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THỰC TRẠNG CHUỖI CUNG ỨNG LẠNH CHO MẶT HÀNG NÔNG SẢN Ở TRUNG QUỐC VÀ ĐỀ XUẤT GIẢI PHÁP CHO VIỆT NAM

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Tóm tắt

Chuỗi cung ứng lạnh giúp bảo quản nông sản, giảm tổn thất và nâng cao giá trị xuất khẩu. Tuy nhiên, hạ tầng logistics lạnh của Việt Nam còn hạn chế, trong khi Trung Quốc đã phát triển hệ thống hiện đại, tối ưu hóa bảo quản và phân phối. Từ đó nhóm tác giả thực hiện nghiên cứu này nhằm đánh giá thực trạng chuỗi cung ứng lạnh tại Việt Nam, so sánh với mô hình phát triển của Trung Quốc để rút ra bài học kinh nghiệm, từ đó đề xuất các giải pháp nâng cao hiệu quả chuỗi cung ứng lạnh. Bằng phương pháp phân tích so sánh kết hợp với tổng hợp dữ liệu từ các báo cáo ngành và tài liệu học thuật. Kết quả cho thấy Việt Nam cần đầu tư vào kho lạnh, mở rộng vận tải lạnh và ứng dụng công nghệ như IoT, blockchain, thương mại điện tử để nâng cao hiệu quả quản lý. Đồng thời, chính phủ cần có chính sách hỗ trợ doanh nghiệp, khuyến khích hợp tác công - tư và xây dựng chiến lược phát triển dài hạn nhằm tăng khả năng cạnh tranh trên thị trường quốc tế.

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ANALYSIS OF COLD CHAIN FOR AGRICULTURAL PRODUCTS IN CHINA AND PROPOSED SOLUTIONS FOR VIETNAM

Abstract

The cold chain plays a crucial role in preserving agricultural products, reducing losses, and enhancing export value. However, Vietnam's cold chain infrastructure remains limited, while China has developed a modern system that optimizes preservation and distribution. Thus, this study aims to assess the current state of cold chain in Vietnam, compare it with China's development model to draw lessons, and propose solutions to improve efficiency. Using a comparative analysis combined with data synthesis from industry reports and academic sources, the study highlights the need for Vietnam to invest in cold storage, expand refrigerated transportation, and apply technologies such as IoT, blockchain, and e-commerce for better management. Additionally, the government should implement supportive policies for businesses, encourage public-private partnerships, and develop a long-term strategy to enhance competitiveness in the global market.

Keywords: Cold chain, Agricultural products, Vietnam, China.

1. Introduction

Although Vietnam is one of the largest exporters of fruits and vegetables, its cold chain logistics remain significantly underdeveloped. The sector is fragmented, dominated by small-scale service providers that lack comprehensive end-to-end solutions. While the demand for chilled and frozen products has been rising due to changing consumer preferences and improving living standards, the country's capacity to meet this demand falls short. Between 2001 and 2017, Vietnam's agricultural trade achieved an impressive compound annual growth rate (CAGR) of 12.5% for exports (Khoi et al., 2019). However, food losses during harvesting, processing, storing, and transporting remain a critical challenge. On average, Vietnam experiences post-harvest losses of 32% for fruits and vegetables, and 14% and 12% for meat and seafood, respectively. Inefficient transportation management, particularly of refrigerated containers, is the primary cause of these losses (Mattos & Brun, 2018).

In contrast, the Chinese government has made significant strides in developing its cold chain infrastructure. From 80 billion RMB in 2011 to 160 billion RMB in 2015, the Chinese cold chain market has expanded by more than 20 percent in the last five years. China also has witnessed rapid growth in the temperature-controlled warehousing sector alongside the development of cold chain logistics. The national cold storage capacity increased from 13 million square meters in 2008 to 76 million square meters in 2014. To meet the growing demand for air transportation in the cold chain, many temperature-controlled warehouses have been built near airports and Airport Economic Zones. Major Chinese airports with cold storage facilities include Pudong Airport (Shanghai), Baiyun Airport (Guangzhou), and Kunming Airport. Companies such as Xiamen Wanxiang Cold Chain Logistics Centre, Central China Hub of Frozen and Fresh Produce have significantly invested in cold storage infrastructure in

these areas (Teng & Chen, 2017). Recent initiatives include upgrading distribution centers and establishing public cold storage facilities, which have improved transportation efficiency and product quality. Such efforts are essential to reducing food waste, which globally amounts to about one-third of all food produced.

Therefore, this article aims to address the pressing need for cold chain improvements in Vietnam by achieving three key objectives: first, to evaluate the critical factors that have contributed to the successful development of China's cold chain system for agricultural products; second, to identify the current challenges and gaps in Vietnam's cold chain infrastructure; and finally, to propose actionable strategies that Vietnam can adopt to enhance its cold chain logistics. Cold chain management will be evaluated through two key factors: cold warehouse and cold transport.

2. Theoretical Background

According to Vietnamese laws, such as the Law on Crop Production (2018) and the Law on Livestock Production (2018), the term agriculture includes the processes of crop cultivation, livestock raising, and related activities aimed at producing food, raw materials, and other products, with the integration of modern scientific and technological advancements to achieve higher levels of productivity, quality, and sustainability while adhering to environmental as well as food safety standards.

2.1. Cold supply chain management

Cold Supply Chain Management (CSCM) is defined as the integrated management of logistics and supply chain activities for temperature-sensitive products. The goal is for these products to be stored, handled, and transported under controlled temperature conditions to maintain quality, safety, and efficacy (Bogataj et al., 2005).

The critical aspect of cold supply chain management is to maintain a proper temperature at all stages, as this would optimize the quality of the product as well as prevent it from rotting. IoT sensors, RFID, and blockchain technologies all enhance monitoring and traceability by allowing real-time temperature and location tracking (Tsang et al., 2018). Efficient logistics, including optimized routing, storage, and transportation, help reduce energy use and operational expenses (Shashi et al., 2018). Equally important is regulatory compliance, which ensures adherence to industry standards such as Good Distribution Practices (GDP) for pharmaceuticals and Hazard Analysis Critical Control Point (HACCP) for food safety (Jedermann et al., 2014). Together, these elements work in harmony to guarantee the quality, safety, and sustainability of products as they move through the cold supply chain.

2.2. Cold transport

Cold transport is very critical in delivering sensitive goods with refrigerated trucks, containers, and other temperature-controlled equipment. Its primary goal is to maintain the integrity and safety of the goods at all times by keeping them within the acceptable range of temperature (Mercier et al., 2017).

The Internet of Things (IoT) enables integrating additional sensors and sophisticated monitoring control systems, which can assist in damage control (Tsang et al., 2018). Furthermore, cold transport is one of the major components that assist in compliance with regulations like Good Distribution Practices (GDP), ensuring that all items are delivered in the desired conditions (Jedermann et al., 2014). Through the integration of controlled temperature, effective monitoring, and enhanced logistics, cold transport makes sure the temperature-sensitive goods are also protected along the supply chain.

2.3.Cold warehouse

A cold warehouse or a refrigerated warehouse (RW) is a specialized storage facility, serves mainly to provide a stable, suitable, and long-term low-temperature environment to conserve the quality of fresh agricultural products after pre-cooling (Han et al., 2021). Equipped with advanced cooling systems, insulation, and temperature monitoring technologies to ensure optimal internal conditions, cold warehouses play a pivotal role in the storage phase of the cold chain.

They are categorized into refrigerated warehouses (also known as chill stores) with temperatures from 1°C - 12°C, commonly being used for storing fresh, dairy products, and other perishable items that require a cool but not frozen environment; and frozen warehouses with temperatures under -18°C, designed to store frozen foods, such as meats and seafood that must be kept at low temperatures to prevent bacterial growth and maintain product integrity.

The global refrigerated warehousing market size was valued at USD 85.04 billion in 2022 and is estimated to grow at a CAGR of 17.8% from 2023 to 2030.

2.4.Cold transport and cold warehouse in supply chain management

Cold transport and cold warehouses play critical roles in ensuring the quality of temperature-sensitive goods from production to consumption. These systems ensure consistent temperature control across all stages of the supply chain, reducing the risk of spoilage and quality degradation.

The increasing demand for perishable goods, including food and pharmaceuticals, has driven significant growth in cold chain logistics. Global disruptions, such as rising commodity prices and supply chain challenges, have posed obstacles, but the cold chain market is projected to expand steadily due to rising consumer demand and technological advancements.

2.5. Agricultural products

According to Clause 7, Article 3 of Decree 57/2018/ND-CP, agricultural products are defined as products of the farming, forestry, fishery, and salt industries (salt making). Specifically:

- Agricultural products: rice, corn, potatoes, cassava, coffee, pepper, pork, poultry meat and eggs, etc.
- Forestry products: exploited wood, firewood, bamboo, pine resin, canarium, mangrove, etc.

- Aquaculture products: shrimp, fish, sea fish, shrimp, oysters, mussels, prawns, etc.
- Salt industry products: salt production.

Gilmour and Phillips (2012) also indicated that Chinese agricultural products include grain and rice, livestock, aquaculture, and fruit and vegetable.

Therefore, in this article, agricultural products are not limited to farmed crops but also include fishery products and meat. Specifically, fruits and vegetables, meat, and seafood are considered agricultural products due to their perishable nature, requiring careful handling at low temperatures (Zhao et al., 2018).

3. Cold chain for Agricultural products in China

3.1. Current situation of cold chain for agricultural products in China

China's cold chain logistics market has expanded exponentially as a result of greater consumer demand for fresh produce, urbanization, and governmental initiatives to modernize agricultural supply chains. The sector will reach USD 85.82 billion in 2024, growing at a compound annual growth rate (CAGR) of 10.07% to USD 138.66 billion by 2029 (Mordor Intelligence, 2024).

3.1.1. Cold Transport

Refrigerated Trucks

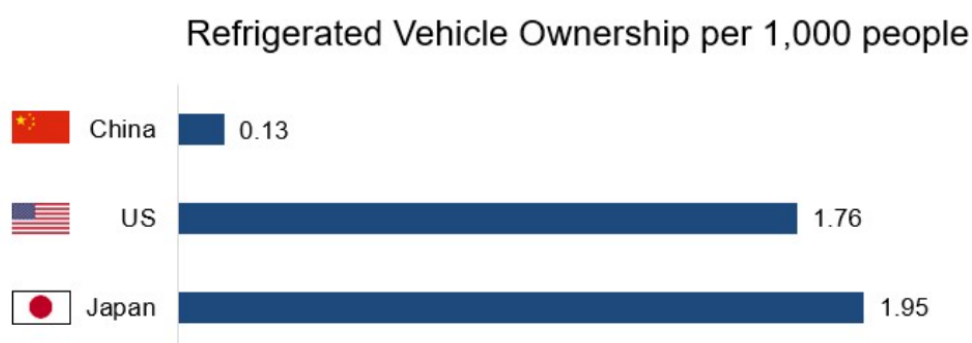
China's refrigerated truck fleet has grown from 180,000 in 2017 to 340,000 in 2024 (Table 1), but remains much smaller than the U.S. with over 500,000 units in operation (Mordor Intelligence, 2024). Currently, less than 35% of perishables are processed through the use of refrigerated trucks, which is a post-harvest loss rate above 20% for sectors like fruits and vegetables (Daxue Consulting, 2022). By 2022, a mere 50% of China's key agricultural produce employed cold chain systems, and this led to food waste worth about USD 30 billion annually (Han, 2021), which caused massive food wastage, higher costs for producers, and reduced global competitiveness for exports.

Table 1: Number of Refrigerated Trucks in China from 2017 – 2024

Year	Number of Refrigerated Trucks in China
2017	180,000
2020	250,000
2022	300,000
2024	340,000

Source: Mordor Intelligence, 2024

Figure 1: Refrigerated vehicle ownership per 1,000 people



Source: daxue consulting, 2022

However, by 2024, China's cold chain environment was much different. Total demand grew by 4.3% to 365 million tons, driven by a rapid shift to new energy refrigerated trucks. Sales of these vehicles surged by 350.8%, reaching 21,368 units, expanding their market share to 33.9%. Equipped with electric power and advanced cooling systems, these trucks became essential to the agricultural supply chain system.

Rail and Air Freight

The Global Times (2025) cites rising air freight of cold chain commodities by 2024, witnessed in the China Eastern Airlines frequent Ezhou-Oslo chartered service started in January 2025. The twice-a-week route had its initial 35 tons of salmon and plans to import 80-90 tons per week. New intermodal sea routes now link inland cities like Beijing and Urumqi to global markets, enabling fresh produce trade and China's foreign trade role.

Air freight volumes of cold chain products have grown by 18% in 2024, as in the case of China Eastern Airlines' chartered flight from Ezhou to Oslo with Norwegian salmon (CFLP, 2024). Air freight accounts for less than 3% of cold chain logistics due to high costs of operation and limited cold storage facilities at airports (Han, 2021). At the same time, rail transport moves less than 12% of perishables, which are constrained by old refrigerated railcars and a shortage of intermodal facilities ([Jia et al., 2024](#)). In an attempt to mitigate such inefficiencies, China is testing cold chain high-speed rail corridors such as the Beijing-Guangzhou railway line, whose utilization reduces fresh produce transit time by 30% relative to truck transport ([Cheng et al., 2024](#)). Strategic investments in multimodal hubs in cities like Xi'an and Chongqing aim to integrate rail, road, and air networks, enhancing connectivity for inland agricultural regions.

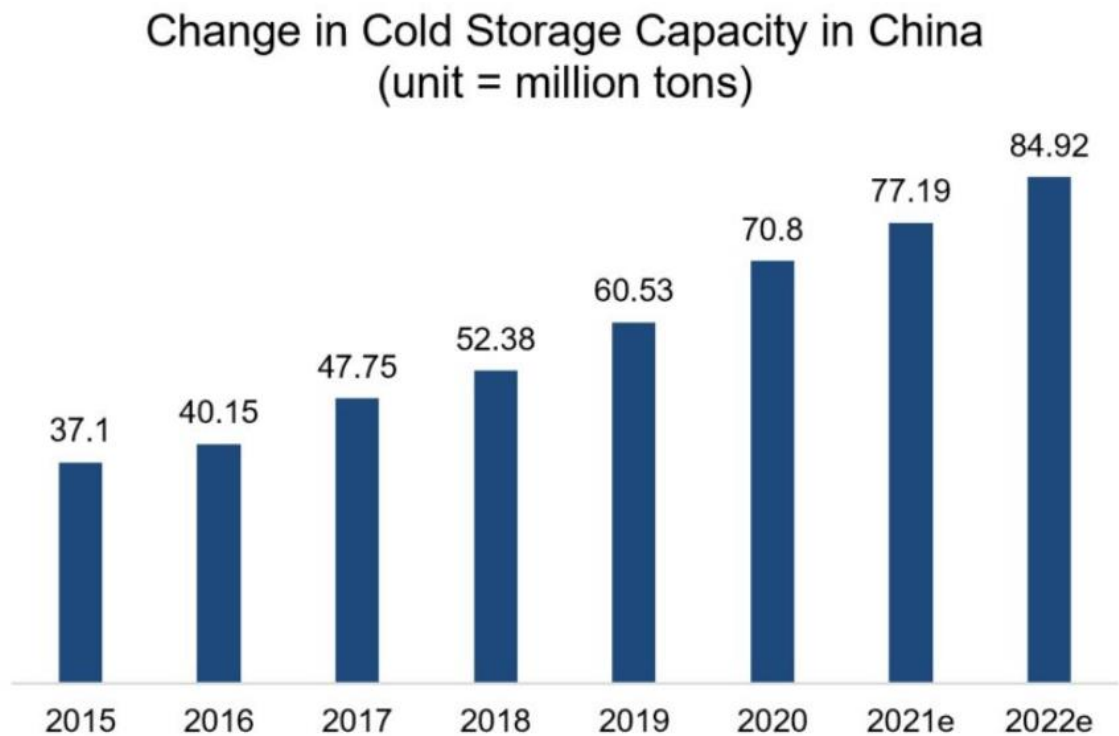
3.1.2. Cold warehouse

Regional distribution and storage capacity

China's warehouses are expanding exponentially to meet the growing demand for fresh and perishable commodities. More than 29% growth in cold chain logistics over the period 2018-2019 only serves to highlight the ever-growing imperative to establish cold storage

infrastructure (Daxue Consulting, 2022). As of 2024, cold storage space in China has increased to 237 million cubic meters, which grew by 7.73% year on year (IIR, 2024). Furthermore, 9.42 million cubic meters of new fresh cold storage was built to offer storage for improved demand for fresh fruits and vegetables, primarily from rural and interior areas.

Figure 2: China's cold chain capacity 2015 - 2022



Source: daxue consulting, 2022

Despite this expansion, 65% of cold storage capacity is concentrated in big economic hubs such as Shanghai, Guangzhou, and Beijing which account for 70% of national cold chain demand (CFLP, 2024). At the same time, major agricultural provinces such as Henan and Sichuan have severe shortages, requiring reliance on costly road transport. For instance, Henan—China's largest vegetable producer—incurs 25% higher logistics expenses than coastal regions due to a shortage of cold storage capacity (Jia et al., 2024). The 2021–2025 National Cold Chain Logistics Plan has prioritized filling this gap by financing rural cold storage programs, which provided 1.2 million cubic meters of capacity in Henan alone in 2024, reducing post-harvest losses of vegetables by 15% (Cheng et al., 2024).

3.2. Achievements of China’s agricultural cold chain

Reduction of food waste and utilization of food preservation

The fresh agricultural product (FAP) requires a perishable nature and timing sensitivity. At the point of origin, FAP logistics involve a number of processes, including grading, packaging, distribution, storage, and preservation. During the production, transportation, storage, and

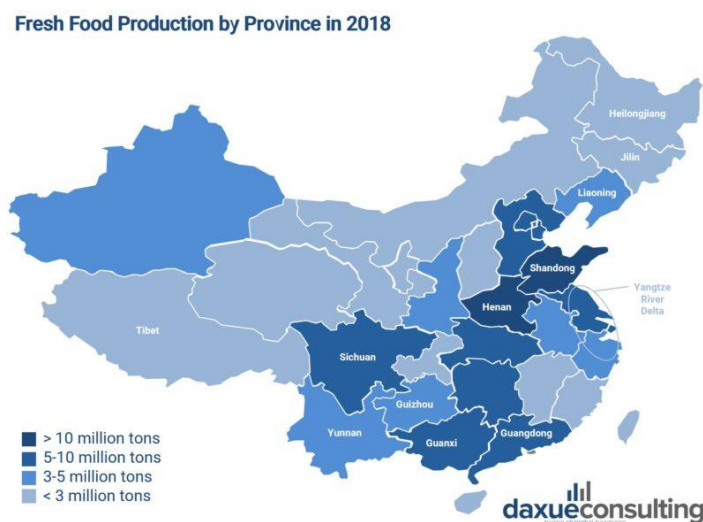
distribution phases, cooling and preservation methods must be applied. Maintaining the freshness of fresh food requires proper storage conditions. Thus, adequate storage space and effective pre-cooling capabilities are essential for the first phase of the supply chain. (Zhou et al., 2024)

Certain FAP deteriorates easily and has a short shelf life, which results in preventable losses. Because of the increased storage needs, the preservation at the point of origin increases efficiency and quality of the food. Therefore, along with the advanced technology applied to cold chain management in China, such as the IoT devices used to monitor temperature and humidity levels in real-time during storage and transportation to ensure optimal conditions for preserving the quality of agricultural products (Huaizhi et al., 2024), cold chain logistics have significantly reduced food spoilage and waste in China, ensuring that more agricultural products reach consumers in good condition.

Shifts of distribution patterns in China

The development of cold chain logistics in China has a significant connection to the patterns of population distribution in various provinces. There has also been a rise in population distribution in the regions where cold chain logistics have grown at faster rates. Compared to China's western regions, the country's northern and southern provinces represented a significant portion of the population distribution (Huaizhi et al., 2024). This can be comprehended by the fact that generally speaking, a province's total food production tends to increase along with its population. As a result, it implies that heavily populated, developed areas typically have more cold chain resources (Dong et al., 2020). Hence, the cold chain distribution had a shifting impact on the population density of China's provinces.

Figure 3: Fresh food production by province in 2028



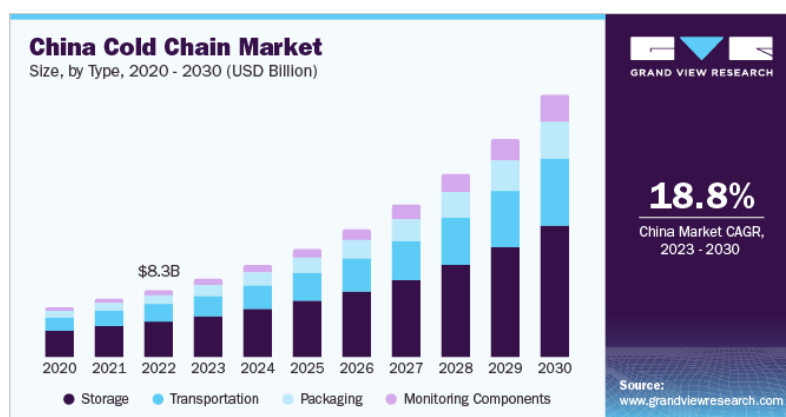
Source: daxueconsulting, 2018

In terms of food consumption, the Chinese population's consumption patterns have also been impacted by cold chain logistics. Many different food types that are consumed and distributed between regions have been affected by the increased accessibility and cost of grains and particulate goods. The Chinese population's consumption patterns have also been impacted by cold chain logistics (Huaizhi et al., 2024). In regions where fresh fruits, vegetables, and meats were previously unavailable, the development of cold chain infrastructure has facilitated the distribution of a broad range of food goods (Ruan, 2020). Because of this increased accessibility to portable produce, it can not only satisfy consumer wants but also changes people's eating habits, increasing the consumption of nutritious, fresh foods.

Contribution to national economic development

In terms of the remarkable growth of China's economy, the refrigerated supply chain contributed partly. The cold chain market value of China has made enormous progress, as in 2022, the cold chain logistics market in China was valued at approximately \$8.31 billion and is expected to grow at a CAGR of 18.8% in the next 8 years (GVR). Demand in the market is rising dramatically, mostly due to the country's agricultural and pharmaceutical industries' rapid expansion. The demand for fresh and perishable products has increased as the nation's population grows and becomes more urbanized. Additionally, rising consumer awareness and attention to product quality and safety are also key variables driving the market's growth.

Figure 4: China cold chain market in 2020



Source: grandviewresearch, 2020

On the other hand, China can import or export more perishable items, such fresh fruits and vegetables, from or to foreign markets with better cold chain networks. This may increase the competitiveness of Chinese agricultural products internationally and create new revenue streams for the nation, making it one of the most developed countries in regards to cold chain management. According to the U.S. Department of Agriculture, food makes up for 25.2% of the cross-border ecommerce (CBEC) import categories (USDA, 2025). In the past, room-

temperature food products have dominated imports of food products because CBEC facilities have limited cold chain availability. In 2022, a few smaller platforms began investigating the import of CBEC fresh produce in small quantities when certain CBEC facilities gained cold-chain capacity. The two largest Chinese e-commerce sites, JD.com and Tmall, began attempting to import fresh fruit through CBEC in the second half of 2024. According to industry experts, in the coming years, CBEC imports of cold-chain items may emerge as the primary factor propelling the rise of CBEC imports overall.

The development of the cold chain infrastructure promotes economic activity in both urban and rural areas along with helping create job opportunities. Modernizing food chain logistics is consistent with China's objectives to reduce food waste and increase food security. Since cold chain logistics has helped the nation build a resilient food supply chain, it increases the dependability and effectiveness of food delivery.

4. Cold chain for agricultural products in Vietnam

4.1. Current Situation of Cold Chain for Agricultural Products in Vietnam

The cold chain for agricultural products in Vietnam has developed significantly in recent years but still struggles to meet rising demand. Despite infrastructure and logistics improvements, transportation and storage inefficiencies continue to cause post-harvest losses. According to FiinGroup (2019), fewer than 50% of perishable agricultural products were handled under proper cold chain conditions, limiting Vietnam's export potential. However, by 2024, cold chain logistics demand has surged due to stricter trade regulations and higher consumer expectations. Investments in temperature-controlled logistics and technological upgrades are driving improvements in operational efficiency and reducing waste (Vietnam Briefing, 2023).

4.1.1. Cold transport

Refrigerated trucking

As of 2019, Vietnam only had around 700 refrigerated trucks, well short of domestic and export demand (FiinGroup, 2019). This has resulted in inefficiencies in the transportation of seafood, fruits, and vegetables, resulting in high spoilage and decreased export potential. Rural producers do not have access to consistent cold transport, so perishables must be transported under suboptimal conditions and suffer heavy losses.

By 2023, with more investment, the cold fleet was still inadequate, and it was projected that 1,500 to 2,000 more vehicles were required to meet market demand (Vietnam Briefing, 2023). Vietnam's agricultural exports, particularly seafood and fruits, have grown extremely rapidly, with seafood export turnover reaching USD 10 billion in 2022, from USD 7.1 billion in 2019 (Vietnam News, 2024). This trend highlights the need to expand and upgrade cold transport infrastructure.

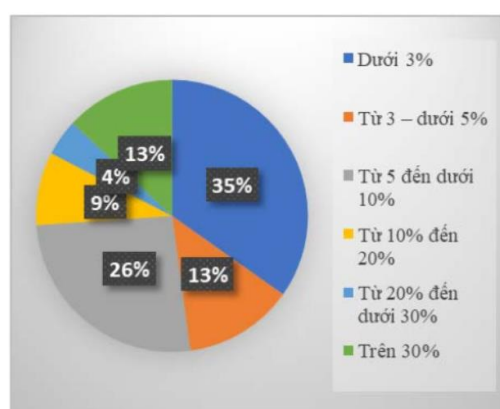
Regional distribution in cold transport services

An analysis of recent logistics infrastructure maps from industry reports (Savills, 2024) indicates that major cold transport networks are concentrated in southern Vietnam, particularly in Ho Chi Minh City and the Mekong Delta. This region benefits from well-established seafood processing hubs and export facilities, creating a higher demand for refrigerated transportation. As a result, businesses operating in these areas have better access to modern cold storage facilities and advanced transport services, ensuring faster and more reliable delivery of perishable goods. While northern and central Vietnam lacks the same level of infrastructure, leading to logistical bottlenecks that hinder the movement of perishable goods. Producers in these regions face significant challenges in accessing temperature-controlled transportation, which increases transit times and causes frequent spoilage resulting in post-harvest losses exceeding 20% for certain high-value crops such as lychee and dragon fruit, further highlighting the urgent need for expanded infrastructure (Savills, 2024).

Cost and technological challenges

Cold chain logistics requires significant energy consumption to maintain stable temperatures throughout the supply chain. Higher fuel and electricity costs have driven freight charges, with refrigerated transport operations 30–50% more than standard logistics, placing obstacles to small and medium-sized agriculture enterprises (Vietnam Briefing, 2023). This issue is further impacted by outdated infrastructure: close to 65% of Vietnam's refrigerated transport equipment employs outdated technologies, resulting in inconsistent temperature control and spoilage rates above 25% for perishable goods such as fruits, vegetables, and seafood (FiinGroup, 2019; Bích Liên, 2020).

Figure 5: The logistics cost ratio to the total cost of agricultural products.



Source: Bích Liên, 2020

Digital adoption remains slow, approximately 60–70% of refrigerated trucks use single-temperature systems with poor-quality insulation, operating at 20–30% lower energy efficiency than modern multi-zone systems (FiinGroup, 2019; Vietnam Briefing, 2023). This is a self-sustaining problem: outdated equipment increases energy and maintenance costs, while delayed modernization perpetuates inefficiencies. For example, temperature fluctuations during

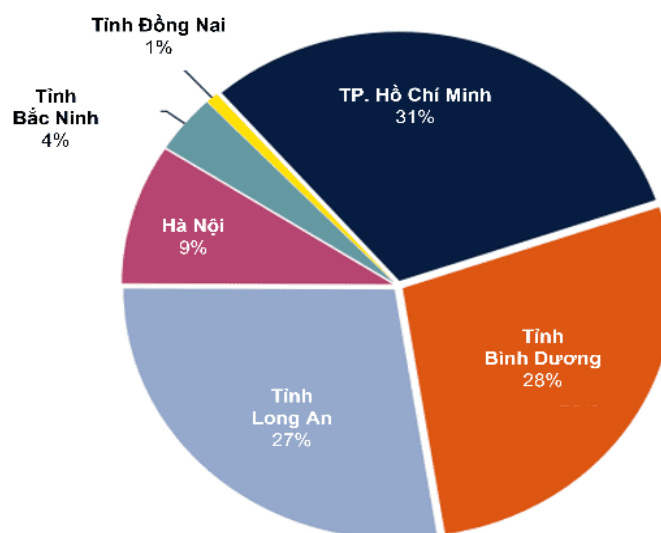
transport damage the quality of such valuable exports as dragon fruit and shrimp, reducing their shelf life and export value by up to 30% (VASEP, 2021; FAO, 2021). In addition, failure to achieve full compliance with international food safety regulations such as HACCP and ISO 22000 prevents access to high-end international markets, further undermining profitability.

4.1.2. Cold Warehouse

Cold storage capacity

The industry of cold storage in Vietnam has significantly expanded over the last couple of years because of increasing country exports of farm produce and developing domestic demand for frozen and chilled goods. By 2023, the estimated overall cold storage capacity in Vietnam is 1.8 million pallet positions and more than 180 facilities are present across the country (Vietnam Cold Chain Association, 2023). However, the allocation of these facilities is extremely unequal, with most being found in major economic centers like Ho Chi Minh City, Hanoi, and Da Nang. These areas host more than 70% of the country's cold storage capacity, enjoying their location near large seaports, airports, and urban consumption points (Innovative Hub, 2023).

Figure 6: Cold storage allocation in Vietnam



Source: Kholanhbachkhoa.net, 2023

In contrast, rural agricultural regions like the Mekong Delta and Central Highlands are plagued by severe shortages of cold storage facilities. The Mekong Delta, which accounts for over 50% of Vietnam's exports of fruit and a significant portion of its seafood production, has less than 15% of Vietnam's cold storage capacity (Tap Chi VNUA, 2022). This results in substantial post-harvest losses estimated at 25–35% annually due to the poor storage and transport facilities. The farmers are usually forced to sell their produce shortly after harvesting at poor prices, thereby implying poor incomes and competitiveness in the export market.

Technological adoption and government policies

Vietnam's cold storage sector is becoming more and more inclined toward adopting innovative technologies, such as IoT temperature monitoring and automated systems, to become more efficient for key agricultural exports like dragon fruit, shrimp, and coffee. Companies like ABA Cooltrans in metropolitan areas of Ho Chi Minh City and Hanoi utilize these technologies to reduce spoilage and maintain product quality, which are critical to meet international requirements (Vietnam Briefing, 2023).

However, adoption is not even: over 60% of rural cold storage houses continue to use outdated equipment, driving energy expenses to 40–50% of operational expenses and increasing post-harvest losses for temperature-sensitive produce like lychee and leafy greens (B-Company, 2023). Limited technical capacity and high upfront costs also constrain modernization, particularly for small-scale farmers and perishable fruit exporters such as berries and fish, which suffer up to 25% value loss due to unreliable storage conditions.

4.2. Achievements and limitations of the cold chain for agricultural products in Vietnam

4.2.1. Achievements

Enhancing export competitiveness

In 2024, Vietnam's agricultural, forestry, and fishery exports saw significant growth, contributing positively to the national economy. According to the Ministry of Industry and Trade, the sector has focused on improving product quality to enhance export value and expand markets (Vietnamplus, 2024). A key factor in maintaining the product quality of those perishable goods is the development of an effective cold chain system, playing a vital role in preserving the freshness and quality of exported agricultural products, and ensuring they meet the stringent international standards.

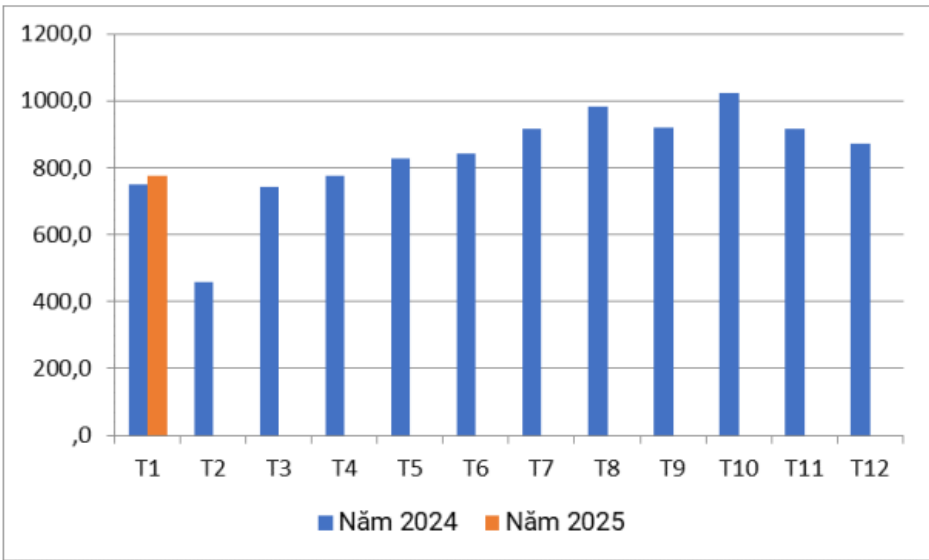
These efforts have yielded impressive results, with the total export turnover of agricultural, forestry, and fishery products expected to reach a record-high 62.4 billion USD, marking an 18.5% increase compared to 2023 (Tra, 2024). To be more specific:

The export value of agricultural products reached 32.8 billion USD, a 22.4% increase, fishery products achieved 10.07 billion USD, up by 12.2%, and forestry products totaled 17.28 billion USD, an increase of 19.4%.

- **Fishery sector**

Vietnam has become a major supplier of fishery products in the region, ranking second in volume and fourth in value to Taiwan (Cục Xuất nhập khẩu, Bộ Công Thương & Trung tâm Thông tin Công nghiệp và Thương mại, Bộ Công Thương, 2025). Key markets for seafood exports include China, Japan, the United States, and the EU.

Figure 7: Export turnover of fishery products in 2024-2025 (Million USD)

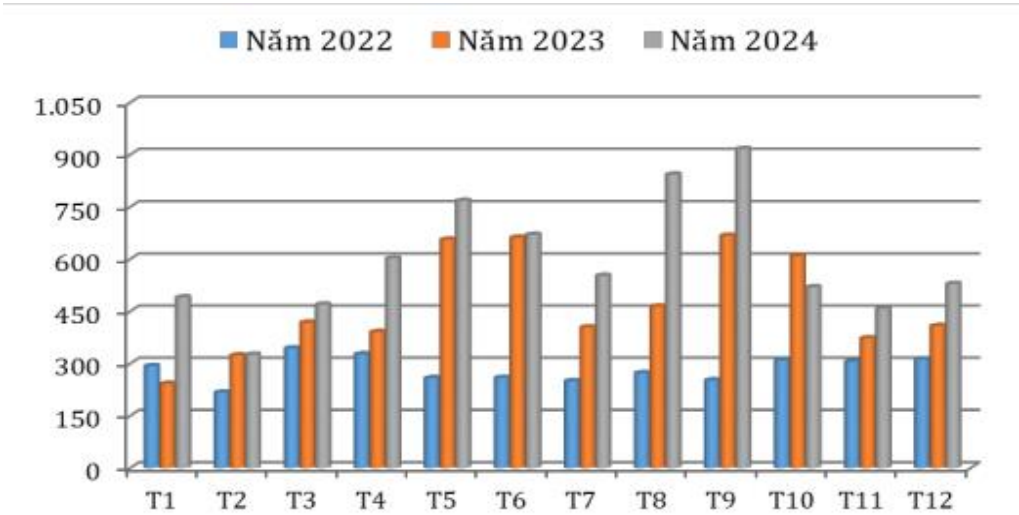


Source: General Department of Customs, 2024

- Fruit and vegetable sector

Fruit and vegetable exports have also reached significant heights throughout the years, The sector achieved an export turnover of 7.15 billion USD in 2024, a 27.6% increase from the previous year (Cục Xuất nhập khẩu, Bộ Công Thương & Trung tâm Thông tin Công nghiệp và Thương mại, Bộ Công Thương, 2025). Notable increases include durian (up 61.1%), mango (up 46.8%), and cashews (up 76.9%). Durian accounted for nearly 50% of total exports, at US\$3,21 billion in 2024. The sector is on track to meet its US\$7 billion target by year-end, exceeding the expectation of US\$ 6-6.5 billion set before.

Figure 8: Export turnover of fruits and vegetables in 2022-2024 (Million USD)



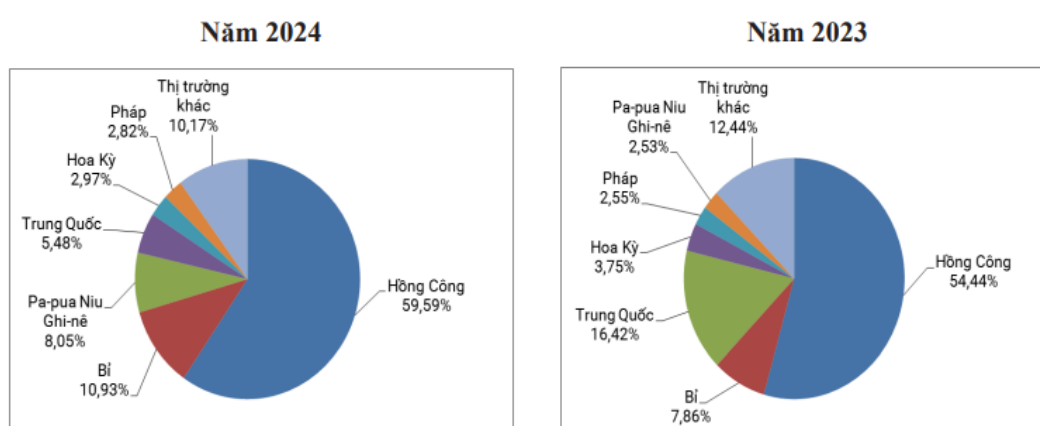
Source: General Department of Customs, 2024

Currently, the Vietnamese fruit and vegetable industry holds the second largest market share in China, and its market share in The United States, Japan, South Korea, the EU, Australia, etc. is increasingly expanding. This is considered the basis for the Vietnamese fruit and vegetable industry to achieve the export target of 8 billion USD in 2025.

- Meat sector

Vietnam's meat exports showed moderate growth, with 24.5 thousand tons of meat and meat products exported, valued at 117.02 million USD, an 8% increase in quantity and 6.1% in value. Fresh and frozen pork remains the most exported meat, accounting for a significant portion of the total meat export value.

Figure 9: Export market structure of meat and meat products (% value)



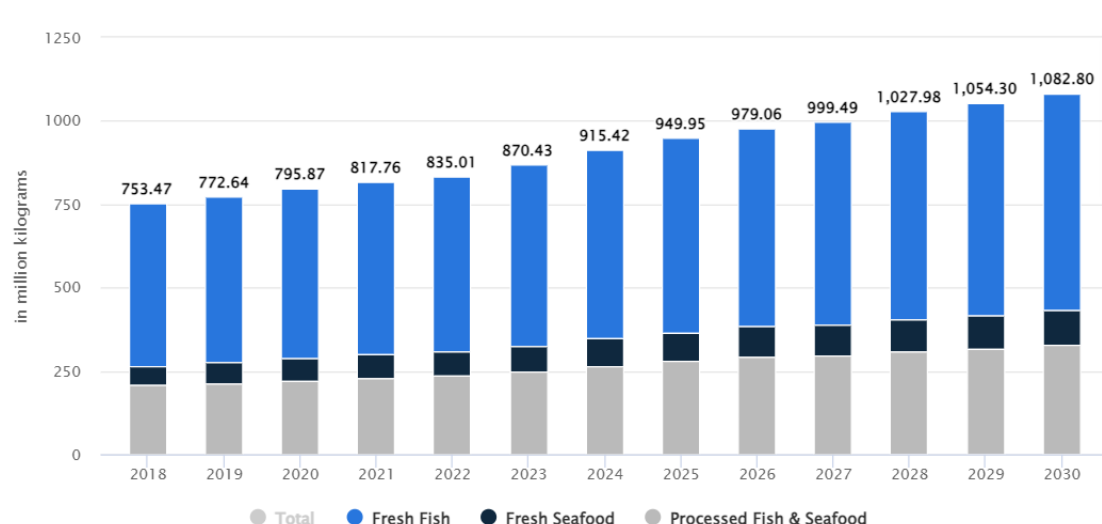
Source: General Department of Customs, 2024

The continued growth in agricultural exports, supported by the strengthening of the cold chain infrastructure, reflects Vietnam's efforts to enhance its export capabilities and meet the growing demand in international markets, solidifying its position as a key player in global agricultural trade.

Strengthening the domestic seafood market

Vietnam's fish and seafood market is experiencing robust growth, with projected revenues reaching approximately USD 12.98 billion by 2025 and an expected annual growth rate of 5.98% from 2025 to 2030 (Statista, n.d.). This surge is driven by increasing consumer demand for convenient, ready-to-eat seafood products, especially in urban areas.

Figure 10: Revenue in the Fish & Seafood market in Vietnam



Source: Statista Market Insights

Vietnam's ready-to-eat (RTE) food market has witnessed significant growth, with its value estimated at USD 410 million in 2022 and projected to grow at a CAGR of 11.19% from 2023 to 2030 (*Vietnam Ready-To-Eat Food Market Size, Share & Forecast 2030*, n.d.). In the domestic market, urbanization and changing consumer lifestyles in major cities like Ho Chi Minh City and Hanoi have driven demand for frozen and processed seafood products. This highlights the indispensable role of refrigerated warehouses in preserving product quality and freshness, ensuring that high-quality and safe food reaches consumers.

Continuous advancements in cold chain technology, along with government support for the food processing industry, are likely to further fuel market expansion. As more consumers seek ready-to-cook and ready-to-eat options, state-of-the-art cold storage facilities help retain the nutritional value and safety of seafood delivered to urban retail outlets and e-commerce platforms. Moreover, refrigerated warehouses help reduce post-harvest losses, which have traditionally been a significant challenge for the seafood industry.

4.2.2. Limitation

Despite the significant progress made in developing Vietnam's cold chain for agricultural products, several limitations hinder its full effectiveness. First, the infrastructure remains unevenly distributed, with most modern refrigerated warehouses concentrated on the Southern side, with 65% market share held by foreign investors, leaving rural regions underserved (*Thị Trường Kho Lạnh: "Mỏ Vàng" Chờ Khai Phá*, n.d.). This regional disparity poses challenges for smallholder farmers and suppliers in remote areas, leading to higher post-harvest losses.

Second, Vietnam's cold chain sector faces high energy costs and limited adoption of renewable energy technologies, which impacts operational efficiency and increases costs for businesses. Additionally, many small and medium enterprises (SMEs) still lack the financial resources to invest in advanced cold storage and transportation technology, limiting their ability to meet export standards.

Lastly, there is a skills gap in the workforce, particularly in the handling, management, and maintenance of cold storage facilities. The limited availability of trained personnel can result in inconsistencies in product quality and safety. Addressing these limitations through targeted government policies, financial support for SMEs, and workforce training programs is essential for enhancing the competitiveness of Vietnam's agricultural exports in both domestic and international markets.

5. Recommendations for the cold chain for agricultural products in Vietnam

5.1. Recommendations for Vietnamese enterprises

Investment in advanced cold chain infrastructure

China has made significant investments in creating extensive cold chain networks, including large e-commerce platforms' self-operated cold chain warehouses (Zhou, 2024). Perishable items are transported and stored under the optimal conditions due to these investments, which have significantly enhanced China's cold chain logistics' efficiency and reliability. Vietnam can improve its cold chain capabilities by making similar expenditures: *Investment in advanced cold chain infrastructure*. Vietnam can increase the quality and durability of its agricultural exports and boost their competitiveness in global markets by building a strong cold chain infrastructure. This would help the nation's agriculture sector thrive overall in addition to increasing export volumes.

China has used advanced technologies like the Internet of Things (IoT), data analysis, and automation in addition to investing in infrastructure for tracking temperature and humidity in the cold chain in real time (MWR, 2025). By providing stable, detailed information on the state of perishable items throughout the supply chain, these solutions allow immediate correction in the event that changes arise. To maintain the reliability of their cold chain operations, Vietnamese businesses had to implement similar technology. Vietnamese exporters can preserve product quality, minimize deterioration, and comply with global food safety regulations by putting technology solutions into practice. With this technological development, Vietnam's position as a dependable provider of outstanding agricultural products will grow, creating new opportunities in global markets.

Take advantage of E-commerce

With the explosive expansion of advanced technology and networking services, E-commerce is playing an important role in the global supply chain. At the moment, there are

over 3,000 e-commerce companies active in different segments of the fresh food marketplace, such as group buying, fresh food e-commerce, and other associated fields (Zhou, 2024). Major Chinese e-commerce platforms, such as Tmall and JD.com, have effectively incorporated cold chain logistics to manage both frozen and fresh produce. As Vietnamese firms had not paid enough attention to cross-border e-commerce, they might consider entering into joint ventures with e-commerce sites to increase market penetration and improve distribution efficiency.

China sets an informative model for other nations by effectively using cross-border e-commerce networks to promote its agricultural products in other markets. Vietnam can investigate these digital channels in the same way to increase its market reach, considering its rich agricultural resources. This strategy guarantees Vietnam's standing as a trustworthy supplier, and creates new opportunities for cooperation and commerce in the international marketplace.

5.2. Recommendations for the Vietnamese government

China's cold chain logistics sector is far ahead of Vietnam's, with a massive fleet of 340,000 refrigerated trucks and 237 million cubic meters of cold storage in 2024. Meanwhile, Vietnam's infrastructure is still playing catch-up, especially in the north and central regions, where limited cold storage and transport options lead to high post-harvest losses. To improve efficiency and competitiveness, the Vietnamese government needs to take strategic action.

First, *expanding the refrigerated transport fleet* should be a top priority. There's a growing demand for refrigerated trucks, especially in underserved areas, and increasing their numbers would help stabilize the supply chain. Public-private partnerships (PPPs) could provide crucial funding for purchasing modern, energy-efficient vehicles. At the same time, offering incentives for hybrid and electric refrigerated trucks would not only align with global sustainability trends but also help businesses cut long-term operating costs.

Second, Vietnam needs *better cold storage infrastructure*. Right now, most of the country's cold storage is concentrated in the south, leaving northern and central regions at a disadvantage. Investing in regional cold storage hubs would reduce waste and improve export potential, particularly for agricultural products. The government should also support small and medium-sized enterprises (SMEs) with funding and technical assistance so they can modernize their facilities with automation and IoT-based monitoring systems.

Third, a *national cold chain development plan is essential for long-term success*. China has a structured approach with its "14th Five-Year Plan for Cold Chain Logistics Development," and Vietnam should adopt a similar strategy. A well-defined plan should set clear targets for infrastructure expansion, efficiency improvements, and sustainability goals. To attract investment, the government could offer tax breaks and subsidies to businesses that contribute to cold chain development, particularly those focused on green technology.

Finally, *addressing regional gaps and encouraging private investment will be a key strategy*. Northern and central Vietnam need more cold chain infrastructure to support local

agricultural producers and reduce losses. The government should make it easier for private businesses and foreign investors to participate in the sector, as joint ventures and FDI can bring in the expertise and technology needed to modernize logistics. At the same time, raising awareness among farmers about the benefits of cold chain logistics would help increase adoption and improve overall efficiency.

Conclusion

Our analysis analyzed the factors which China used to manage its cold chain for agricultural products. In the end, it was a combination of good logistics structure, technology integration, and government policies that are key to providing the country with a sustainable environment for future growth. Sufficient governmental financial support as well as private investments made it possible to provide farmers with modern means of transportation like green refrigerated trucking systems. As a result, a reduction in food waste, shifts in distribution patterns, improvements in product quality, and the strengthening of the supply chain were all witnessed in the following periods of the Chinese economy.

As a country in the neighboring region with similar geographical and weather conditions, Vietnam can take a few pages out of China's experience to improve their own cold chain system. By building better cold storage facilities, implementing blockchain technology, and encouraging cooperation between the government and private companies, Vietnam may experience similar results such as fewer food losses, higher economical gains, and by taking advantage of the booming e-commerce situation, improve the competitiveness of the local agricultural products in both regional and international markets. However, it is advisable for Vietnam to adapt these solutions at a fitting pace to achieve our own specific needs and conditions.

Some other notable answers for the aforementioned issues should include more investments in the infrastructure with more technology integration, financial incentives for private businesses, and further education for farmers about the benefits as well as how to operate and maintain cold chain systems. On an endnote, by working closely together, Vietnam can create a stronger and more efficient cold chain network that will be sufficient to support its agriculture, ensure food security, and boost the economy to higher levels of growth.

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