manager address, and other h, this function is used for user interface			complete	bool	whether this record is finished		

Figure 8: The variables and functions for Transportation Smart Contract

				Processo	r C	Cont	ract						
Variables						Functions							
manager		address	address of the person who is managing record	ig and creating the processor			Constructor function that record the manager's account address, his working processor name, the processor address and certification, id						
processor_name		string	the processor company of this manag	ager is working at createRecord			Called by the manage	ger, the produce record IOT technolog	is entering y	into the system with			
processor_address		string	the address of this process of	company createOrder				Called by the ma system, th	nager to enter the proce	ssor's orde paid with s	ar information into ome ether		
certification_id		string	certificate of manufactur	urer CheckerRegister			Called when each de	apartment's checker nee	ds to regis	ter to check whether			
department_name		string	string the department of the checker is re-			asponsible with approveRecord			the registered checkers	to approve	e a record		
work_id		string	the id to identify the chec	cker finalizeRecord			eBecord	Called by the manag	er to make sure this rec	ord match	the order information		
checkersCount		uint	the number of total registered	checkers	neckers				and finalize this re	cord			
checkers		mapping	list of addresses for every worker who is checker	registered to be a	agistered to be a finalizeOrder			Called by the manager and finalize order and send the money to the farm					
records		Record[]	List of produce records that are cre	ated with IOT		purchaseInfo Called		Called by the manager to enter the order information from the distribution					
orders		Order[]	the list of orders are created by th	he processor		finalizePurchase		Called by the manager to ensure this purchase is finished					
purchases		Purchase	the list of the order information from	the distribution		getSummay		Only view the number of orders, records, manager address, and other information, this function is used for user interface					
Record struct	Record struct		Order struc	Order struct				Purchase struc	t				
temperature	temperature uint the		emperature of operation	order_from		string the n		ame of farm	purchase_company	string	the company to purc	hase this order	
delivered_date	string	the	date to receive the milk	order_product		string	the name of	the product name	purchase_product	string	the product name	of purchase	
delivered_product	string	the pro	duct they order from the far	order_amount		uint	the product	amount of product	purchase_amount	uint	the total amount	is ordered	
delivered_amount	uint	the amount of	milk to be successfully delivered	total_payment		uint	the total payment for this order		shipping_date	string	the date of produc	ts have to be	
product_name _id	string	the final finished pr	oducts' name and barcode(Great Value chocolate name)	expect_delivery_d	ate	string	the date is e	xpected to delivery	purchase_payment	uint	the distribution need	s to pay for this	
expire date	string	the barco	de of the products' package	recipient		address	the farm, wi	o will get the total ayment	complete	bool	Whether this purch	ase is finished	
product_amount	uint	the pu	rchase amount of product	complete		bool	Whether thi	s order is finished		<u> </u>	1		
complete	bool	Wh	ether the order is done	L									
approvals	mapping	track which	checker has approve the order										
approvalCount	uint	track the	number of approval checkers										
	1	1											

Figure 9: The variables and functions for Processor Smart Contract



Figure 10: The variables and functions for Distribution Smart Contract

			Re	tail Co	nt	ract				
Variables						Functions				
manager	address		address of the person who is managing an creating the record			retail	Constru	uctor funct	ion that enters the manager and the store information	
store_name	store_name string		the store of this manager is working at			createOrder	Called t	by the mai and p	hager to create a new product order, ay for the total_payment	
store_address	string		the address of the store	e		createRecord	Called b	by the mar	ager , the record process is finished with IPT technology	
department_name	department_name string		the department of the checker is with	responsible		checkerRegister	Calleo	d when ea	ch department's checker needs to	
work_id	work_id string		the id to identify the chec	:ker		approveRecord	Called	by the rea	istered checker to approve a record	
checkersCount	sCount uint		the number of total registered checkers				called by the registered checker to approve a rect			
checkers	mapping		list of addresses for every worker who is registered to be a checker			finalizeRecord	Called by the manager and finalize record			
orders	Order[]		Lis of orders that the manager has created			finalizeOrder	order, the manager will finalize it and send the mone to recipient			
records	Record[]		List of records that the IOT recorded			getSummay	Only v	Only view the number of orders, manager address, and other information		
Record struct						Order struct	t			
temperature	uint		the temperature of storage			distribute_nam	ne	string	the name of distribution	
Product_name	string	t	e name of product needs to be ordered			order produc		etring	the name of the product name	
product_id	string		the barcode of the product			order_produc	a sung			
receive_date	string	ť	he date to receive the products			order_amoun	t unt		the product amount of product	
product_amount	uct_amount uint		the amount of order products			total_paymen	t uint		the total payment for this order	
expire_date	string		the expire_date of product			recipient	address		the processor, who will get the order total payment	
complete	bool		Whether the order is done			expect_receive_e	date	string	the date is expected to get the products	
approvals	mapping	trac	k which checker has approve the order			complete		bool	Whether this order is finished	
approvalCount	uint	track	the number of approval checkers							

Figure 11: The variables and functions for Retail Smart Contract

## Factory contract to deploy more contract instance

In a real practical logistics supply system, there will be more than one participant who needs to be added to the supply chain to record their transaction data. There is more than one solution can achieve this function. We designed my solution satisfied with two basic principles: to keep all source code security and immutability, to allow an ecosociety developing environment. As Figure 12 shown the example of factory contract for Farm participant, other participants use the same solutions.





Figure 12: The method to deploy more than one Farm Smart Contract

## 4.2 Create a Campaign

More transparent and clear revenue and expenditure details help donors better understand the dynamics of the proposed concept and their investment income and can provide timely support or question the implementation expenditure requirements. Each contributor needs to be responsible for their money to the crowdfunding. In Figure 13 shown the details variables and functions for crowdfunding Smart contract.

Campaign Contract									
Variables				Request struct					
manager address		3	address of the person who is managing and creating the record	ing and description		string	Purpose o	f request	
national_id	string		the store of this manager is working at		value	uint	the value of tr	ansfer Ether	
minimumContribution	string		the address of the store		recipient	address	The account will r	eceive the Ethe	
project_info string			the department of the checker is responsible with		complete	bool	Whether the re	quest is done	
approvers	mappin	9	list of addresses for every person who has donated money		approvals	mapping	track which contributor has appro the request		
approversCount uint			the number of contributors		approvalCount	uint	track the number of approvi		
request	Request	٥	List of records that the IOT recorded						
Functions									
Campaign		Constructor function that sets the minimumContribution, provides the project distribution and the creator's national ID information							
contribute		Called when someone wants to donate money to the campaign and become ab 'approver', this function needs to be sent some ether							
createRequest		Called by the manager to create a new ' spending request'							
approveRequest		Called by each contributor to approve a spending request							
finalizeRequest		After a request has gotten enough approvals, the manager can call this to get money sent to the vendor							
getSummay		No gas needed, Only view the minimumContribution, manager address, the number of sending request, the number of contributors, the total received money, this project distribution.							

Figure 13: The variables and functions for Campaign Smart Contract

## 4.3. User Interface for Decentralized Application

Figure 14 demonstrated that how Next.js framework handles smart contract code, contacts with Ethereum network and shows the user interface to each participants and customers.



Figure 14: The working principle of Next.js framework

# 5. CONCLUSION

This is a better efficient and traceability dairy logistics supply system using Blockchain technology to identify and validate various stages of the food chain from farm to table or plates. This system can avoid the central authority involved, disparate and consensus data storage allows the data is visible and impossible to be altered without detection. Real-time and efficient track and trace capability make recalling action become more effective and improve dairy food safety.

More trust and security will be built up among the whole transaction system and this is crucial in the global food trade due to multi-ingredient food includes materials from a variety of food chains & countries. Crowdfunding supported by the Smart contract makes it impossible to have the chance to be possible. Customers will have the ability to lead the new direction of productivity in the future.

The successful execution of this research makes a positive impact on all the three sustainability parameters:

## **Environmental:**

This proposal undertakes an approach to develop a better efficient and traceability dairy food supply system with Blockchain to improve dairy food safety. Immediate recalling action when a foodborne happens and reduction of consumer concerns can partly reduce food loss and waste globally. Reduction of the total food wasted in the world will avoid the needlessly produce, the less greenhouse gas emissions will contribute the global warming and climate change problems. The application of local blockchain is more environmentally friendly because of the less squandering of resources including electricity, land, and other energies.

## Social:

Without safe, adequate food, trust, and a healthy environment, a society cannot flourish. This research contributes to preventing the public from suffering from hazardous to serious food safety problems through various means. Thus, the improvement of food safety will make a positive impact on the health of the current population and future generations. More trust and security will be built up among the whole supply system including customers. As a very important part of consumption, customers can guide the direction of production and create their customized supply system.

## **Economic:**

The success of this proposal will support a sustainable economy by three means: a) it reduces the risk posed by food safety problems on the public; b) it allows reduction of the total food wasted in the world will contribute to the less

squandering of resources including water, land, energy, labor, and capital; c) it clarifies the consumption interest, direction, and quantity of consumer groups, and avoids waste caused by mistakes or overproduction.

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