

A Review of Pricing Research on Prefabricated Food Supply Chain Considering Blockchain Technology

Jiarui Yang^{1,*}

¹ School of Management, Shanghai University, Shanghai, China

* Corresponding author

Abstract: As the pace of urban life gradually accelerates, prefabricated foods that balance efficiency and health have come into the public view. Given the rapid development of the prefabricated food industry in China, studying relevant issues in the prefabricated food supply chain is of great significance. This article conducts a literature review by searching for keywords such as prefabricated foods, supply chain pricing, and blockchain technology, analyzing trends, and summarizing findings. It is found that research on prefabricated foods, both domestically and internationally, mainly covers aspects such as raw material processing, product quality, microbial contamination prevention and control, and nutritional value assessment. Regarding pricing decisions in food supply chains, the literature discusses the impact of food loss, inventory strategies, market demand, and pricing on profits. Additionally, researchers have explored the application of blockchain technology in food supply chains, including the influence of conditions and parameters on pricing decisions. Although existing research provides important insights into prefabricated food supply chain management, there are still some limitations. Future research directions include sustainability and environmental factors, emerging markets and international trade, and the application of digital and intelligent technologies. These studies will provide theoretical guidance and practical recommendations for the sustainable development and innovation of prefabricated food supply chains, supporting the establishment of efficient shared cooperative relationships.

Keywords: Prefabricated Food; Block chain; Supply Chain.

1. Introduction

Due to the popularity of the "lazy" and "cooking novice" ideologies, as well as the rapid development of society, there has been a significant transformation in the consumption structure of national food and beverages. Prefabricated foods, including ready-to-eat meals and cooking kits, have become new highlights in the catering industry due to their convenience and speed. On February 13, 2023, the "Opinions of the Central Committee of the Communist Party of China and the State Council on Promoting Rural Revitalization in 2023" was issued. This first central document of 2023 required the enhancement of industry standardization and regularization of fresh vegetables, central kitchens, and the cultivation and development of the prefabricated food industry. After several years of rapid development, weaknesses in the prefabricated food industry, such as the lack of production standardization, relatively single product categories, and bottlenecks in research and development innovation, have gradually emerged. Standardization is a key feature and core difficulty of prefabricated foods. In the future, prefabricated food enterprises must achieve quality improvement and sustainable development, and enhancing product competitiveness is crucial. This involves not only achieving product standardization, nutrition, and convenience but also inheriting the traditional catering's taste, aroma, color, and shape. Prefabricated food enterprises should not blindly expand but should establish professional production management standardization systems and research and development systems. Efforts should be made to upgrade towards automated and digital production on the basis of standardization. Moreover, China is vast and rich in agricultural resources. With the formation of consumption upgrades and diversified dietary structures, R&D in prefabricated foods should not be limited to existing

traditional categories. It should combine market research in different regions and the current nutritional and health needs of consumers, fully tapping into the characteristics of miscellaneous grains, local specialty ingredients, and dual-use food materials to develop more distinctive and differentiated prefabricated food products.

In the prefabricated food trading market, consumers are very sensitive to product prices. At the same time, decision-makers in enterprises along the supply chain are also very sensitive to the costs and benefits of introducing new technologies. Therefore, reasonable pricing of products and decisions regarding the introduction of blockchain technology in prefabricated food supply chain enterprises are among the issues of concern to theoretical researchers. Thus, this article summarizes relevant literature on prefabricated food supply chain pricing and the introduction of blockchain technology in food supply chains to provide theoretical guidance and practical suggestions for establishing efficient shared cooperation relationships among prefabricated food supply chain enterprises.

2. Literature Review

2.1. Prefabricated Foods

Early foreign research on prefabricated foods mainly focused on the influence of raw materials and their processing on product sensory quality, differences in industrialized formulations and processes compared to traditional dishes, and their evaluation of nutrition. Further research involved the establishment of risk models for microbial contamination control in prefabricated foods, detection of flavor additives, assessment of nutritional value, monitoring of microorganisms and parasites, and the impact of industrialized prefabricated dishes on mass consumption. In recent years, emphasis has shifted towards improving safety

control systems, nutritional regulation of prefabricated products, and the use of new technologies to enhance product quality and safety. Early domestic research on prefabricated foods was based on the industrialization of processed meat products and dishes. Scholars such as Wang Jing and Sun Baoguo analyzed the industrial production of major traditional Chinese foods and dishes, identifying key scientific issues and proposing pathways for the modernization of traditional Chinese foods. Zhao Juyang and Li Manxiong discussed preservation techniques for processed meat products and the development and quality research of prefabricated processed food dishes. Wang Jichuan and others surveyed the microbial contamination status of prefabricated food enterprises and analyzed influencing factors. Zhang Qun, Zhao Jinglin, and others studied quality control of prefabricated processed dishes, industry status, and issues. Currently, the development of prefabricated foods in Europe, America, Japan, and Korea has matured, especially for various industrialized meat dishes that require no cooking and can be consumed with simple heating or preparation. Industrialized dishes such as braised beef, shredded green pepper with meat, and mapo tofu, blending Eastern and Western traditions, have become exemplars of prefabricated dishes. In China, the early development of prefabricated foods coincided with the emergence of convenient, leisure, and pre-prepared foods, attracting attention as traditional dishes became industrialized. The Chinese Academy of Agricultural Sciences introduced such technologies from Japan and conducted related research and industrial applications, discussing the processing technology of prefabricated dishes in 2013. Document [2016] No. 93 from the General Office of the State Council proposed "encouraging the industrial development of staple foods, developing and producing a batch of traditional rice, flour, miscellaneous grains, and prefabricated dishes," and Document [2021] No. 2 from the Ministry of Agriculture and Rural Affairs mentioned "innovative development of agricultural commercial supply, prefabricated dishes, restaurant takeout, and cold chain delivery," clearly defining the types of "prefabricated dishes" at the governmental level. Nowadays, various enterprises are entering the hot track of prefabricated dishes. Meat processing enterprises, based on canned foods, pre-prepared meat products, and military food, have launched various prefabricated products mainly using meat as the main ingredient. The catering industry extends its industry and explores new avenues through central kitchen construction. The number of prefabricated dishes and related enterprises exceeded 40,000 in 2015, reached 80,000 in 2018, registered 12,500 new ones in 2020, and currently exceeds 68,000, with nearly 58% established within the last five years. The domestic prefabricated food market was nearly 400 billion yuan in 2022 and is expected to exceed 500 billion yuan in 2023, possibly surpassing one trillion yuan by 2026.

2.2. Pricing in Food Supply Chains

In literature on pricing decisions in food supply chains, due to the perishable nature of food, many scholars have studied the impact of food loss and inventory strategies on pricing and profits for supply chain members. For example, Cai and Ma studied the decision-making and coordination issues of a three-tier food supply chain composed of producers, third-party logistics, and distributors, where food market demand is influenced by both price and freshness. Zhu et al. explored the joint impact of food freshness and sales efforts on supply

chain decision-making in fresh food markets. Gao et al. studied the impact of inventory sharing among retailers on the supply chain, finding that when the supplier dominates, inventory sharing increases retailer ordering and total supply chain profit is always greater than in the traditional model. Darom et al. proposed a two-stage supply chain recovery model considering safety stock and carbon emissions affected by supply disruptions. Zhang Xu and Zhang Qing considered the perishable nature of fresh food and fairness concerns among supply chain members, studying supply chain decision-making and coordination issues. Fan Chen et al. studied logistics cooperation and price integration decisions between producers and retailers in a dual-channel fresh supply chain, considering consumer purchase decisions influenced by fresh product prices and freshness, and achieved supply chain coordination using linear compensation and revenue-sharing contracts. Cao Yu et al. studied the impact of "free-riding" behavior and channel out-of-stock substitution behavior on supply chain inventory competition and promotion decisions under random demand, finding that the optimal inventory level of fresh food suppliers in online channels depends on consumer sensitivity to promotional efforts. Chen Wuyuan et al. compared the freshness efforts, inventory levels, and profits of suppliers and retailers in two modes of joint inventory control and dispersed inventory control, analyzing fresh supply chain profits. Zhang Mingyang et al. discussed the optimal pricing and joint inventory decisions of fresh supply chain members under two models: one where pricing is unaffected by the degree of corruption and another where pricing varies with the degree of corruption.

2.3. Blockchain Technology

Blockchain technology is a forward-looking technology for future development. With its characteristics of tamper resistance, smart contracts, and decentralization, it has been applied in many fields, with the application of blockchain technology in food supply chains pioneering the way. In literature on supply chain management considering blockchain technology, scholars from domestic and foreign contexts have discussed the critical conditions for supply chain members to adopt blockchain and the impact of relevant parameters of blockchain technology on pricing decisions for supply chain members. Wu et al. found that the adoption of blockchain technology depends on consumer acceptance of products without blockchain technology, perishable product spoilage rates, and the proportion of FPSC traceability costs. Li et al. studied the supply chain coordination problem under the joint action of blockchain technology and random demand, finding that when retail prices are stable and under profit-sharing coordination mechanisms, the use of blockchain technology can increase both supply chain member and total supply chain revenue. Choi found that the convenience utility provided by traditional retailers is a key factor in choosing between traditional retail network operations and blockchain technology-supported platforms. Liu et al. explored the impact of blockchain technology on information sharing among supply chain members under retailer risk aversion behavior, finding that under decentralized decision-making, the level of blockchain technology application by fresh food suppliers is influenced by retailer order quantities. Liu et al. found that fresh food suppliers always produce low-quality products when there is no blockchain, but when the quality cost ratio is sufficiently high and blockchain adoption costs

are low, blockchain technology can encourage fresh food suppliers to produce high-quality products. Shen et al. found that blockchain secondary platforms prefer to sell products with low uniqueness and low quality (or high uniqueness and high quality). Hayrutdinov et al., by comparing equilibrium solutions in different decision scenarios, found that efforts to share product lifecycle information in blockchain systems can increase overall supply chain profits. Niu et al. considered a two-stage supply chain consisting of two fresh drug suppliers and one general retailer, finding that when channel competition is weak and demand differences are small, retailers have the motivation to participate in blockchain. Guan Yue built a blockchain-based supply chain information collaboration supply chain model, demonstrating that the collaborative benefits brought by blockchain-based supply chain information collaboration exceed those of traditional supply chains. Tang Dan et al., using the newsboy model, compared and analyzed the differences in benefits of blockchain debt transfer platform models and traditional supply chain financing models from the perspectives of various supply chain entities, showing that blockchain debt transfer platforms can increase supplier output, improve the income of supply chain members, and maximize the benefits of accounts receivable financing. Zhang Zhi et al., addressing the additional inventory costs and poor demand forecasting accuracy caused by asymmetric information in traditional supply chains, constructed two models of blockchain application conditions with and without blockchain. Sun Zhongmiao et al. studied the optimal pricing problem of supply chains driven by blockchain technology based on the identification needs of loyal and general customers for brand product authenticity. Guan Zhimin et al. discussed the impact of blockchain technology on cross-border supply chain decisions under the background of additional tariffs under different contracts. Li Junxiang et al. analyzed strategies for preventing moral risks of third-party logistics service providers using blockchain technology. Dong Xinglin et al. constructed a "blockchain + B2B online supply chain finance" model and used the modified Shapley value method to allocate cooperative benefits of online supply chain financing alliances, finding that the "blockchain + B2B online supply chain finance" model can reduce risks for various business nodes and increase the income of participating members. Liu Lu et al., using the Stackelberg game method, depicted traditional supply chain finance models and blockchain supply chain finance models, finding that when the enterprise's cost of capital is high, blockchain supply chain finance can achieve win-win results for supply chain members.

3. Summary

In summary, existing literature has outlined the application of blockchain technology in supply chains, especially in food supply chains, as well as issues related to the development of prefabricated foods and pricing and quality decisions in food supply chains. It is evident that an increasing number of scholars are beginning to focus on the development of prefabricated food supply chains from different perspectives, yielding numerous valuable research findings that are of significant reference value to this article. However, through the review of the above literature, several main limitations can be identified:

1. Existing research on pricing in prefabricated food supply chains mainly involves aspects such as food loss and

inventory strategies, market demand, coordination and cooperation among supply chain members, safety stock and supply interruptions, application of new technologies, and consumer behavior. These studies aim to understand the complexity and challenges of pricing in prefabricated food supply chains and explore ways to optimize pricing strategies to enhance supply chain efficiency and overall benefits. However, there are still some directions worth further exploration, including sustainability and environmental factors, emerging markets and international trade, application of digitization and intelligent technologies, and food safety and quality control. These studies will provide more effective decision support and theoretical guidance for future supply chain management, promoting the sustainable development and innovation of prefabricated food supply chains.

2. Regarding research on the application of blockchain technology in supply chains, existing literature from domestic and international sources mainly focuses on the conditions for adopting blockchain technology under different backgrounds, with only a small amount of literature studying the impact of food supply chain members' choices on the application of blockchain technology. Blockchain technology can address a series of pain points in prefabricated food supply chains caused by information asymmetry and is an important technology to drive the development of prefabricated food supply chains. Future research directions include the application of blockchain technology in various aspects of the supply chain, covering production, procurement, logistics, etc., to improve efficiency and transparency. Secondly, research on the application of smart contracts and automation technology in prefabricated food supply chains is needed to improve process efficiency. Additionally, it is necessary to study the role of blockchain technology in promoting cooperation and collaboration among supply chain members, while also addressing data security and privacy protection issues and paying attention to legal and regulatory challenges to maintain market order and consumer rights.

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