Blockchain Technology Adoption in the Food Supply Chain: Challenges and Recommendations for Modern Businesses

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Abstract. The adoption of digital technology in modern commerce has driven growth in total online sales and stimulated the development of new business models that combine online and offline sales activities. However, this change has created unique challenges in the food supply chain, requiring businesses to adapt to changing customer preferences and demands. In response to these changes, many businesses have begun leveraging blockchain technology to enhance supply chain efficiency, ensure food safety, and build consumer trust. This paper explores the specific challenges food businesses face operating in an integrated online and offline model. It analyzes how blockchain technology can address these challenges at different nodes within the supply chain. Focusing primarily on upstream sourcing, inventory management, and information transparency, specific strategies for blockchain adoption are provided. By examining the motivations and difficulties for food companies to invest in blockchain technology, the paper provides practical recommendations to improve the performance and efficiency of digital transformation in the food industry.

Keywords: Enter key words or phrases in alphabetical order, separated by commas.

1. Introduction

The introduction of digital technology in modern business provides a driving force for the online rate of total retail sales of purchasing stimulate the development of new business model combined with online and offline sales activities. Online sales bring new chances to business while decreasing offline store demand [1]. To better evaluate the competitive advantages and adverse impact of the new business model and blockchain technology's role in increasing revenue, in-depth research should be conducted. This paper analyzes different strategies of blockchain technology applied in different nodes of the food supply chain system to deal with specific problems related to daily operations in the food business supply chain system. The supply chain system of the food business, especially enterprise, which integrates e-commerce and offline stores, is evaluated in separate parts to display different impact factors. Those factors play different roles and have different weights in daily business operations according to specified challenges that food enterprises meet. The paper mainly concentrates on the following questions:

Q1: How could blockchain technology benefit the food supply chain system in different nodes?

Q2: How can the food build a wiser blockchain technology strategy to interact on the node with the biggest impact on the efficiency and profitability of the whole supply chain system?

Q3: How could food enterprises applying business integrated e-commerce and offline use blockchain technology to explore competitive advantages?

The paper may provide suggestions for blockchain technology strategies for the food business. Enterprises may adjust investment in blockchain technology according to their challenges and specific requirements to achieve better benefits. Although many researches explored the advantages and challenges for businesses in the food industry to introduce blockchain technology, the discussion of the impact factors of different nodes in the food supply chain system for business combining e-commerce and offline is rare, and the paper has innovation.

2. Case Description

Covid-19 has brought great changes in social and economic formation, and online activities have been introduced to people's lives [2]. The preference of customers' purchases has also transformed according to the trend, even some older people, who are usually believed to be "old-fashioned", have to learn online shopping, even if not initiatively. Even though the epidemic is believed to be as severe as before, the lifestyle it catalyzes has a lasting influence. The online lifestyle trend contributes to the development of digital technology, such as artificial intelligence, cloud computing and blockchain, and these technologies bring revolution and provide new opportunities to modern business. To better adapt to the changing environment, enterprises apply new business models, and online sales gradually take more and more important roles in business plans. However, in the food industry, the growth of economics and the development of technologies for food storage and cold chain delivery encourage customers to build higher requirement for food safety and diversity [3], which lead the business to a platform that asks for more complex system of the food supply chain, more strict control on food inventory and more flexible information transformation in different participated nodes of the whole supply chain system. Offline stores with touchable goods give trust and safety sense to customers and provide convenience to customers with regular work time who feel tired of communicating with couriers about delivery time. To meet the personalized and diverse requirements of customers, an integrated online and offline model is considered by many companies in the food industry. While the new model faces challenges in purchase, inventory and delivery. To deal with the emerging challenges, blockchain technology has gradually attracted managers' interest. The characteristics of blockchain, which include transparency and traceability, non-localization, security, smart execution, and so on [4], are believed to provide a feasible solution to problems in the food supply chain system, such as fraud, shortage and delay.

Meanwhile, blockchain can integrate various stakeholders to eliminate sharing revenue with greedy intermediaries and promote information flow among suppliers and retailers [5]. An advantage that blockchain technology could bring to enterprises is a decrease in delivery delay and the belief in fresh and good quality purchase, leading to higher customer satisfaction and greater customer loyalty. The number of research related to blockchain technology transformed into revenue in supply chain system increased exponentially in recent years, and research focus on both theoretical and practical aspects. However, business still holds concerns about the potential risks of using blockchain in the whole supply chain system. Many businesses need help to afford the costly blockchain technology.

In contrast, for those with advantages in cash flow, the return on the investment of blockchain technology may take time to observe. On the other hand, information sharing among participants and third-party logistics increases the opportunity for information leakage. Thirdly, employees are likely to rely on their experience to make decisions in supply chain systems rather than consider suggestions from new blockchain technology.

Even though digital transformation is considered a new and inevitable trend in business, enterprises still face obstacles related to digital transformation strategies. From tracking the digital transformation of Chinese companies of Accenture, although the advantages created by the digital transformation of leading companies constantly expand, most businesses, especially small to medium enterprises, hold an increasingly cautious, if not passive, attitude to digital transformation. Huge investments, long payback periods and high requests for technology are believed to be common difficulties for business digital transformation. These concerns are not groundless. Yonghui Superstores, one of the earliest and biggest players in the fresh food market, faced a decrease in market share and revenue after changing its business strategy to digital transformation, attributed to strategy imbalance in introducing digital technologies. To maximize revenue by introducing blockchain technology to the supply chain system, business should carefully figure out suitable strategies according to the business environment and customers' needs for the specific company [6].

3. Analysis on Problems

Intertwined supply chain system and many participants increase the difficulty of selecting upstream for enterprises. Customers are asking more for food on their tables. Once, they went to the supermarket seafood counter and only asked questions about the kind of fish and price. Now, they are critical about the origin and farming methods of the fish, and they may even be curious about carbon emissions during fish transportation. They may leave for another supermarket since they are satisfied with one small product detail, benefiting from varied choices nowadays. While the diversity of food supply brings challenges for business upstream purchase. Business has to collect as much information as possible to support a wise choice among countless suppliers and constantly monitor the market to prepare for marketing changes. The game usually happens between supplier and retailer to compete for better performance and higher revenue [7]. Since some nodes in the food supply chain system can change their roles from suppliers to retails according to business condition, and they may sell products at a reduced price to customers when, as a retailer, the trade price cannot be guaranteed for the one who always plays as retailer [8]. Food quality is also a big concern, since it is difficult for businesses to check every piece of food from their suppliers carefully. Alibaba suffered a huge loss because of a batch of quality ingredients from one of its suppliers. In addition to the visible food quality, more details about the food should be considered for retailers, such as carbon emissions during the production and processing process, since customers pay more and more attention to these sectors. Since these factors cannot be observed directly, the cooperation between retailers and suppliers may be influenced by inconsistent perceptions according to specific factors. Due to information asymmetry, food businesses need help in searching for satisfied and capable long-term cooperation suppliers and maintaining friendly business relationships. Some business has to seek intermediaries to collect information from plenty of retailers and pay extra cost [9].

Due to the perishable property of food, food inventory usually costs more, while food preservation time is usually shorter than most other products. The diverse food choices for customers always means higher inventory pressure for business to satisfy customers' needs. Online and offline integrated business models increase the risk of the bullwhip effect and put forward higher requirements for inventory control and demand prediction [10]. On the one hand, business needs to develop resilience strategies to confront uncertain environment and increase the ability to resist disruption [11]. On the other hand, businesses need to consider return and food surplus to relieve the pressure of inventory and food waste due to perishable. For customers, they want to buy food more than only not rotten. Commonly, dessert sellers sell pastries produced exactly that day at a quite low price before closing. Hema Fresh used to include in a scandal that its' employees replaced food labels to make the food seem fresher than it is, which damaged the brand image and disappointed its customers. In the modern city, space can also be considered a scarce resource. Better inventory control can expand the profit opportunity for business [12]. In the supply chain operation of the business, with the ambition to combine online and offline sale models, face the challenge of inventory allocation plan. Customers' orders may contain products in different warehouses or offline stores, and an unwise inventory allocation plan would decrease response speed and increase order delivery costs. During the delivery process, businesses face challenges dealing with customers' personalized needs and diverse delivery times while maintaining response efficiency to emergencies. Business in the food industry faces challenges to perform better under the pressure of customers' complicated needs and personalized service requirements and to control inventory better and predict demand while decreasing food preservation and inventory allocation costs.

Frequent food fraud seriously damages the relationship between customers and businesses in the food industry. In contrast, customers are increasingly strict with food on their meal tables with the growth of the economy [13]. Customers nowadays care more about food safety and information authenticity than ever [14]. One of the most notorious examples of food fraud in China is the milky product contamination that happened in 2008. The brand Sanlu and the word melamine were connected for years after the scandal that the milk powder of Sanlu contained excessive melamine. The influence of the scandal has only partially been eliminated until now, and most customers hold a

negative attitude toward the Sanlu brand. The brand suffered from a significant loss, but similar events continue today. Many supermarkets, such as Walmart, Carrefour, and Eurospin, have experienced one or even more food recalls in recent years. Many retailers need more quality monitoring and help to afford the cost of tracking each step during food processing, leading to the potential risk of substandard food. Even though food recall displays a positive attitude for businesses to solve the problem, the behavior pressures enterprises' cash flow and brand reputation, which would be a catastrophe for small to medium businesses.

Meanwhile, food recall cause customers' concerns about other products. For a business own food processing chain, the ingredient problem means the whole effort of processing is in vain. If the business cannot locate the use scope of problematic raw materials, more products need to be recalled and much more economic loss. From customers' perspective, to meet their specific preferences, they may want to gain more information about the fish lying on the freezer counter. For example, some customers want salmon from Alaska waters in the United States, and they would ask retailers to provide evidence to support that the salmon they claim originated from Alaska is actually from a specific area. Businesses in the food industry face challenges to monitor food production, processing and transportation to ensure food quality, decrease the potential risk of fraud, and provide information to customers to win trust and consumer confidence.

4. Suggestions

Food businesses can build suitable blockchain multi-chain systems to relieve the pressure of upstream purchase. For problems such as price change games, quality inspection and trust crises among collaborators, blockchain technology can support business in monitoring price fluctuation, tracing procurement sources, tracking the purchasing process to select suppliers and reducing procurement process instability to improve upstream purchasing performance. Smart contract develops on the basic blockchain framework to promote information sharing among participants and constrain the commercial behavior of each participant during the transaction [15], providing auto information feedback and disruption detection [16]. The smart contract investment increased exponentially as computation difficulty increased according to the quantity growth of participants. Retailers can use credit supervision as an auxiliary method to support the upstream supply chain daily operation and decrease potential risks of fraud and breach of contract. Business can adjust the proportion of smart contact technology introduction according to procurement requirements, which means investing in smart contract technology before the nodes have more business activities in the supply chain system. For products with large demand and popularity among customers with few specific characteristics, smart contract technology can be applied to seek and filter suppliers that supply stable and trustworthy. While for products that can only be found in a few origins with more specific preferred factors from customers, such as fresh salmon from the Gulf of Alaska caught the specific day and transported in a low carbon method as possible, businesses can adopt a strategy that combines profession purchasing personnel with credit supervision system to guarantee food quality meanwhile control the cost. Hema Fresh takes similar strategies that build a professional purchasing team to take responsibility for purchasing high-end fresh food for people with high consumption ability and successfully receive profits. Digital technologies can be introduced to satisfy popular demands, and experienced purchasing employees are placed to serve high-demand customers with high consumption ability. The strategy would relieve investment pressure at the beginning of digital transformation and reduce technical difficulty and employee education time within the organization.

Companies with business models integrated online and offline can take advantage of the specific business model combined with blockchain technology to deal with inventory and delivery challenges. Demand fluctuations are increasingly becoming a problem in modern supply chain operations [17], limitations of product storage and tradable periods in the food industry forced enterprises to be more sensitive to demand fluctuations. As customers become increasingly accustomed to online shopping, they put forward more personalized delivery requirements. For example, some customers prefer

delivery on weekends or evenings after work or may want to change their order or delivery destination at the last moment. Adjusting inventory allocation according to different last-mile delivery methods would help enterprises improve the supply chain system performance [18]. Delivery service is important in customer loyalty and future purchase behavior [19]. Business can consider introducing blockchain that assists business in building an efficiency strategy to connect inventory allocation and delivery processes rather than focusing on only one of the operations. Offline stores can act as small warehouse to store food that circulates fast, such as rice or flour, or food with specific characteristics, such as chocolate eggs, during Easter. Other products with less storage conditions or timeliness requirements can be preserved in warehouse in the suburbs. Since distributed warehousing replaces integrated warehousing, the impact of the bullwhip effect is reduced. Blockchain technology improves delivery performance through automated sorting, distribution and packaging, optimizes transportation routes, and reduce delivery time.

Meanwhile, data information related to delivery can give business feedback to assist businesses in responding more quickly to inventory fluctuations and making more accurate demand predictions. Data collection during the package and delivery process can analyze customers' preferences, connect customers' online and offline shopping experiences, and provide more precise service to improve customer satisfaction and increase customer loyalty. To better benefit from blockchain technology, companies can make the best use of the advantages of the business model combined with online and offline transaction.

Enterprises can seek cooperation in building information traceability through blockchain technology. Transparent, reliable, secure, and tamper-proof are widely regarded as the main advantages of blockchain technology [20]. Radio frequency identification technology (RFID) can combine with blockchain system, apply traceable system to food products in the supply chain operation and mitigate the risk of hacker attacks [21]. Traceability can not only be used for customers to evaluate the quality and resource of food but also benefit enterprises working as monitors of the performance of products and collector for customer consumption habits. Customers nowadays pay more attention to food safety and food origin and are likely to pay more attention to clear and accurate information related to the field [22].

Moreover, enterprises with more precise information would also benefit from detecting food safety issues timely to take necessary measures to maintain brand image and customer confidence. Customers expect traceability and transparency in the purchase process, so information is required from retailers to third-party logistics service provider. A study analyzed blockchain technology application in the fresh food industry. It displayed that the blockchain technology investment from whatever role in the whole supply chain system can benefit each participant and improve performance and efficiency [23]. Retailers can cooperate with third-party logistics service provider for the beginning investment of blockchain technology to reduce the resources invested. Since blockchain technology has the characteristics of encryption protection and openness, concerns about information leakage by partner companies can be reduced. Alibaba cooperated with other companies, such as blackmore, to create a framework of food trust in 2017, which was used to track dairy products from Australia and New Zealand through blockchain technology. Enterprises only need to provide customers with the necessary information they need to make purchasing decision, too much information may drown out the most important part and have an adverse impact on customer purchasing. Suitable cooperation with other participants in the supply chain system could be a choice for companies with less cash flow to build the whole blockchain technology at once.

5. Conclusion

The paper considers the strategy of the food business introducing blockchain technology to promote the performance and efficiency of the supply chain system operation under the modern business background of digital transformation. The new business model that integrating online and offline stores is believed to be a popular trend in the future business and brings challenges for digital

transformation. Since technology applications are usually accompanied by unavoidable problems such as the great difficulty of technology development, long-term return, and vague rate of return, the business has to take full account of currently operated difficulties and future development plans when making decisions related to digital transformation. It targets investment in a different part of the supply chain system based on actual conditions to gain maximum profit. The paper discusses challenges possibly faced by business in the food industry, including upstream purchasing, inventory allocation and information visibility and provided corresponding suggestions according to the blockchain technology introduction. The paper mainly conducts a qualitative analysis of motivations and difficulties for food companies to invest in blockchain technology and come up with suggestions for business to improve the performance and efficiency of digital transformation based on specific problems in practical application, different strategies are suggested for different business requirements. To gain a better understanding of the weights of different nodes in the supply chain system operation and provide more accurate suggestions of strategies of digital transformation in modern business environment to companies in the food industry, quantitative analysis should be taken into consideration in the future and models which can reflect changeable market environment can be built to display research outcome better. Considering that the number of participants in the food supply chain is increasing continuously and the intertwined supply chain network structure is becoming increasingly complex, research on the impact coefficient of applying blockchain technology into part of the network structure of a supply chain system rather than a single node would be valuable in the future.

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