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Digital Transformation of Agriculture Supply Chain in Vietnam: Current Status and Proposal of Roadmap

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Abstract

As the main driver of economic growth and employment, the agricultural sector plays an important role in Vietnam's economy. However, in recent years, the sector has faced new challenges and also presented new investment opportunities to stimulate agricultural growth. Many Vietnamese agricultural producers currently lack the modern technology and decision support tools needed to maintain and improve productivity in a rapidly changing environment. Other stakeholders in the agricultural value chain, such as input suppliers, distributors, and consumers, also face significant challenges, including disrupted value chains, transportation costs. The cost of transporting goods across the supply chain continues to increase and information exchange remains fragmented. A potential solution to address these challenges is the application of digital transformation in agricultural supply chains. Farmers and other value chain participants can improve the production of their goods and procedures by utilizing new and cutting-edge technologies that are integrated into a unified system as part of the digital transformation of agricultural supply chains. In this study, we evaluate the current status of digital transformation in the supply chain of the agriculture industry by finding and examining pertinent publications from key agencies as well as prior research. From there, in the framework of the digital economy, this study suggests a digital transformation roadmap for the agricultural supply chain.

Keywords: *Digital transformation, Agriculture, Supply chain, Vietnam, Roadmap, Ecosystem*

1. Introduction

The agricultural sector has always been the backbone of the global economy, providing food and raw materials for various industries. However, it is fraught with challenges such as climate change, resource scarcity, supply chain inefficiencies, and fluctuating market demands. Traditional agricultural practices, although tried and tested over centuries, often fail to address these modern issues.

The agriculture supply chain (ASC) encompasses the entire journey of agricultural products from farms to

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consumers. It involves a complex network of activities and stakeholders, including farmers, processors, distributors, retailers, logistics providers, and the consumers (Fig.1). This chain begins with the cultivation and harvesting of crops or raising livestock, followed by various stages such as processing, packaging, and quality control. Each stage adds value and ensures that the products meet safety and quality standards. Effective management of the agricultural supply chain is crucial for ensuring food security, reducing waste, and enhancing sustainability. It also plays a critical role in improving the economic outcomes of farmers and meeting the evolving demands of consumers.

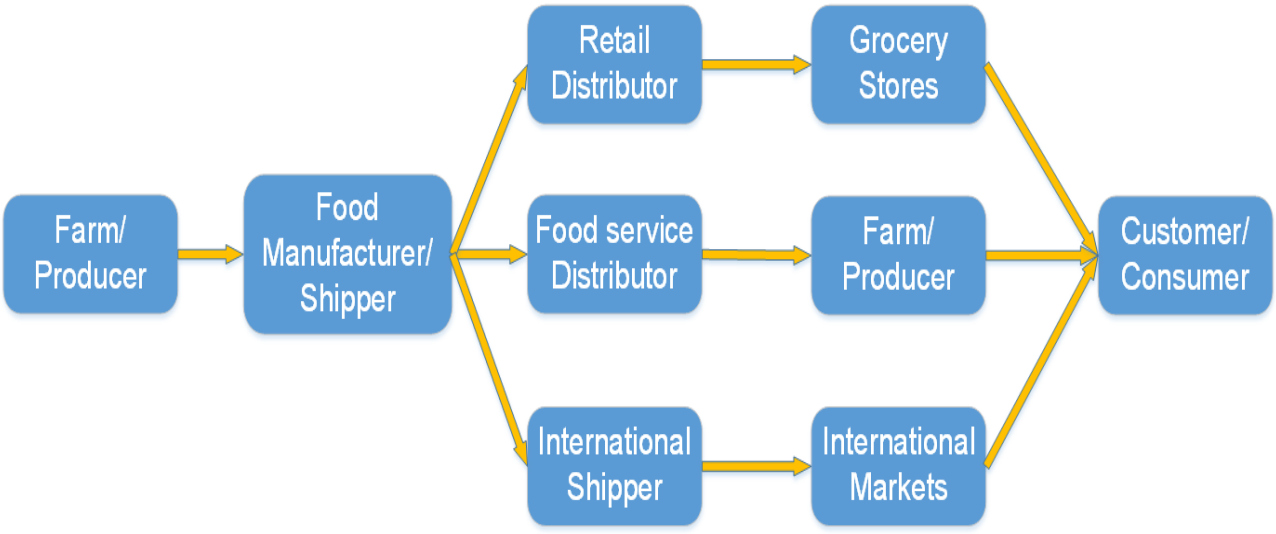

Figure. 1. A typical model of the supply chain in agriculture starts from the farmer to the destination, which is the consumer or the customer.

Vietnam's agricultural sector plays an indispensable role in the national economy, contributing substantially to GDP and employing a significant portion of the population. Traditional agricultural practices are deeply embedded in Vietnam's cultural and social fabric. Although these practices have sustained the nation for generations, they have inherent inefficiencies, such as labor intensive processes, limited scalability, and susceptibility to weather and market fluctuations. In recent years, Vietnam, with the advantage of being an agricultural country, has increasingly promoted its role in promoting innovation in the economy, contributing to national GDP growth, ensuring food safety and positioning Vietnam in the global supply chain. In fact, in recent times, the Party and State have had many policies to promote and improve the safe agricultural production supply chain. In particular, Decree No. 98/2018/ND-CP dated 5 July 2018 of the Government on policies to encourage the development of cooperation and linkage in the production and consumption of agricultural products, linking along the price chain [1]. The value of agricultural products is a form of linkage in agricultural production along the chain, from the supply of materials, input services, production and processing associated with consumption of agricultural products.

The existing supply chain, typically characterized by its length and complexity, is often modular and inefficient, leading to substantial post-harvest losses, lack of transparency, and poor market access for farmers.

The need to overcome these inefficiencies and make the ASC more resilient, transparent, and sustainable is paramount. Digital transformation presents itself as a holistic approach to remedy these issues through the

application of the Internet of Things (IoT), data analytics, blockchain, artificial intelligence (AI), and other emerging technologies. The digital transformation of the ASC represents a seismic shift in how agricultural activities, ranging from planting to the end consumer, are managed and executed. This transformation involves the integration of advanced technological solutions into agricultural practices to improve efficiency, reduce waste, improve productivity, and ensure sustainability. Digital transformation in the ASC is not only a testament to the power of technology, but also an answer to the growing global demand for food security in the face of climate change and an ever increasing population. As Vietnam progresses on its journey of digital transformation, technology implementation must be strategically aligned with the specific requirements of the ASC for sustainable growth and robustness despite fluctuating market conditions and environmental challenges.

From the analysis of the need for digital transformation for the circular ASC in Vietnam in the context of the digital era. This paper focuses on analyzing the components of supply, analyzing the current state of the ASC transformation process, thus proposing a number of solutions and a digital transformation roadmap for the supply chain for Vietnamese agricultural products in the coming time.

The integration of digital technologies into agricultural supply chains has been gradual but transformative. Traditional agricultural practices relied heavily on manual labor and rudimentary tools, limiting scalability and efficiency. The advent of the Internet of Things (IoT), big data analytics, blockchain, and artificial intelligence (AI) has revolutionized the sector, facilitating real-time decision-making, improved productivity, and transparency. The incorporation of technological advancements such as GPS-based soil sampling and precision farming techniques sets the stage for the current digital shift [2]. IoT devices, for example, enable real-time tracking of crop health, soil conditions, and environmental factors. IoT sensors deployed across fields provide continuous data streams that can be analyzed to optimize irrigation, fertilization, and pest control [3]. An IoT-based monitoring system for the cultivation of indoor Ganoderma Lucidum was developed at a minimal cost in terms of hardware resources and practicality [4]. In addition, blockchain technology has also emerged as a critical component, particularly in ensuring transparency and traceability. By creating immutable records of every transaction and movement within the supply chain, the blockchain addresses the issues of fraud, counterfeiting, and inefficiency. Blockchain can improve trust among consumers, producers, and retailers by offering verifiable histories of agricultural products from farm to fork [5]. A blockchain-based smart tracking and tracking platform was proposed by [6]. Digital platforms can streamline operations, resulting in faster turnaround times and more reliable supply chains was developed by [7]. The mediating effect of smart technologies on the relationship between digital supply chain transformation and operational performance was investigated by [8]. A circular supply chain for Vietnamese agricultural products was addressed by [9]. The authors pointed out that limited resources, digital illiteracy, and resistance to change pose significant barriers to the successful implementation of digital transformation initiatives within the agricultural sector. The implementation of sustainable development goals and the current state of the digital infrastructure for the sustainable development of Russian agriculture were accessed by [10]. The extent of readiness for digital transformation within economic actors in agricultural production and the limitation of readiness for digital transformation in agriculture [11]. Although the studies listed above have outlined the advantages and challenges of digital transformation for the agricultural industry. However, these studies have not yet come up with specific solutions and a digital transformation roadmap for the ASC. Therefore, this paper focuses on analyzing the current advantages, challenges, and difficulties of the digital transformation process for ASC. Subsequently, we present solutions and a roadmap to facilitate the digital transformation of the ASC in Vietnam.

2. Methods

The research uses qualitative methods through the collection and synthesizing secondary data from domestic and foreign articles, magazines, and specialized reports. Specifically, in the research the author used keywords to search for domestic and foreign documents such as 'digital transformation in agriculture"; “Digital Transformation in agriculture supply chain”; “Technology use in ASC'. Therefore, the method used is mainly descriptive statistics after studying related sources. Legal documents, planning, industry development strategies in Vietnam, and reports are also included in analysis, statistics, and comments to serve as a basis for proposing appropriate solutions. In addition, the applied methodology is based on standard systematic review procedures that incorporate search strategy, record extraction, and reporting of results [12]. On the other hand, the literature review is a methodology for conducting research and offers an overview of different types of review, as well as some guidelines on how to conduct and evaluate a literature review paper [13].

3. Results and Discussion

3.1 Challenges of digital transformation for ASC in Vietnam

As shown in Fig. 2, there are many significant challenges to digitalization in Vietnamese agriculture and manufacturing enterprises [14].

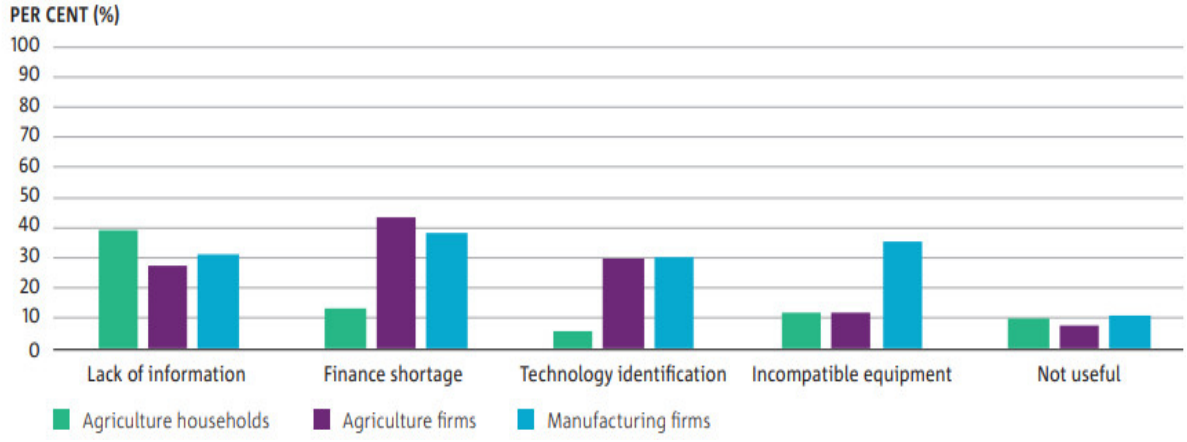

Figure 2. Top challenges to digital transformation process in Vietnamese agriculture sector and manufacturing firms

These challenges are lack of information, finance shortage, technology identification, incompatible equipment, and irrelevant data. There are 39% of agriculture households and 27% of agriculture firms due to lack of information on the digital transformation process. Moreover, there are 42% of agriculture households and 38% of agriculture firms having a finance shortage for the digital transformation process. Similarly, 40% of agriculture households and agriculture firms have difficulty identifying technologies for the digital transformation process. In addition, based on research and related documents, some challenges of digital transformation for ASC in Vietnam can be listed as follows.

+ Limited Technological Infrastructure

Digital transformation requires robust technological infrastructure, including high-speed Internet, reliable power supply, and advanced machinery. Rural areas, where most agricultural activities occur, often lack such infrastructure. The digital divide between urban and rural areas impedes the penetration of advanced technologies, thus stalling the transformation process. Firstly, the fragmented nature of the agricultural landscape in Vietnam, marked by a plethora of smallholder farmers spread across vast rural regions, poses significant hurdles in achieving seamless digital integration. This fragmentation often results in inconsistent data collection and resistant adoption of technological solutions due to varying levels of digital literacy among farmers. In addition, inadequate rural infrastructure, particularly internet connectivity and access to modern farming equipment, further exacerbates the digital divide. The lack of reliable connectivity hampers real-time communication and data exchange, which are critical components for the efficient functioning of a digital supply chain.

+ Financial Constraints

The financial constraints faced by farmers and agro-entrepreneurs also play a critical role, as the initial investment in digital tools and technologies can be prohibitively expensive. The costs associated with adopting digital technologies can be prohibitive for small and medium enterprises (SMEs) and individual farmers. The initial investment in technology, training, and maintenance can overwhelm stakeholders operating on tight margins. Financial support and favorable policies are often inadequate, hampering the wider adoption of digital solutions.

+ Low digital literacy

The successful implementation of digital technologies hinges on the ability of users to operate and use these tools effectively. The low levels of digital literacy among farmers pose a significant barrier. Most farmers are used to traditional methods and may resist transitioning to unfamiliar technologies due to fear of the unknown or lack of training.

+ Data Security and Privacy Concerns

With increased digitization comes the risk of data breaches and cyber threats. Farmers and stakeholders may be reluctant to engage in digital platforms due to concerns about data security and privacy. Ensuring that their data are protected and used ethically is crucial to fostering trust and encouraging participation.

+ Fragmented Supply Chain

Vietnam's agricultural supply chain is highly fragmented and characterized by numerous smallholders and intermediaries. Coordinating and integrating these fragmented units into a cohesive digitized supply chain presents logistic and administrative challenges. Streamlining operations and ensuring seamless communication and coordination among various stakeholders is vital but complex.

3.2 Proposal of the roadmap for the development of digital transformation in ASC

The roadmap development of digital transformation in agriculture supply chain in Vietnam is shown in Fig.3. In the first step, digitization of links in the agricultural value chain, data collection is implemented in this step. The second step is to collect the generated data in the first step and build an e-Commerce network to connect agriculture firms with processing and consumption in the supply chain. The final step is to use the generated data and the network in the previous step to establish the digital ecosystem.

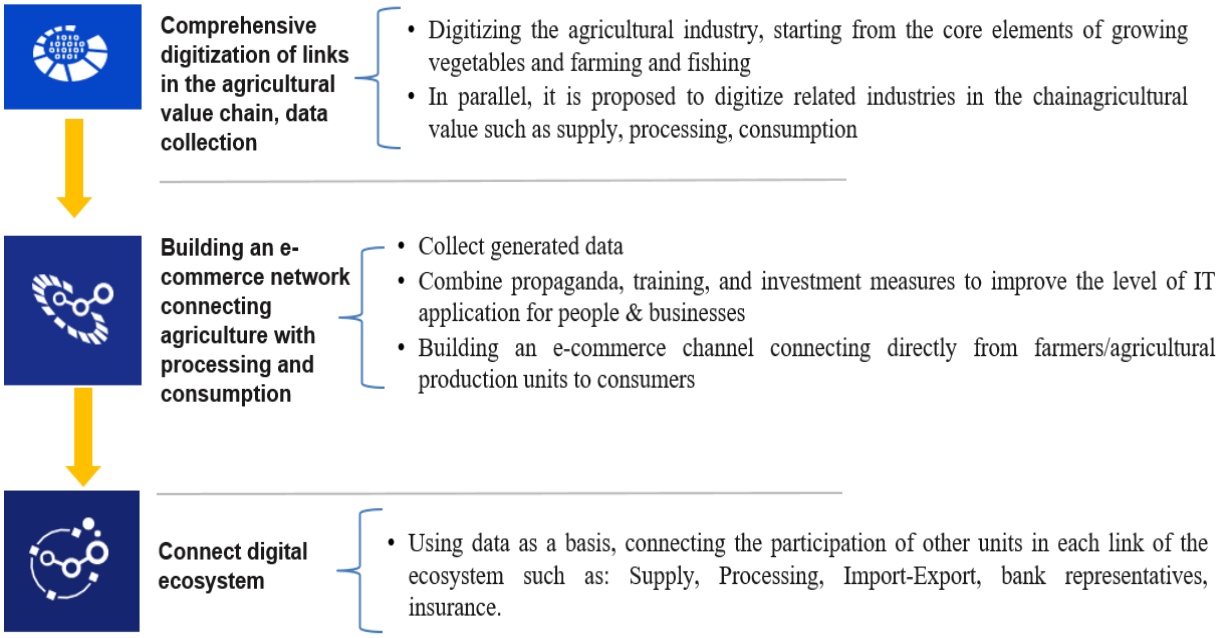

Figure 3. Proposing the roadmap for the development digital transformation process for ASC with the following steps: 1. comprehensive digitization, 2. building an e-commerce network and 3. connect digital ecosystem

On the other hand, based on some challenges of digital transformation for ASC, some solutions to overcome challenges can be listed as follows:

+ Enhancing Technological Infrastructure

Investment in rural infrastructure, especially in digital connectivity and power supply, is paramount. Public-private partnerships can play a critical role in the development of the necessary infrastructure. Governments can facilitate this by providing subsidies, tax incentives, and supportive regulatory environments to encourage private sector investment.

+ Financial Support and Incentives

Governments, financial institutions, and international organizations should collaborate to provide financial support to farmers and small businesses. Microfinance, grants, and low-interest loans can mitigate the initial financial burden associated with adopting digital technologies. Furthermore, subsidies and incentives for purchasing advanced machinery and tools can stimulate adoption.

+ Promoting Digital Literacy and Training

Educational initiatives focusing on digital literacy for farmers are essential. Workshops, training programs, and extension services can equip farmers with the knowledge and skills needed to use digital tools effectively. Collaborations with agricultural universities, technology providers, and nongovernmental organizations (NGOs) can drive these educational efforts.

+ Ensuring Data Security

Implementing robust cybersecurity measures and establishing clear data protection laws can address security and privacy concerns. Creating transparent data governance frameworks and educating stakeholders about data rights and protections can build trust and encourage engagement with digital platforms.

+ Streamlining the Supply Chain

Digital platforms that facilitate transparency and coordination between stakeholders can streamline the fragmented supply chain. Technologies like blockchain can ensure traceability and trust, while IoT can improve real-time monitoring and decision making. Developing integrated platforms that bring farmers, suppliers, distributors and consumers together can improve efficiency and reduce waste.

+ Establishing an ecosystem for digital transformation in the agricultural supply chain

The ASC digital ecosystem requires interaction and cooperation between different components. In particular, farm households and agricultural enterprises play a central role in the ecosystem, as shown in Figure 4. Other actors in the ecosystem include the Government, Technological enterprises, Financial organizations, Customers, Logistics enterprises, and Retail businesses. In which, the government will provide regulations and policies to support and ensure economic and social security for the entire agricultural ecosystem, and technological enterprises develop practical technology applications in the agricultural industry. Financial organization support and investment fund for technology agricultural units and retail businesses anticipate consumer food demand and promote safe food consumption habits. Logistics enterprises improve technology to enhance the efficiency and effectiveness of warehouse and distribution management, and education organizations supplement research and education programs that drive innovation in the agricultural industry. Finally, the customer is in the habit of consuming clean and quality food from agricultural farms applying high technology.

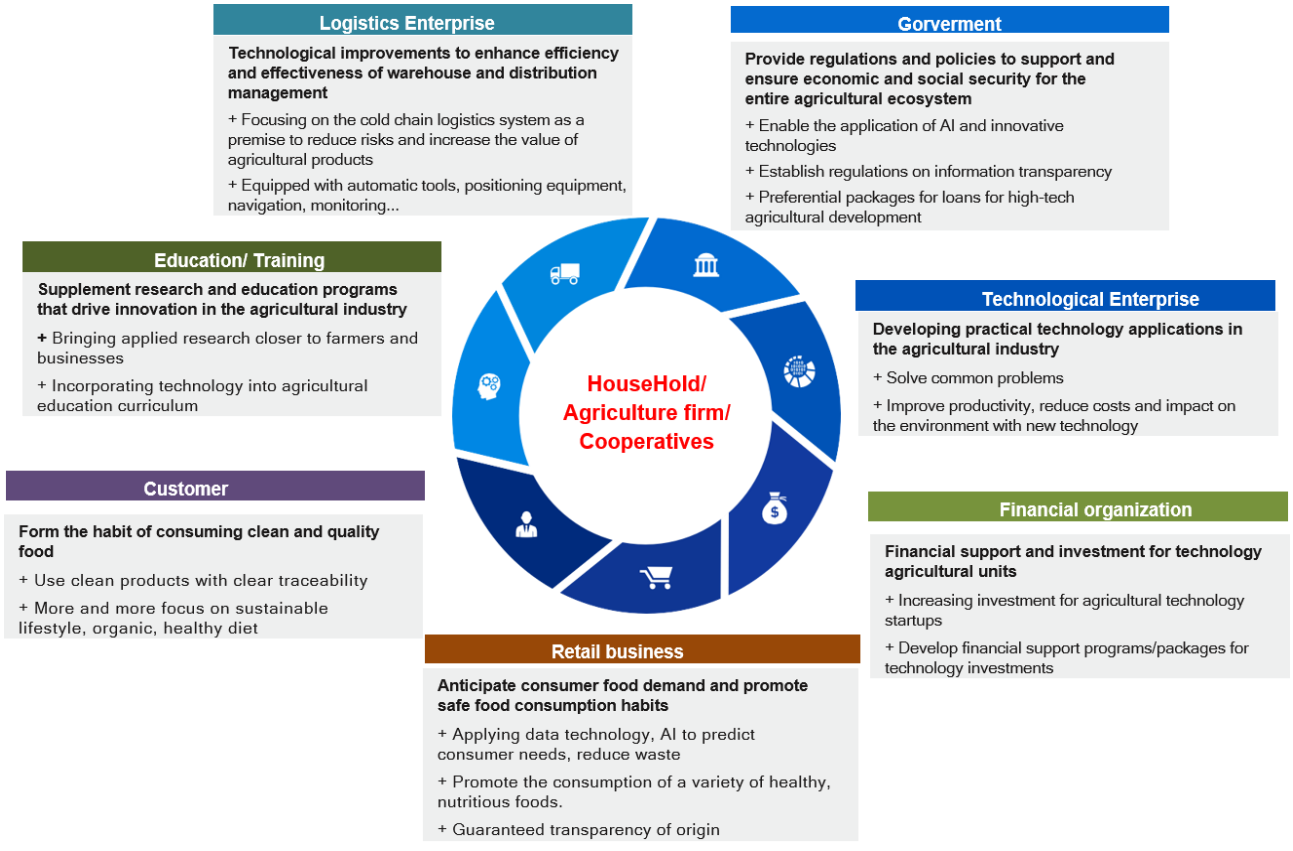

Figure 4. Proposition of a digital ecosystem for the ASC in which farmers' households and agricultural enterprises play a central role in the ecosystem

5. Conclusions

The digital transformation of Vietnam's agriculture supply chain holds immense promise for improving productivity, ensuring food security, and fostering economic growth. While the journey toward a fully digitized supply chain is laden with challenges, targeted solutions can pave the way for a more efficient and resilient agricultural sector. By investing in infrastructure, offering financial support, promoting digital literacy, ensuring data security, and streamlining operations, Vietnam can harness the power of digital technologies to revolutionize its agricultural supply chain. To achieve this objective and ensure a sustainable and successful future for Vietnam's agriculture, the government, the business sector, and the international community must work together. The utilization of cutting-edge technologies combined into a single system to enable farmers and other value chain participants to enhance their output and workflows is known as the digital transformation of the agriculture supply chain. In this paper, we examine the state of the agricultural supply chain's digital transformation as of right now. In the framework of the digital economy, this study currently offers a digital transformation roadmap for supply chains in the agriculture sector.

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