Proceedings of the 2nd International Conference on Financial Technology and Business Analysis
DOI: 10.54254/2754-1169/70/20231684

Application of Virtual Organizations in the Integrated Model of the Feed Industry

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Abstract: This paper addresses the extended development of the integrated model of the industry chain, utilizing the form of virtual organizations for further expansion. Given the necessity of concentrated resource allocation in the feed industry chain, virtual organizations, with their advantages of dynamism and flexibility, can enhance internal communication and collaboration efficiency, strengthen collaborative effects, scale effects, market effects, and reduce market competition and risks. The article enriches the integrated application model of the feed industry by drawing on three novel supply chain strategies. Empirical research indicates that the application of virtual organizations in the integration of the feed industry can fully leverage their effectiveness and applicability. Performance analysis indicators are also enumerated. In the future, it is expected to conduct more extensive research on virtual organizations, proposing innovative conceptual applications for the integrated integration of agricultural industry chains.

Keywords: Virtual organizations, Integration, Industry chain, Feed industry

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1. Introduction

In light of the release of the Central Document No. 1 in 2023, the Central Committee emphasizes that the most arduous task for achieving the comprehensive construction of a socialist modern state remains in rural areas. Urgent action is required from the entire party and society to maintain the focus on the core work of “agriculture, rural areas, and farmers” and take a historic stride toward comprehensive rural revitalization. The agricultural product manufacturing industry holds tremendous potential in the steady promotion of rural economic revitalization, particularly in the process of its integrated allocation. The collaboration of upstream and downstream industries in the supply chain not only meets the growing demand for agricultural products but also facilitates the centralized, scaled, and industrialized development of the industry.

In the process of the overall development of the modern agricultural industry chain, the feed industry plays a crucial role in connecting the links of planting, breeding, and agricultural and sideline product processing. It is also a more flexible component that can better leverage its ecological circular development. Positioned in the middle of the chain, the feed industry serves as the link between

DOI: 10.54254/2754-1169/70/20231684

planting and breeding, supports the processing of by-products, and is interconnected with other retail industries. With the potential for high added value, effective coordination and organization of various elements in the production process are essential. Additionally, considering the development environment and policy orientation of China's feed and agriculture industries, there is a need for a systematic analysis of the operation of the feed industry chain and its various links. This will help identify a path suitable for the green and efficient development of the feed industry in China.

Driven by the integrated model, China's feed industry has evolved from traditional scattered farming operations to centralized industrialization. However, the limited application of its integrated allocation restricts its comprehensive competitiveness. Fluctuations in the prices and costs of agricultural production, storage, and processing, for example, can lead to a decline in price competitiveness. Introducing the virtual organization management model into manufacturing industry clusters has the potential to achieve group leaps, overcome resource limitations, and enhance both horizontal and vertical collaboration, ultimately seeking greater economies of scale.

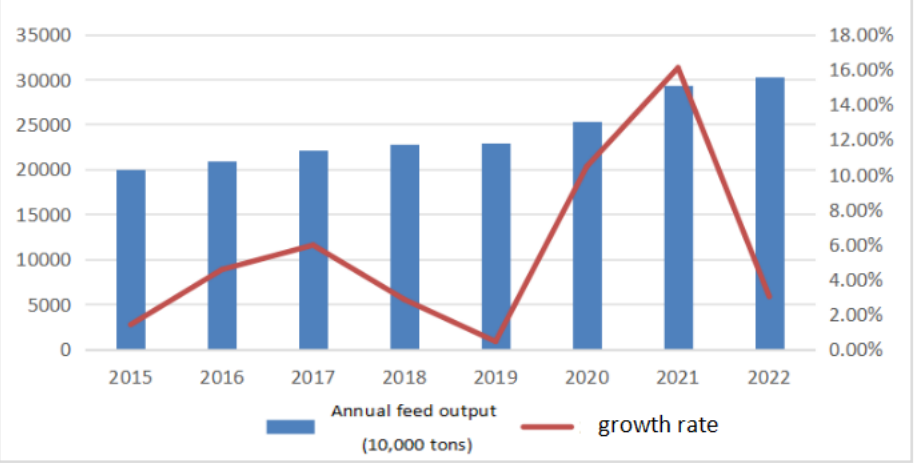

Figure 1: National Feed Production and Growth Rate from 2015 to 2022
Data source: China Feed Industry Association

Virtual Organization (VO) was first proposed by Kenneth Preiss in 1991 in "Research on the Manufacturing Enterprises of the 21st Century: Industrial Determinants of the Future." Originally discussed as a significant means of systematic innovation for enterprises, the concept of virtual organization has gained increasing attention from scholars with industrial development. Currently, in the wake of the global COVID-19 pandemic, the virtual organization management model has once again become a focal point, domestically and internationally. Scholars are actively discussing the necessity of constructing virtual teams due to their cross-regional, flexible, and convenient nature. Presenting virtual organizations as a strategic tool to respond to external uncertain environments demonstrates the mechanism based on resource-based platform integration effects and the complexity of dealing with overall operational risks within organizations. This implies that organizations in the industrial chain between upstream and downstream should not only establish virtual organizations based on maintaining sufficient communication flexibility. As the complexity of interaction increases, they should also provide higher-level resources, such as building learning organizations through virtual platforms to reduce the risks brought by cultural differences and increase space for inter-company cooperation and trust, thereby reducing the vicious competition in the market.

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2. Research Overview

As a strategic approach in business competition, virtual organization has become the focal point of enterprise relationship aggregation. Virtual organization is defined as an organization that continuously redefines and reinvents its design in an open manner, heavily relying on collaborative links with resources beyond its formal jurisdiction[1]. Xu Ruomei and Wang Shuo[2] propose that as a network organizational structure, virtual organization can effectively integrate organization, manpower, technology, and information. The efficient allocation of resources in virtual organizations is considered a key factor in gaining sustained competitive advantages in the modern market[3], particularly for small enterprises with a limited capital base that lacks rapid investment in new resources. Black & Boal[4] emphasize the role of inter-resource relationships in creating configurations that are irreplicable and irreplaceable, effectively utilizing every resource element in the industrial chain.

In the transitional phase of China's feed processing industry from a growth period to maturity, upstream and downstream enterprises in the industry chain should play a collaborative role in their relationship clusters. Through the digital virtual aggregation of the industry, the development promotes technological progress and optimizes technical efficiency, driving the growth of total factor productivity, reducing production costs, achieving dynamic flexible growth, and gradually making technological progress triggered by digital virtual aggregation a major force in improving national economic development and productivity[5]. Simultaneously, Guo Xuelu[6] analyzes the virtual organization accounting information system and mentions that the centralized level of control is limited. Therefore, there is an urgent need to develop a decentralized management system to distribute messages to participants in the virtual organization, ensuring transparency in asset utilization while gaining trust in the virtual organization.

In terms of theoretical research on the application of virtual organizations in industrial chain integration, foreign scholars have contributed rich perspectives. György Kovács and Sebastian Kot[7] contend that traditional supply chain concepts are competing for customers, and the most important factors influencing customer purchasing decisions are cost, delivery time, quality, and customization. They establish three novel supply chain strategies—Lean Supply Chain, Agile Supply Chain, and Resilient Supply Chain. Eric T.G. Wang[8], through establishing a virtual supply chain integration model, plays a crucial role in this model in generating supply chain performance in two dimensions—manufacturing flexibility and comparative cost advantage. Patanjal Kumara[9] proposes a virtual organization model of Industry 4.0, suggesting that the supply chain forms strategic alliances through information technology, and the establishment of a virtual organization requires determining supply chain balance units, forming various centers, and achieving cross-regional, cross-unit, cross-center coordination. Susan L. Manring and Samuel B. Moore[10], from the perspective of sustainable development in green production, emphasize the increasing importance of inter-organizational network structures in achieving broad common goals using different resources. They highlight the need for virtual organizations to coordinate the intentional, systematic development of stakeholders in the network between organizations, integrating ecological, economic, and social resources for clean production. Falk Graser[11], in a study on the performance evaluation of virtual organizations, suggests that uncertainty, dynamics, changes in goals, and the number of participating stakeholders have a significant impact on the performance of virtual organizations. He indicates that the performance evaluation of virtual organizations remains a new issue that urgently needs to be addressed. For manufacturing enterprises, Artur Swierczek and Danuta Kisperska-Moron[12] propose operating in a virtual supply chain environment. In addition to considering cost and efficiency, they emphasize the importance of quality in products and processes and explicitly regard customer orientation as a crucial strategic goal, contributing to enhancing competitiveness in the market.

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In summary, existing research has mostly explored the application value and scalability of virtual organizations from a broad perspective. There is a lack of empirical research and targeted theoretical exploration focusing on the degree of application in segmented industries and the coordination mechanisms of upstream and downstream integration on the agricultural product manufacturing industry chain. Simultaneously, the performance measurement standards of virtual organizations for low-carbon industrial chains should be reconsidered, distinguishing them from traditional industrial chain models. Therefore, in this study, considering virtual organization's coordination of supply chain integration in the feed industry, the goal is to reveal the following issues:

(1) How does the virtual organization model help achieve vertical and horizontal integration coordination in the feed industry?

(2) What are the performance measurement standards of virtual organizations for the supply chain in the feed industry?

(3) How does the virtual organization model on the industrial chain outperform traditional coordination mechanisms?

3. Analysis of the Application Model of Virtual Organization in Feed Industry Integration

Regarding the definition of virtual organization, this paper considers virtual organization not only as a structure for organizational discussion but also as a means to achieve strategic goals within a dynamic external environment, serving as a strategic framework[13]. Essentially, it involves forming the organizational foundation around a core enterprise, absorbing external specialized enterprises, utilizing information networks to share industry chain information such as production processes, financial data, inventory management, and logistics assembly, and removing independence and singularity from each part. Simultaneously, as a temporary organization, it has the advantage of rapidly integrating resources and reducing financial pressure when dealing with market opportunities. It utilizes internal and external cooperative networks to extend and expand functions, achieving shared technology, cost-sharing, and meeting market demands.

To achieve coordinated development of cost-effectiveness and flexible efficiency in industrial chain integration, virtual organizations break through the limitations of traditional mergers and acquisitions and outsourcing. Through virtual integration, non-equity-based enterprises are allowed to closely collaborate through information networks for process planning, execution, and control, replacing ownership responsibility with partnership relationships. This paper draws on the enriched three novel supply chain strategies proposed by György Kovács and Sebastian Kot[7]—Lean Supply Chains, Agile Supply Chains, and Leagile Supply Chains.

3.1. Lean Supply Chains

The primary goal of applying Lean Supply Chains is to achieve cost-effectiveness through the integration of the upstream and downstream industry chains, focusing on maximizing cost savings by eliminating unnecessary processes and waste, shortening manufacturing cycles, and streamlining and improving processes. To promote high-quality development in the manufacturing industry chain supply chain, Wang Deqiang and Zhang Ran[14] propose a "Lean+" strategy, considering lean management as a fundamental project to drive industrial transformation, upgrading, and high-quality development. They emphasize the development of lean digital transformation, promoting the connection of various elements within enterprises, reducing information gaps between upstream and downstream, and enhancing the flexibility and resilience of enterprise production and supply chain industry chains.

As one of the first national key leading enterprises in China's agricultural industrialization, New Hope Liuhe Co., Ltd., under New Hope Group, is based on a modern food and agriculture industry

DOI: 10.54254/2754-1169/70/20231684

chain layout, involving feed, breeding, food processing, and terminal sales. New Hope Liuhe, initially rooted in the feed industry, currently has an annual production capacity exceeding 20 million tons and sales exceeding 15 million tons, leading the industry in feed market share. To ensure stability in upstream raw material supply, competitive prices, and quality, New Hope proposes Lean Operation Management in supply chain management. This approach provides more significant advantages in terms of higher productivity, higher resource utilization, reduced inventory pressure, and shorter delivery cycles. Simultaneously, New Hope Liuhe, as early as 2014, integrated pig farming with the internet, introducing the "Cloud Farming" project to achieve value extension in the breeding industry. With continuous R&D investment, New Hope Liuhe, through the continuous updating of information management systems on cloud technology platforms, integrates management tools with a professional service team. On one hand, this system standardizes production, material, and financial management in pig farms, transmitting real-time status across the entire industry chain from raw material planting and processing to inventory management, channel supply, and logistics, achieving vertical integration. On the other hand, New Hope Liuhe breaks through traditional geographical, time, and cost constraints, pioneering a dual offline and online (O2O) training system in cloud education. By establishing Fuda Cloud School, they have initiated a precedent for training breeding talents in large-scale and standardized agricultural and animal husbandry enterprises.

3.2. Agile Supply Chains

The Agile Supply Chain emphasizes "dynamic" and "agile," referring to the ability of the supply chain to rapidly adjust strategies when facing a changing market competition environment and fluctuating customer demands. It involves making swift responses and adaptations by fully leveraging enterprise innovation and the introduction of new products. An agile supply chain requires companies to possess a certain level of market sensitivity, and companies can form strategic alliances through information sharing to achieve complementary advantages among enterprises, facilitating the rapid expansion of business scale. Simultaneously, partners in an agile supply chain typically form dynamic collaborations within the framework of a virtual enterprise network[15]. The characteristic of a virtual organization is to construct a dynamic and flexible network, bringing together independently advantaged enterprises in the form of strategic alliances to effectively address market opportunities. The primary goals of such partnerships are risk mitigation, competition diversification, and cost reduction.

China's agricultural leading enterprise, Haida Group, founded in Guangzhou, Guangdong, in 1998, has developed a modern agricultural and animal husbandry industry chain covering feed, seeds, animal vaccines, intelligent farming, food processing, and more. With feed production as its core business, the group achieved annual sales exceeding 21.65 million tons, especially excelling in the field of aquatic feed with leading technology and scale advantages domestically. Since the "863 Program," Haida Group has maintained a trend of independent innovation, implementing strategic planning for the extension of the entire industry chain based on specialization and scale. In recent years, the company has conducted extensive and close "industry, academia, and research" cooperation projects with various universities and research institutes, including Sun Yat-sen University, Jinan University, South China Agricultural University, Huazhong Agricultural University, Chinese Academy of Agricultural Sciences, South China Sea Institute of Oceanology, and Pearl River Fisheries Research Institute. These collaborations cover the entire industry chain in terms of technological innovation activities. Haida has gradually shifted its research focus towards green, safe, efficient, and environmentally friendly products. Simultaneously, seizing the opportunities of the "Belt and Road Initiative," the company strengthens cooperation with supply chains in multiple countries, achieving the internationalization of its seed sector. As of now, Haida Group has successively invested in seed farms in various countries or regions, including India, Ecuador,

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Indonesia, Vietnam, Egypt, among others, adopting a localization strategy to timely capture market opportunities and provide products and services that better meet local market needs.

3.3. Leagile Supply Chains

Jamie Stone and Shahin Rahimifard[16] identified three components that influence the adaptability cycle: "resilience" (the ability to absorb changes), "adaptability" (the ability to develop given operating forms), and "convertibility" (the ability to fundamentally change unsustainable operating systems). These constitute effective control mechanisms through which organizations can influence the adaptability cycle stages. Therefore, as a combination of Lean and Agile, Leagile Supply Chains are more flexible, aiding strategic virtual collaboration to enhance the flexibility of the supply chain, adapting to uncertainties and risks in dynamic markets. The Decoupling Point plays a permeating role in the operation of Leagile Supply Chains, where order-driven activities and forecast-driven activities usually converge[17], as shown in Figure 2.

Figure 2: Leagile Supply Chains

4. Case Study: Operational Model of Virtual Organizational Integration in Tianma Group

We propose a virtual integration model that achieves centralized resource allocation by increasing internal and external controls, reflecting the flexibility and cost advantages of the supply chain. Virtual organizations exhibit characteristics such as functional expertise, operational collaboration, and organizational decentralization. With the core enterprise at the center, virtual organizations demonstrate strong cohesion and support for member companies. The establishment of a virtual organization requires extensive coordination and trust-building. Therefore, on the one hand, it demands that the core enterprise actively responds to market opportunities, with the diversity of market opportunities determining the differentiation of member composition. The core enterprise needs to select member companies based on strategic goals and their compatibility with member enterprises. On the other hand, from the perspective of transaction costs and cost-sharing contracts, as cooperation repeats, a bilateral regulatory structure for the virtual organization credit model should be established. This involves creating a credit evaluation system, conducting full-process credit checks and evaluations for each organization member formed, using a combination of qualitative and quantitative approaches to achieve scientific behavior allocation and benefit sharing[17].

China's feed industry is undergoing a new trend, with competition shifting from technological, scale, product, and marketing leadership to an industry chain model. Companies are also transitioning from being a single "feed supplier" to playing the role of "integrators of agricultural industry chains with feed as intermediate products." Since its establishment in 2002, Fujian Tianma Technology Group Co., Ltd. has been recognized as a national key leading enterprise in agricultural industrialization, focusing on aquaculture, animal husbandry, the first to third industries, marine food, and marine seed industries. It went public on the Shanghai Stock Exchange main board in 2017 (stock code: 603668). Tianma Group integrates and develops special aquaculture, animal husbandry, the first to third industries, marine food, and marine seed industries, making great efforts to promote the

DOI: 10.54254/2754-1169/70/20231684

integrated development of the first to third industries, aiming to create a fully integrated food supply chain platform.

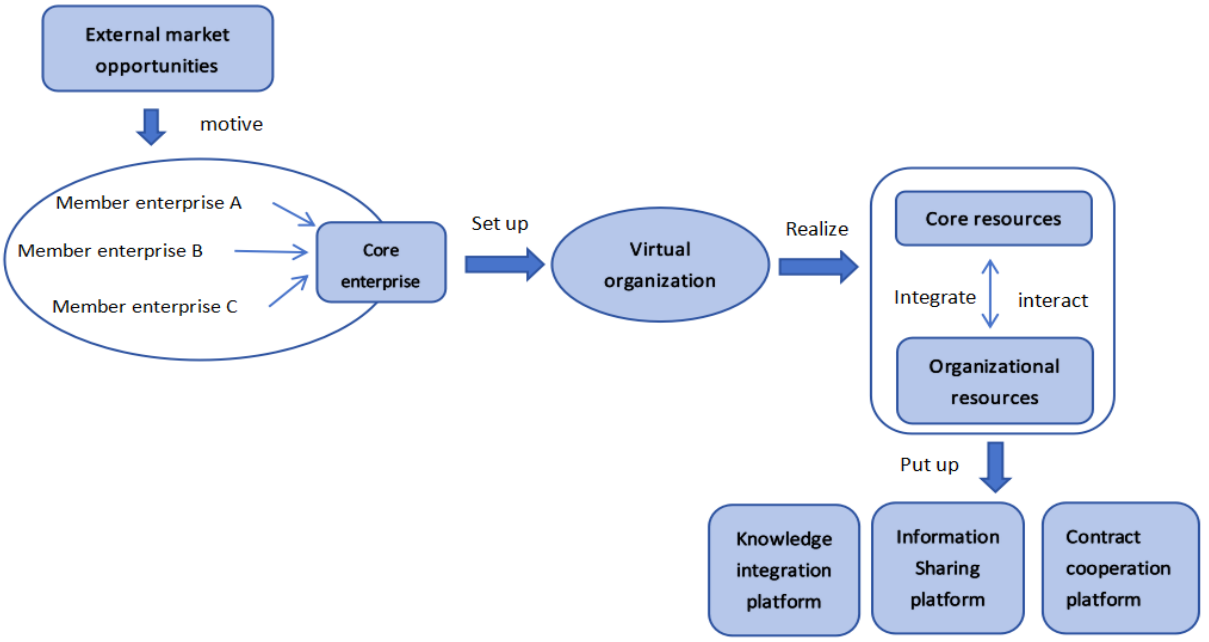

Figure 3: Virtual Organizational Integration Model

4.1. Horizontal Integration to Achieve Economies of Scale

Horizontal integration reflects the integration in the horizontal direction of the industrial chain. Enterprises primarily achieve this through strategic alliances, self-construction, mergers and acquisitions, joint ventures, etc. Horizontal integration can enhance the concentration of the market, expand market share, establish entry barriers, thereby strengthening the company's control over the market, and achieving market competitiveness. Additionally, under the virtual organization model, horizontal integration, in form, lacks inherent geographical and temporal constraints, facilitating the crossing of boundaries and strategic groups.

Tianma Group, in realizing horizontal integration in the supply chain, mainly adopts forms such as industry mergers and strategic alliances. In 2017, when it just went public, its annual revenue was only CNY 11.36 billion, and the annual feed production was 106,400 tons. By 2022, Tianma has achieved revenue breakthroughs, surpassing CNY 70.07 billion, with a significant increase in feed production capacity. Notably, Tianma executed nine mergers and acquisitions during these five years. In 2018, Tianma Group's eel feed production and sales had consecutively ranked first in China for several years. At this point, they planned to initiate industry chain integration starting from the eel sector. Tianma Aquatic Products, as Tianma Technology's platform for the circulation and processing of special aquatic products, acquired 90% of the shares of Jiangxi Xilong Food Co., Ltd., held by the controlling shareholder and actual controller Chen Qingtang, for CNY 30 million. The main business of Xilong Food is the production, processing, and sale of eels. In 2019, Tianma Group acquired 72% of the shares of Hualong Group as a crucial step in its industrial strategic expansion. Hualong Group, established in 1987, was initially affiliated with the Fujian Provincial Agricultural Committee, with management overseen by the Fujian Provincial Academy of Agricultural Sciences. It was jointly initiated by seven research institutions, including the Fujian Provincial Academy of Agricultural Sciences Animal Husbandry and Veterinary Medicine Institute, forming a union consisting of closely connected, semi-connected, and loosely connected enterprises. Through this acquisition, Tianma

DOI: 10.54254/2754-1169/70/20231684

formed its core revenue business of "aquatic feed + livestock and poultry feed." The assets achieved sales of 304,000 tons and profits of CNY 26.8909 million in 2019, accounting for 47.29% of that year's net profit. The following year, it accounted for 72.84% of the annual net profit. In 2021, the controlling company, Hualong Group, through Hualong Biology, initiated the acquisition of China National Cereals, Oils, and Foodstuffs Corporation (COFCO) Huagang Feed, achieving further expansion after the merger. The acquisition of COFCO Huagang, based in Fujian, brought in revenue of CNY 777 million, providing Hualong Biology with a capital increase of CNY 118.78 million. This move also contributed to Tianma Technology's 2021 Hualong Group revenue of CNY 3.505 billion, a year-on-year increase of 75.25%.

In terms of strategic cooperation, Tianma Group places significant emphasis on the research and development of new products and the expansion into new markets. To enhance market share, Tianma Group conducts seed research and development innovation guided by customer demands. Internally, the company has established an enterprise technology center and formed a dedicated R&D team composed of professional technical personnel, establishing a technology innovation system centered around the company and market-oriented. Externally, Tianma Group radiates to the surrounding areas of Fujian through forms such as acquiring equity, acquiring assets, and self-construction. Simultaneously, the company accelerates the progress of constructing its own eight major fisheries industrial cluster factory-scale and circular water ecological aquaculture bases. Furthermore, Tianma Group has strategically collaborated with research institutions such as the Institute of Oceanology of the Chinese Academy of Sciences, the Feed Research Institute of the Chinese Academy of Agricultural Sciences, Zhejiang University, Xiamen University, Fujian Freshwater Fisheries Research Institute, and Jimei University School of Fisheries. Leveraging the technological and talent advantages of industry experts and research institutions, Tianma Group taps into the latest technological achievements from both domestic and international sources. It establishes a specialized knowledge service platform for aquaculture, recognizing that the innovation capacity of an enterprise depends on its ability to connect with knowledge-intensive resources. By connecting enterprises with core capabilities through information networks and forming a "core competency" network, the virtual organization utilizes not only the knowledge existing within the company but also connects internal systems with other external virtual organizations, creating a cross-enterprise knowledge network[17]. Tianma Group integrates this knowledge platform with the reality of China's aquaculture industry, launching high-tech products and continuously improving the quality of the company's products.

4.2. Vertical Integration for Internal Value Chain Enhancement

China's agriculture is still in the growth stage of the industrialization life cycle. The full industry chain strategy, as a special form of vertical integration strategy, plays a positive role in promoting the industrialization process of agriculture in China and optimizing structural reforms. The full industry chain is a continuous extension based on the industrial chain. Underlying the "chain," each link is effectively connected, with a high degree of coordination between different industry lines. The balance of upstream and downstream resource allocation allows the realization of the enterprise's value in different links of the industry chain. It naturally aggregates resources to the higher value-added links, ultimately achieving cost-effectiveness and brand value. Xu Yiliang [19] and others propose that the "full industry chain" integrates vertical integration and closely-knit diversification, using "synergy" to achieve their mutual integration. This approach allows rapid identification of key points for value addition within the industry chain network, achieving benefits such as business integration, resource complementarity, and cost offset, leading to an efficiency greater than the sum of its parts (1 + 1 > 2). Xie Qilin and Cai Ke [20] similarly recognize the characteristics of vertical integration and diversification. The pursuit of synergies and the resultant influence are the most direct reasons why large enterprises choose the "full industry chain." The governance of the full industry

DOI: 10.54254/2754-1169/70/20231684

chain operating model mainly involves three types: resource-dominant, market-dominant, and technology-dominant [21]. Tianma Group continually optimizes its industrial layout and promotes structural adjustments, leading the development of the full industry chain supply chain platform with resource, market, and technology dominance. It strategically advances the industry chain, including "seeds → feed → aquaculture → animal protection → food → catering," steadily promoting the deep integration and development of the primary, secondary, and tertiary industries.

4.2.1. Backward Integration

Backward integration involves the upstream processes of the industry chain, primarily encompassing cultivation, primary processing, and raw material production. Firstly, in the cultivation phase, the external market of the feed industry faced tremendous pressure in 2022, with factors such as rising feed raw material prices, fluctuations in downstream animal husbandry demand, stricter environmental policies, increased supply chain risks, high logistics costs, extreme weather conditions, and weakened terminal consumption intensifying industry uncertainties and instability. Tianma Group accelerates the integration of the primary, secondary, and tertiary industries, adhering firmly to the "integrated farming" ecological strategic development plan. It vigorously develops the aquaculture seed industry, promotes the establishment of national excellent breeding bases, accelerates the planning and layout of industrial bases, and drives the construction of integrated industrial parks for the convergence of the primary, secondary, and tertiary industries. In response to compressed profit margins, the group subdivides the aquaculture business segment, concentrating resources on advantageous segments of the industry chain. It follows a distinctive "specialization and expertise" development path in the marine economy, comprehensively advancing the "Ten Fish" strategy. This ensures stable product output and quality while enhancing the operational efficiency of specialty aquaculture throughout the entire industry chain. Building upon a resource-dominant industry chain, Tianma Group starts with raw material control and seed breeding. It strategically breaks through in eel farming, exploring a refined model for eel and catfish cultivation. The company's finely tuned model gradually achieves advantages in survival rate, profitability, and output, making eel and catfish ecological farming a new profit growth point. Consequently, the company plans to establish a national excellent breeding base and a joint research center for seed breeding. It addresses key seed technologies, vigorously constructing an entire industry chain for seed production, including "scientific research and development trials, ecological technology demonstrations, seed industry incubation, and technology transfer." It builds an integrated system for breeding and reproduction, and each subsidiary establishes a smart aquaculture system covering the entire process, including intelligent dissolved oxygen regulation, online water quality monitoring, remote disease diagnosis, and full-process traceability, ensuring stable and sufficient output of raw materials.

Secondly, in the production and processing phase, based on a technology-dominant industry chain, continuous improvement of technological capabilities in the production line is pursued to meet demand targets and enhance product quality. The company typically establishes subsidiaries locally and adopts localized production methods. In the deep processing phase, integrating technology across the industry chain is more conducive to achieving standardized and specialized production. The production of feed products by each subsidiary primarily follows an order-based production model. Based on the order demand provided by the sales department, production plans are formulated according to region and variety, with prior arrangements for raw material procurement and processing. In the decision-making process for production planning, many companies utilize the New Jia F3 system to integrate real-time information on production, sales, and inventory. This system serves as a basis for company production decisions, ensuring coordinated operations across relevant departments.

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4.2.2. Forward Integration

The forward integration model of the feed industry chain primarily revolves around the control of the sales process and channels by distributors or suppliers. It implements a business sales network that integrates from the midstream to downstream, contributing to increased profit margins in the sales process and enhancing the market adaptability and competitiveness of enterprises. Existing feed processing enterprises have moved beyond the business model of treating feed as the final product. Instead, they extend the industry chain, selling the produced feed directly to the livestock enterprises in the industry chain, and even extending to food production enterprises. Treating feed processing as an intermediate link connecting planting and breeding can internalize market transactions, reduce transaction costs, and make the distribution process more agile.

In a market-driven industry chain, enterprises aim to increase market share through brand, channel, and marketing resource advantages. Tianma Group has strategically positioned itself in domestic and international food markets, continually building a comprehensive strategic sales network covering coastal and inland areas from the Bohai Gulf to the Beibu Gulf. The group is advancing the implementation of the “Hundred Regiments Campaign” medium and long-term strategic plan, actively exploring overseas markets, and improving its global strategic layout. Simultaneously, it enters mainstream online and offline sales channels such as e-commerce, new retail, supermarkets, central kitchens, and catering, leveraging the flow economy to expand product sales and brand influence, aiming to create the leading brand in China’s marine food industry. Due to the large quantity of feed products and the cost pressure associated with inventory management and transportation, the group adopts a “distribution + direct sales” sales model. It establishes subsidiaries in key market regions, implementing local production and on-site sales.

5. Performance Analysis of Integrated Virtual Organization in the Feed Industry

The performance evaluation of virtual organizations remains a pressing issue. Numerous scholars have attempted different methods, such as collaborative performance, cost-sharing contracts, balanced scorecards, etc. However, most performance methods focus solely on measuring a specific stage of a single organization. The dynamic nature of virtual organizations and the collaborative effects among multiple organizations create limitations in traditional performance measurement methods. Scholars like Falk Graser[11] argue that existing performance evaluation methods cannot fully meet the specific requirements of virtual organization management, particularly in the crucial aspect of collaborative performance. So, how can we evaluate the performance of virtual organizations in a manner that aligns with the sustainable development trend of feed industry integration?

In recent years, both domestic and international scholars have made significant contributions to the performance of supply chain management, as summarized in Table 1. These research frameworks and evaluation indicators offer different perspectives and dimensions, assisting enterprises in better understanding and rating the performance of their supply chains.

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Table 1: Supply Chain Management Models and Performance Evaluation Indicators

Research Theories and Models	Supply Chain Management Performance Evaluation Indicators
SCOR Model (Supply Chain Operations Reference Model)	Responsiveness, Delivery reliability, Flexibility, Cost, Asset management efficiency
Delone and McLean Model	Reliability, Responsiveness, Quality
CSCMP Model (China Supply Chain Management Best Practices Model)	Internet of Things (IoT), Mobile cloud computing, Big data, Artificial intelligence (AI), Cognitive computing, Blockchain
Balanced Scorecard-based Supply Chain Performance Evaluation Model	Financial, Customer, Internal business processes, Learning and growth
Capability-based Supply Chain Performance Evaluation Model	Resource acquisition capability, Resource integration capability, Product innovation capability
SPM Model (Strategic Profit Model)	Based on cost drivers, Uses return on investment and return on net assets
GSCF Model (Global Supply Chain Forum Model)	Customer relationship management, Customer service management, Demand management, Order fulfillment, Manufacturing process management, Supplier relationship management, Product development and commercialization, Returns management
SASC Model (Strategic Audit Supply Chain Model)	Customer orientation, Distribution, Sales planning, Lean production, Relationship and comprehensive chain management capabilities
EFQM Model (Excellence Model)	Customer-centricity, Leadership, Goal definition, Process-based management, Employee involvement, Continuous innovation processes, Partnership development, Citizen responsibility
Supplier Collaboration Model	Information sharing, Early supplier involvement, Supplier diversification
Sustainable Supply Chain Model	Environmental sustainability, Social responsibility, Supply chain performance

Improving supply chain performance is a prerequisite for evaluating the effectiveness of virtual integration. In the virtual integration theory of improving supply chain performance, Eric T.G. Wang[8] and others selected samples such as environmental uncertainty, virtual integration, supplier responsiveness, cost advantage, and manufacturing flexibility. They concluded that virtual integration plays a crucial role in generating supply chain performance in two dimensions—manufacturing flexibility and comparative cost advantage. Ingo Westphal[22] proposed virtual organizations as a special type of collaboration and encouraged the inclusion of collaborative performance in VO performance evaluation. The introduction of "Commitment" as a new sub-perspective for collaborative performance summarizes various aspects of collaborative performance. Falk Graser[11] and others proposed the concept of complexity, indicating that uncertainty, dynamism, changes in goals, and the number of participating participants have a crucial impact on the performance of virtual organizations.

Based on the above analysis, the author believes that the evaluation of virtual organization value for the integrated model of the feed product supply chain should start with the core enterprise. Through virtual integration, it can bring about varying degrees of performance improvement for the core enterprise and other member enterprises. Due to the centralized production characteristics of the feed industry, a "close" virtual organization is more suitable for resource integration than a "loose" one. From the perspective of overall supply chain operations performance evaluation, it mainly includes key indicators such as supply chain reliability, customer response, flexibility, cost, and quality. To leverage its advantages in functional integration, virtual organizations need to integrate

DOI: 10.54254/2754-1169/70/20231684

business processes such as procurement, production, transportation, and warehousing, coordinating them to achieve optimized resource allocation. Their common goals also play an indispensable role. Manufacturing flexibility and cost advantage are the two main competitive goals pursued by manufacturers. From the perspective of supply chain risk management performance evaluation, the feed industry supply chain faces various risks, including supply chain risks, market demand risks, logistics risks, and warehousing risks. Virtual organizations help achieve spatial integration, integrating geographically and temporally dispersed suppliers, resources, and markets. By establishing a distributed logistics network and a shared information platform, virtual organizations can reduce logistics costs, improve efficiency, enhance customer response capabilities, and promote communication and cooperation among suppliers, customers, and markets, enhancing synergy.

Furthermore, in the development of the feed industry towards a green and sustainable supply chain, enterprise competitive strategic management is closely linked with ESG (Environment, Social, and Governance) responsibilities, constituting a crucial aspect of corporate value creation and performance measurement. ESG emphasizes measuring the sustainable development performance of enterprises from the perspectives of environmental, social, and corporate governance, combining financial and non-financial indicators as well as short-term and long-term benefits, comprehensively assessing the development potential of the enterprise. From a short-term perspective, based on cost-effectiveness considerations, whether it is the architecture of the entire industry chain or the integration of virtual organizations, it cannot bring positive returns to the company. It may even result in negative growth in financial performance, posing a challenge to trust relationships among organizational members. Simultaneously, achieving the goal of industrial chain integration is not an overnight process. The establishment of virtual organizations requires strategic coordination, emphasizing internal communication, process integration, scientific decision-making, and necessary technical support[4]. From a long-term perspective, guided by the guiding ideology of "leading with the strategy of rural revitalization and taking the structural reform of the agricultural supply side as the main line," the State Council General Office issued the "Opinions on Promoting the High-Quality Development of Animal Husbandry" in 2020. It emphasizes promoting the efficient utilization of non-grain feed resources such as straw. Under the guidance of a series of general policy tools, the basic tone of ecological construction and development in the livestock feed industry has been established, and the framework structure of ecological construction has become clearer. In terms of the environment, the feed processing production process primarily involves the preparation, mixing, heating, and reshaping of raw materials. The main pollutants are dust, exhaust gases, and noise, with no production of other toxic and harmful wastewater or waste materials. This underscores the process of effective circular utilization of resources. In the social aspect, the impact of the feed industry on human consumption and food safety, including the use and residue issues of feed additives, is considered. In terms of governance, government market supervision departments need to raise the entry threshold for the feed industry, improve its administrative licensing mechanism, accelerate the improvement of relevant laws and regulations in the feed industry, strengthen regulatory efforts, and vigorously promote the ecological green and environmentally friendly "crop-livestock integration" breeding model, providing a foundation for the integration of the feed industry chain.

DOI: 10.54254/2754-1169/70/20231684

Table 2: Green Supply Chain ESG Performance Evaluation Indicators

Primary Indicator	Secondary Indicator	Tertiary Indicator	Indicator Attribute
Environmental Responsibility (E)	Environmental Pollution	Greenhouse Gas Emissions	Negative Indicator
		Hazardous Waste Amount	Negative Indicator
		Energy Consumption	Negative Indicator
	Environmental Management	Resource Reutilization Rate	Positive Indicator
		Energy-saving Measures	Positive Indicator
	Green Supply Chain Emission Reduction	Green Supply Chain Productivity	Positive Indicator
		Green Supply Chain Innovation Total Investment	Positive Indicator
		Green Supply Chain Total Profit	Positive Indicator
Social Responsibility (S)	Suppliers and Customers	Product Qualification Rate	Positive Indicator
		On-time Delivery Rate	Positive Indicator
		Customer Satisfaction	Positive Indicator
		After-sales Service Compliance Rate	Positive Indicator
	Government and Society	Various Taxes Paid	Positive Indicator
		Total External Public Welfare Donations	Positive Indicator
	Employee Situation	Total Number of Employees	Positive Indicator
		Employee Turnover Rate	Negative Indicator
Corporate Governance Responsibility (G)	Operational Performance	Operating Ability	Positive Indicator
		Operational Efficiency	Positive Indicator
		Debt Repayment Ability	Positive Indicator
	Governance and Supervision	Board Size	Positive Indicator
		Situation of Directors, Supervisors, and Executives	Positive Indicator
		Number of Shareholders' Meetings Held	Positive Indicator
		Number of Negative Company Events	Negative Indicator

6. Conclusion

This paper, based on the virtual organization management model, refines the application model and performance evaluation of the feed industry's production and sales integration. It proposes strategies to achieve precise coordination of supply and demand in the supply chain and organization, utilizing the support of the digital economy for modernizing the industry chain. The construction of a digital supply chain is encouraged, promoting information sharing in areas such as orders, production capacity, and channels. The main development strategies are outlined as follows:

(1) Innovative Mechanism Environment Facilitated by Government as the Main Body: In recent years, the National Development and Reform Commission and 13 other departments jointly issued the "Opinions on Supporting the Healthy Development of New Formats and Models, Activating the

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Consumption Market, and Promoting Employment Expansion." The document proposes the creation of "virtual" industrial parks and industrial clusters transcending physical boundaries, implementing actions to nurture new forms of the digital economy. As the guardian of the market, the government needs to actively guide the structural adjustment of corporate industrial chains, providing a market environment conducive to digital innovation. In fulfilling ESG responsibility performance, influenced by low costs and differentiated competition, its indicators may bring some lag to the financial performance of companies in the short term. This requires the government to provide necessary policy support and assistance in technology, funds, and talent.

(2) Leading Core Enterprises, Improving Mechanisms for Shared Interests, and Managing Interests and Organization: Currently, the overall situation of China's feed industry is still in the importation phase. With low barriers to entry, an increasing number of small and medium-sized enterprises are joining, resulting in a relatively low degree of overall market concentration and intensifying market competition. Encouraging leading enterprises to play their role in aggregation, leveraging their advantages in funding, technology, management, and talent, is crucial for industry chain integration. Simultaneously, industry integration can raise the industry access threshold and market concentration of the feed industry, preventing the blind entry of small and medium-sized enterprises driven by interests, disrupting the production environment, and disturbing market order.

(3) Information Technology as a Driving Force: Loose relationships among members need to be built through convenient, platform-based information technology networks. Information technology networks facilitate convenient, fast, and low-cost communication among members, enabling the sharing of industry chain information. To successfully "advance the feed industry through technology," the Chinese feed industry needs to actively leverage information technology, break through market and geographical constraints, enhance the degree of informatization, increase market information transparency, and achieve diversified development.

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