e-ISSN 3050-9637
p-ISSN 2795-3222

www.gphjournal.org
SOCIAL SCIENCE AND HUMANITIES RESEARCH
Open Access
Global Publication House
International Journal

10.5281/zenodo.16753053 Vol. 08 Issue 05 May - 2025 Manuscript ID: #01975

Current status of transportation and logistics infrastructure in relation to the development of key agricultural products in the Central Highlands

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Abstract

The Central Highlands is an important agricultural region of Vietnam, well known for its production of coffee, pepper, rubber, cashew nuts, tea, and vegetables. However, its logistics infrastructure, which relies mainly on road transportation, faces significant challenges such as long delivery times, high costs, and limited connection, reducing the competitiveness of agricultural products. Highway and railway projects are currently being implemented to improve connection and reduce logistics costs. This paper assesses the current state of transportation and logistics infrastructure in the Central Highlands, analyzes its challenges, and examines the impact of infrastructure development projects on the growth of key agricultural products. Based on this, the paper proposes solutions for developing logistics infrastructure in connection with the advancement of several strategic agricultural commodities in the region.

Keywords:

Current situation, transportation infrastructure, logistics, key agricultural products, Central Highlands.

How to cite: Nhung, B., Tran, K., & Than, H. T. K. (2025). Current status of transportation and logistics infrastructure in relation to the development of key agricultural products in the Central Highlands. *GPH-International Journal of Social Science and Humanities Research*, 8(05), 80-101. https://doi.org/10.5281/zenodo.16753053

1. Introduction

The Central Highlands - Vietnam is an economic zone in the south-central region, comprising five provinces: Dak Lak, Dak Nong, Gia Lai, Kon Tum, and Lam Dong. With its highland terrain and cool climate, the area is ideal for cultivating crops such as coffee, pepper, rubber, cashew nuts, tea, and vegetables. The Central Highlands plays a vital role in Vietnam's agricultural economy, especially with its coffee output accounting for approximately 95% of the country's total, making Vietnam the second-largest coffee exporter in the world (IDH, 2020). The increasing production scale and export value of these products create an urgant demand for a synchronized development of transport and logistics infrastructure to meet the needs for efficient transportation, storage, and distribution.

In the context of globalization and intensifying market competition, logistics plays a pivotal role in the agricultural value chain. An efficient logistics system not only improves product quality and adds value to agricultural goods but also helps optimize resource allocation, reduce costs, boost production, expand markets, and promote sustainable development in production areas - especially in underdeveloped regions like the Central Highlands (Thuy, N.T.T, 2017). On the other hand, socio-economic development at the local level also serves as a strong foundation to promote logistics infrastructure investment and expansion, thereby creating a positive development cycle.

However, logistics infrastructure and services for agriculture in the Central Highlands still face many limitations. According to the Vietnam Logistics Report 2024, Vietnam's transportation system still relies on roads for up to 80% of cargo movement, while lacking effective connections between other means of transportation, such as railways and waterways (Ministry of Industry and Trade, 2024). Specifically, the Central Highlands is located deep inland and far from major seaports, leading to extended transport times and increased costs, negatively impacting post-harvest quality (Ministry of Industry and Trade, 2024). Moreover, the lack of linkages between production and consumption, limited infrastructure for storage and post-harvest processing, and the absence of modern logistics technologies are major factors contributing to the high logistics costs for Vietnam's agricultural products - accounting for 12–38% of product prices, significantly higher than the average of countries in the area (Ministry of Agriculture and Rural Development, 2024).

Therefore, this research titled "*Current status of transportation and logistics infrastructure in relation to the development of key agricultural products in the Central Highlands*" is conducted to explore the relationship between logistics infrastructure and the development of primary agricultural yields. Specifically, the study focuses on the following objectives: (1) provide a theoretical overview of logistics development in agriculture; (2) evaluate the current logistics systems serving key agricultural products in the Central Highlands; (3) identify challenges in agricultural logistics in the region; and (4) propose suitable solutions to improve logistics capacity and thus promote sustainable agricultural development in the Central Highlands.

2. Theoretical Framework

2.1. Concepts and Components of Infrastructure

Logistics infrastructure is one of thebasic elements of the logistics system, serving as the connector between stages in the supply chain, including transportation, storage, distribution, and related support services. According to the World Bank (2018), logistics infrastructure include both physical infrastructure and logistics services that help optimize cost, time, and quality in the transportation of goods from producers to consumers.

Logistics is a part of the supply chain, which focuses on planning, executing, and efficiently managing the flow of goods,information, and services from the starting point to the consuming point to meet customer needs:

"Logistics is a component of supply chain practices that manage the efficient and effective forward and reverse flow and storage of goods, services and related information between supplier and manufacturer in order to meet customers' requirements" (Douglas L., 1999).

Infrastructure is defined as the physical, institutional, and organizational structures - the economic and social foundation that supports the functioning of a society (Snieska&Simkunaite, 2009). According to this definition, logistics infrastructure covers both the transport and communication aspects.

According to the Vietnam Logistics Business Association (VLA), logistics transportation infrastructure comprises transportation facilities (road, rail, waterway, air), logistics centers, warehouses, ports, transportation vehicles, and IT systems for management and coordination (Ministry of Industry and Trade, 2023). The World Bank (2024) defines logistics infrastructure as the "physical and organizational infrastructure necessary to ensure the efficiency of global supply chains."

Thus, logistics transportation infrastructure refers to the physical and service-related technical infrastructure designed and operated to support the circulation, storage, and distribution of goods effectively within the supply chain. This serves as the material foundation for smooth logistics operations from production to consumption, including transport, preservation, and inventory management. In addition to traditional transport infrastructure, Information and Communication Technology (ICT) is an essential component of modern logistics systems. Logistics systems are built upon four factors: (1) Human resources and capacity; (2) Public and private logistics and transport service providers; (3) Provincial and national institutions, policies, and regulations; and (4) Transportation and communication facilities (Banomyong et al., 2015). These elements are connected and determine the overall capability of the logistics system. This study focuses on the fourth aspect—transportation and communication system.

Components of logistics transportation in frastructure

Logistics transportation infrastructure encompasses not only transport networks but also warehouse systems, technologies, and supporting services. The synchronized development of these components helps reduce logistics costs, improve supply chain efficiency, and promote economic development.

(i) Transport system

This includes modes of transportation that serve the movement of goods and people. It is the lifeline that connects production, consumption, and export areas.

- *Road transport*: Road transport is the most basic infrastructure for both domestic and import-export goods transportation. It includes expressways, national highways, provincial roads, urban roads, and interconnecting routes. Road transport is one of the most common logistics transport modes and plays a crucial role in connecting regions and destinations, while supporting goods transportation to markets (Glaeser, E.L., 2018).

For export agricultural products, goods are transported to seaports and airports through domestic transportation modes (Rodrigue, J. P., 2020). Therefore, road infrastructure is closely related to on-time delivery. If the road network and quality are inadequate, transportation costs for agricultural products will rise due to higher fuel consumption and longer transit times (Celbis, M., Nijkamp, P., & Poot, J., 2014). Increased investment in road infrastructure by national and local governments positively impacts export growth and reduces logistics costs.

-*Airtransport:* The air transport system includes international and domestic airports, with modern facilities and equipment such as cold storage, hazardous goods warehouses, and advanced security inspection systems (Kasarda, J. D., 2015). The contribution of air freight infrastructure to goods trade has been increasing (Button, Doh, & Yuan, 2010), reflected in on-time delivery indicators and shifts in production networks, fostering sectoral and regional economic growth through the movement of people and goods (Florida, R., Mellander, C., & Holgersson, T., 2015). However, high costs and limited flexibility are key challenges in developing air transport in developing countries.

- *Maritime transport:*Maritime transport is considered a vital component of international trade (Suárez-Alemán, A., et al., 2015), especially for developing economies (Munim, Z. & Schramm, H., 2018). It is often chosen for bulky goods that are difficult or costly to transport by air (Suárez-Alemán, A., et al., 2015). Seaports are crucial hubs in the global logistics system, where international cargo is loaded, stored, and distributed. The development of modern ports with automated loading equipment and advanced information infrastructure is key to enhancing logistics system efficiency (Rodrigue, J. P., 2020).

According to UNCTAD (2018), about 80% of global trade is carried by sea; thus, port quality and efficiency are essential for national development. However, poor port-hinterland connectivity is slowing domestic logistics flows. Additionally, logistics costs rise if agricultural production areas are far from or poorly connected to seaports.

- *Rail transport:* Rail transport is considered an efficient domestic transport mode that provides easier access to inputs and raw materials (Rodrigue, J. P., 2020). For landlocked countries or those lacking natural seaport advantages, rail - alongside road - is an appropriate choice for freight transportation, while also reducing environmental impacts (Aritua, B., 2019). Rail transport is particularly effective for moving large volumes, heavy goods, or over long distances. The rail system connects inland regions and links seaports with dry ports, facilitating import-export operations (Rodrigue, J. P., 2020).

(ii) Related services

-*Warehousing and logisticscenters*: Warehousing and logistics centers play a central role in the supply chain by supporting storage, classification, preservation, and coordination of goods. According to Rodrigue, J. P. (2020), warehouses are not just storage places but are "critical links" in ensuring continuity and efficiency in logistics operations. Modern agricultural storage requires cold storage facilities. The development of large-scale logistics centers, especially near seaports and airports, shortens transit time, reduces transportation costs, and increases the competitiveness of export goods (Tongzon, J., & Oanh, N.H., 2021).

A World Bank study (2023) also shows that countries with well-developed logistics center networks tend to have higher Logistics Performance Index (LPI) scores, significantly improving national competitiveness in the global market.

-*Technology and supportingservices*: Technology and supporting services are indispensable "catalysts" for modernizing the logistics system. The application of digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), blockchain, and Warehouse Management Systems (WMS) enhances monitoring, control, and operational optimization (Wang, Y., et al., 2019). According to Hofmann, E., &Rüsch, M. (2017), blockchain technology increases transparency and traceability in supply chains, particularly useful in agriculture, food, and pharmaceutical sectors.

- Other supportservices whichinclude cargo insurance, electronic customs procedures, logistics-related financial services, and supply chain consultancy. Effective coordination among stakeholder - logistics businesses, regulatory authorities, and service providers - helps create a comprehensive logistics ecosystem (Christopher, 2016).

2.2. Agricultural Products and Their Characteristics

Agricultural products, or agricultural commodities, are goods produced from agricultural activities, including crops, livestock, and processed products derived from them.

According to the Food and Agriculture Organization of the United Nations (FAO, 1995), agricultural products are defined as any products or goods, in raw or processed form, brought to the market for human consumption (excluding water, salt, and additives) or for use as animal feed. Agricultural commodities include a wide range of categories, such as: tropical products (tea, cocoa, coffee, pepper, etc.); cereals (wheat, rice, millet, maize, cassava, etc.); meat and meat products (beef, pork, poultry, etc.); oils and oil-based products (oilseeds like soybean, sunflower, etc., and vegetable oils); dairy products (butter, cheese, and other milk-

based items); raw agricultural materials (cotton, jute, fiber, natural rubber, etc.); and fruits and vegetables (various edible roots, tubers, vegetables, and fruits).

From the EU's perspective, a relatively detailed list of goods is classified under agricultural products, divided into two main groups: (i) Group 1: Animals and products of animal origin, and (ii) Group 2: Plants and products of plant origin, which includes 14 product categories: live plants and other floricultural products; edible vegetables, stems, tubers, and fruits; oilseeds and oleaginous fruits, industrial raw materials, medicinal plants; preparations of vegetables, fruit, nuts, and other plant parts; coffee, tea, additives, and spices; cocoa and cocoa preparations; cereals; milling products; preparations of cereals, flour, and starch; lac, gums, resins, and other plant extracts; sugar and sugar confectionery; beverages, spirits, and vinegar; tobacco and related products; vegetable fats and oils.

In Vietnam, agriculture is broadly defined to include crop production, animal husbandry, fisheries, forestry, and salt production. Under this definition, agricultural products encompass outputs from these activities. However, agro-processing industries are categorized under the industrial sector (as per Decree 57/2018/NĐ-CP).

In Vietnam, confectionery, soft drinks, alcohol, sugar, and dairy are classified under industry. However, the EU classifies them as agricultural products. Conversely, sectors like fisheries, forestry, and salt production are considered agriculture in Vietnam but not internationally recognized as such. *"Agricultural products are the outcomes of agricultural production activities, including finished or semi-finished goods obtained from crops or livestock, or from the cultivation and raising of crops and animals (excluding products from the forestry and fishery sectors)."*

Vietnam's definition of agricultural products is broad and relatively complex. Since this study focuses on the current state of transport and logistics infrastructure in relation to the development of key agricultural commodities in the Central Highlands, "key agricultural products" in this paper are defined as those derived from land as a production factor, including all crop products in raw or processed form. For general references, the concept of agricultural products presented above is used in combination with the Standard International Trade Classification, Revision 3 (SITC Rev.3). Based on export turnover data, the key agricultural products examined in this study in the Central Highlands are: (1) Coffee, (2) Pepper, and (3) Vegetables and fruits.

2.3. The Relationship between Logistics Infrastructure and Agricultural Development

Logistics infrastructure plays a vital role in supporting the overall development of the agricultural sector, particularly in the agricultural products domain. It provides the foundation for an efficient agri-supply chain from production, harvesting, storage, and processing to domestic consumption and export.

(1) Logistics Infrastructure and the Agricultural Supply Side: Optimizing theSupply Chain and Product Quality

Logistics infrastructure is a key factor in determining the efficiency and productivity of the agricultural value chain. Roads, warehouses, seaports, airports, transit hubs, and specialized transport vehicles reduce transit time. Upgrading logistics infrastructure facilitates faster and more timely movement of goods across regions, contributing to a better balance between supply and demand and unblocking trade flows (Limao, N. & Venables, A. J., 2002; Micco, A. & Serebrisky, T., 2006). Improved logistics infrastructure shortens the time required for sourcing materials and delivering products, ensuring a stable and timely supply for production. It also enhances producers' access to both input and output markets, even in distant areas, promoting efficient investment allocation and boosting local production.

Agricultural products often suffer from high post-harvest losses without proper transportation conditions. India's experience illustrates how poor transportation—characterized by limited vehicles, inefficient transport systems, high costs, and lack of refrigerated trucks for perishables—can significantly obstruct the agricultural supply chain (FICCI, 2010). In regions with high export volumes of agricultural goods, the quality of transportation infrastructure becomes even more critical. Rehman, F., Noman, A., & Ding, Y. (2020) point out that infrastructure like roads, railways, and airports reduces losses during transportation. According to the World Bank (2020), post-harvest losses in developing countries, including Vietnam, can reach 20–40% of total production, mainly due to weaknesses in transportation, storage, and distribution. Developing agricultural logistics systems not only expands production scale but also encourages investment in post-harvest processing technologies, enhancing value-added and the global competitiveness of Vietnamese agricultural products.

Additionally, the lack of modern logistics infrastructure forces Vietnamese farmers to rely on traders and traditional markets, reducing their control over quality and pricing. For fresh goods like fruits, vegetables, seafood, and coffee, the absence of cold storage, refrigerated containers, and specialized logistics systems increases dependence on the Chinese market and limits access to high-end markets such as the EU, Japan, and the U.S., due to long distances and high requirements for products quality.

(2) Logistics Infrastructure and Agricultural Demand: Market Connectivity, Consumer Needs, and Export Potential

If production represents the "supply," then logistics infrastructure serves as the bridge that connects agricultural products to consumers and export markets—i.e., fulfilling the "demand" side. Well-developed logistics infrastructure reduces distribution costs, increases market access in remote and urban areas, and improves international market reach.

Research by the OECD (2021) shows that logistics costs account for 20–25% of the total cost of agricultural products in Vietnam. The absence of well-planned raw material zones linked to logistics centers, inland container depots (ICDs), and agricultural trade hubs results in passive market connectivity. Improving transportation infrastructure lowers

logistics costs and expands markets by improving connections to ports and export destinations, thereby encouraging investment in processing facilities and value-added industries.

An efficient logistics system is also essential to meet technical requirements and traceability standards in importing markets. According to Portugal-Pérez, A. & Wilson, J. (2010), the quality of transport infrastructure has a positive impact on export growth in 101 countries, including developing economies. In the context of new-generation trade agreements such as EVFTA, CPTPP, and others, logistics is not only a technical issue but also a benchmark for transparency and compliance with international trade commitments.

3. Research Methodology

3.1. Data Collection Method

The authors applied desk research to systematize theoretical foundations regarding transport logistics infrastructure and agricultural development, including their roles and interrelationships.

This study provides a literature review of theories and research on logistics infrastructure and agricultural development. Relevant studies were selected from databases such as Scopus, the online library of Vietnam Logistics Review, and specialized journals like Economic Forecasting Journal, Industry and Trade Review, etc. Secondary data used in the article was sourced from the Ministry of Agriculture and Rural Development, the project "Development of a Logistics System to Enhance the Quality and Competitiveness of Vietnamese Agricultural Products by 2030, with a Vision to 2050", the Vietnam Logistics Business Association, the General Statistics Office, and the official websites of the five Central Highlands provinces: Kon Tum, Gia Lai, Dak Lak, Dak Nong, and Lam Đồng.

Key content was analyzed thematically and synthesized narratively. To assess the current state of logistics infrastructure and agricultural development in the Central Highlands, the research focused on the following aspects: (i) Overview of key agricultural products in the region; (ii) Current status of logistics transport infrastructure in the Central Highlands; and (iii) Key achievements, remaining limitations, and underlying causes. Data was collected from domestic and international scientific publications, as well as from the Ministry of Industry and Trade, the Ministry of Agriculture and Rural Development, and the People's Committees of the five Central Highlands provinces. The authors then synthesized and selected relevant information, and applied descriptive statistical methods to clarify the current situation.

3.2. Data Processing Method

Collected data were compiled, calculated, and presented in tables and charts. Based on this data, the research team conducted evaluation and analysis to identify achievements, limitations, and propose solutions to develop logistics infrastructure in association with the development of key agricultural products in the Central Highlands.

4. Current Status of Logistics Infrastructure Linked to the Development of Key Agricultural Products in the Central Highlands

4.1. Overview of Key Agricultural Products in the Central Highlands

The Central Highlands, with its plateau terrain at an average altitude of 500–600 meters above sea level, along with its distinct climate and fertile red basalt soil, provides ideal natural conditions for agricultural development—especially for perennial industrial crops and fruit trees. The region is divided by numerous river systems and high mountain ranges, creating elevation diversity from 300m to 1700m across various plateaus such as Konplong, KonharNung, Pleiku, Buon Ma Thuot, MoDrak, Di Linh, Đắk Nông, and Bình Sơn – Da Lat (Ministry of Construction, 2022).

The total natural area of the Central Highlands is approximately 5.45 million hectares, of which agricultural and forestry land accounts for 91.4%, including 1.3 million hectares of red basalt soil suitable for a variety of crops (GSO, 2021). Thanks to this, the Central Highlands has become a key production area for Vietnam's major agricultural products such as coffee, pepper, rubber, cashew, macadamia, and various fruits. Notably, in 2024, the region ranked as the country's largest producer of durian, macadamia, coffee, and pepper, with agricultural export turnover reaching around USD 7 billion (vov.vn, 2024).

Currently, the Central Highlands has 141 safe food supply chains linked to specialty products such as coffee, macadamia, and honey, and 583 OCOP (One Commune One Product) items have been certified (Tuan Minh, 2022).

Table 1. Summary of Key Agricultural Products in the Central Highlands

Product	**Proportion Compared to the Whole Country**	**Notable Results**
Coffee	94.8% of national output	Mainly in ĐắkLắk, famous for Buon Ma Thuot
Pepper	68.6% of national output	Important export commodity
Rubber	22.1% of national output	Well-suited to local soil conditions
Avocado	78.1% of cultivated area, 81.9% of output	Rapid development in the Central Highlands
Durian	43.1% of cultivated area, 36.3% of output	Great export potential
Passion fruit	Over 70% of cultivated area	Largest production area in the country

Source: Ministry of Industry and Trade, 2024

In addition to the significant share of coffee and pepper, the production of fruit crops has been rising rapidly. Durian accounts for 43.1% of the cultivated area and 36.3% of total output; avocado occupies 78.1% of the area and 81.9% of production. The Central Highlands

is also the largest passion fruit-producing region in Vietnam, with over 70% of the total cultivation area. In this article, three representative product groups are highlighted:

- Coffee: The Central Highlands mainly grows robusta coffee, which has high export potential and economic value, contributing significantly to agricultural exports.
- Pepper: Major production is concentrated in ĐắkNông and Gia Lai provinces.
- Fruits and Vegetables: Including avocado, durian, and macadamia—products that are growing rapidly and have high value.

Despite playing a crucial role in the national agricultural economy, the agricultural supply chain in the Central Highlands faces several notable challenges (Tuan T.T. & Hung L.T., 2023):

- *Small-scale and fragmented farming***:** Agricultural production in the CentralHighlands is primarily based on smallholder farming, which is scattered and fragmented. This leads to difficulties in collection, processing, transportation, and marketing. The lack of horizontal linkages (among farmers) and vertical linkages (between farmers and enterprises) makes the supply chain disorganized and fragmented.
- *Inconsistent product quality and standards***:** Due to the small-scale nature of production and variations in farming conditions, techniques, and climate, agricultural products in the region often lack uniformity in size, shape, weight, and quality. This presents a major obstacle to accessing high-standard export markets such as the EU and the US.
- *Perishable nature of produce and strict storage requirements***:** Among key products, fresh fruits and vegetables have short shelf lives and require cold storage and rapid handling to avoid loss and maintain quality. High temperatures accelerate spoilage, leading to increased preservation and transportation costs. It is estimated that 25–30% of perishable food is wasted, most of which could be saved with proper post-harvest cold chain practices (G.G. Stonehouse & J.A. Evans, 2015).
- *Strong seasonality:* Agricultural production is highly seasonal, with a sharp increase in supply during the harvest season and high prices during the off-season. This requires effective strategies for storage and supply-demand balancing.
- *Bulky nature and high logistics costs:* Agricultural products typically have a low value-to-weight ratio, making transportation costly. The Central Highlands is far from seaports, and 80% of transportation depends on roadways, leading to high logistics expenses.
- *Outdated processing and storage technology***:** The processing segment remains small in the overall supply chain. Most products are exported raw, resulting in low added value.
- *Weak supply chain structure with spontaneous development***:** The supply chain lacks tight coordination among stakeholders. Horizontal linkages between farmers (through cooperatives) and between farms are limited. Vertical linkages between farms and processing plants or export companies are also relatively weak.

Table 2. Summary of Agricultural Product Characteristics and Their Impact on Logistics

Agricultural Characteristic	Description	Impact on Logistics
Perishability	Short shelf life, requires special storage conditions	Increases logistics costs, requires fast handling
Seasonality	Production depends on seasons, supply is inconsistent	Causes price fluctuations, requires effective storage strategies
Bulkiness	Large volume, low value-to-weight ratio	Raises transportation and storage costs
Quality fluctuations	Quality varies due to weather, soil, and farming techniques	Difficult to standardize, affects selling price
Inconsistency in quality and size	Dependent on natural conditions, leads to shortages or surpluses	Price volatility, risk for producers
Fragmented production	Many small-scale farmers, widely dispersed	Complicates collection and marketing
Processing requirements	Needs to be processed before consumption, adds complexity to supply chain	Increases costs, requires processing technology

***Source**: Compiled and analyzed by the author group*

In the context of the Central Highlands being a major agricultural production region, characteristics such as perishability, seasonality, bulkiness, and fragmented production require a modern logistics system and advanced processing technology. However, limited infrastructure, high logistics costs, outdated processing technology, and the low proportion of deep processing are hindering the region's ability to enhance value addition and improve the competitiveness of its agricultural products.

4.2. Analysis of the Logistics Infrastructure Status in Relation to the Development of Key Agricultural Products in the Central Highlands

(1) Current Status of Transportation Infrastructure for Logistics

The Central Highlands region comprises five provinces: Dak Lak, Dak Nong, Gia Lai, Kon Tum, and Lam Dong. The development of the logistics sector, especially logistics infrastructure, is a prerequisite for large-scale agricultural development and export.

- *Road Transport*: Road infrastructure is the main transportation mode in the Central Highlands. The road network plays a crucial role in connecting production areas with processing centers, consumption markets, and export gateways. According to the Ministry of Transport (2023), the national road network totals 595,201 km. Key national highways crossing the Central Highlands include National Highway 14 (running north–south through

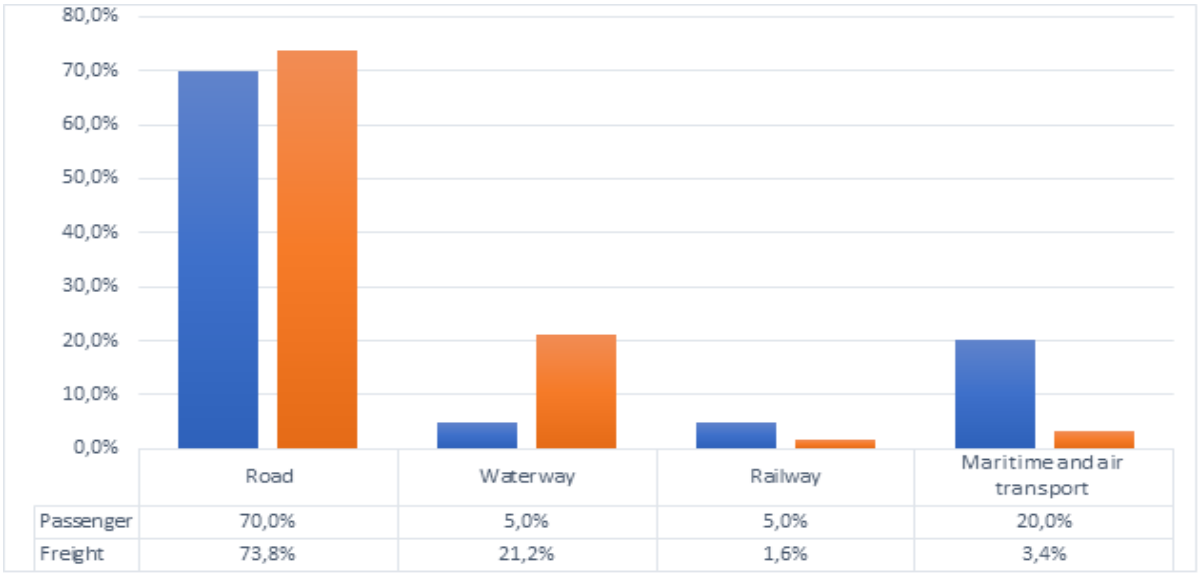
the region), National Highway 26 (connecting Dak Lak with Khanh Hoa), and Highways 27 and 19, which serve as vital transport arteries. The region has over 35,000 km of roads, with a hard-surfacing rate of over 50%. However, many roads traverse rugged terrain, and several segments are degraded, narrow, and below the required standards for heavy transport, making it difficult to move large volumes of agricultural goods (Huy, N.K., 2024). Additionally, the proportion of asphalt or concrete-paved roads remains low, especially in remote areas where most small-scale farmers are located.

- *Rail Transport:* Currently, there are no operational railway lines in the Central Highlands, creating a significant gap in the region's logistics system. The absence of rail transport greatly limits the ability to move bulk agricultural commodities to seaports in Central and Southern Vietnam (Ministry of Industry and Trade, 2023). This is particularly critical during harvest seasons for key crops such as coffee and pepper, which require fast, stable, and cost-effective transportation. The lack of rail connectivity poses a major bottleneck.
- *Inland Waterway and Sea Transport*: The Central Highlands is landlocked and lacks major rivers suitable for inland waterway transport. Therefore, the region relies entirely on road transport to connect with seaports in Da Nang, Quy Nhơn, and Ho Chi Minh City. The lack of multimodal transport options increases logistics costs and reduces the international competitiveness of the region's agricultural products (World Bank, 2022).
- *Air Transport:* Airports such as Buon Ma Thuot, Pleiku, and Lien Khuong primarily serve passenger transport. Their cargo handling capabilities remain limited. Air freight services for fresh produce, vegetables, and flowers from Da Lat are still sparse, and a specialized air logistics network for agricultural export has yet to be developed (GSO, 2023).

Thus, road transport remains the only practical choice for the Central Highlands. Enhancing the road transport network is essential to strengthening the region's logistics infrastructure and integrating the Central Highlands with other regions.

(2) Transport Capacity of the Logistics Infrastructure

According to the Ministry of Transport (2023), the transport capacity of the national logistics infrastructure - especially along the North–South corridor - is significantly imbalanced. In terms of domestic cargo transport, road and inland waterway systems currently dominate my



	Road	Waterway	Railway	Maritime and air transport
Passenger	70,0%	5,0%	5,0%	20,0%
Freight	73,8%	21,2%	1,6%	3,4%

Figure 1. Volume of Passenger and Domestic Freight Transport
Source: Ministry of Transport (2023)

One of the major limitations of the logistics system in the Central Highlands is the lack of regionally scaled, agriculture-specialized logistics centers. According to the Vietnam Logistics Report (2023), the Central Highlands has no level-II (regional) logistics centers. Existing facilities are mostly small-scale warehouses privately invested by businesses, concentrated in cities such as Buon Ma Thuot and Da Lat. The cold storage infrastructure for preserving fruits, vegetables, and export-oriented agricultural products is severely lacking, leading to high post-harvest losses—up to 20–30% for fruits and vegetables. Currently, most agricultural goods are transported directly from farms or cooperatives to traders or processing plants without passing through transit stations, cold storage facilities, or automated sorting systems.

(3) Logistics Connectivity from Production Areas to Seaports and Export Markets

The current infrastructure is still insufficient to meet the requirements for efficient agricultural goods transportation. Inter-regional transport routes are sparse, with winding mountain passes and operational speeds of only 40–50 km/h, which significantly hinders the flow of goods from production areas to seaports, airports, or consumption centers (SGGP, 2023).

Connecting the Central Highlands' production zones with major seaports like Quy Nhon, Da Nang, and Cat Lai faces many challenges due to mountainous terrain, long distances, and high transport costs. For instance, the route from Dak Lak to Cat Lai Port (Ho Chi Minh City) is approximately 350–400 km and takes 10–12 hours to travel, which negatively affects the quality of fresh agricultural exports. Despite ongoing improvements, inter-regional routes still have limited scale and low density, with steep and winding terrain and slow average speeds (40–50 km/h), which only meet basic transport needs. The region

currently lacks any expressways that directly connect the Central Highlands to nearby regions, seaports, or airports (SGGP, 2023).

As of now, the Central Highlands has no completed expressway directly linking it with key logistics hubs such as Ho Chi Minh City, Dong Nai, or central coastal ports. The Khanh Hoa – Buon Ma Thuot Expressway project (117.5 km long, with an investment of nearly VND 22 trillion), expected to be completed between 2026–2027, is anticipated to shorten transportation times from the Central Highlands to seaports and promote agricultural exports (baogialai.com.vn, 2023).

In addition, container transport systems from the Central Highlands to seaports are not efficiently organized. Small businesses and agricultural cooperatives typically consolidate goods manually and hire individual transport services, without forming regular containerized transport routes. This results in logistics costs for agricultural products in the Central Highlands being 10–15% higher on average compared to lowland regions such as the Mekong Delta or the Red River Delta (Ministry of Transport, 2023).

(4) Current Status of Logistics-Related Services in the Central Highlands

One of the biggest barriers to developing agricultural logistics in the Central Highlands is the lack of on-site supporting services such as preliminary processing, packaging, and preservation at the production sites. Many farmers have to transport their agricultural products to other provinces like Dong Nai or Ho Chi Minh City for these services, increasing transportation and post-harvest handling costs, and reducing the competitiveness of their products (Nhan, A.T.T., 2024).

Additionally, the region lacks adequate cold storage facilities and on-site inspection and irradiation centers to match its agricultural potential. Currently, Vietnam only has two irradiation facilities that meet export standards—one in the North and one in the South—placing considerable pressure on agricultural exporters from the Central Highlands (NIF, 2023).

Regarding technological application in logistics, although the adoption of warehouse management systems (WMS) and real-time order tracking technologies is growing nationwide, their implementation among small and medium-sized enterprises (SMEs) in the Central Highlands remains very limited. According to statistics, most logistics enterprises in Vietnam are small-sized, with 89% having capital under VND 10 billion, and mainly providing basic services such as customs declaration and vehicle tracking (The Ministry of Finance, 2023).

Box 1. Case Study: Logistics Model in the Central Highlands

Amid numerous limitations, the emergence of pioneering enterprises such as Truong Hai International Logistics and Forwarding Company (THILOGI) stands out as a noteworthy highlight. THILOGI has developed a specialized, full-package logistics model for agriculture, including transportation, warehousing, preservation, customs procedures, and shipping agency services. Notably, THILOGI has implemented multimodal transport combining road, sea, and cross-border logistics, helping to optimize costs and strengthen supply chain connectivity.

The cold storage system at Chu Lai Port, with a total area of 5,000 m² and a refrigerated container yard of over 10,000 m², has significantly supported the preservation and export of agricultural products from the Central Highlands, as well as from Laos and Cambodia. In 2021 alone, THILOGI transported more than 24,000 containers of agricultural goods, affirming its vital role in the regional supply chain.

Source:Vietnam Integration Journal (2021)

(5) Current Status of Logistics Infrastructure Planning and Investment in Relation to Agricultural Development in the Central Highlands

Resolution No. 23-NQ/TW of the Politburo on the orientations for socio-economic development and ensuring national defense and security in the Central Highlands region by 2030, with a vision to 2045, clearly emphasizes the viewpoint: *"Developing transport infrastructure as a driving force to create room for regional development"*, and sets out a key task to *"Develop transport infrastructure in a synchronized and modern manner, facilitating regional connectivity to seaports, domestic and international airports"* (Politburo, 2022).

The Central Highlands has planned both intra-regional and inter-regional connections with the South Central Coast and Southeastern regions. The total investment demand for transport infrastructure in the Central Highlands over the next ten years is estimated at around VND 156 trillion (vtv.vn, 2023). From 2026 to 2030, the state budget will allocate capital to implement expressway projects outlined in the master plan, which have interregional connectivity potential, with a minimum capital requirement of about VND 89.165 trillion (e.g., the western North-South Expressway segments from Gia Nghia to Chon Thanh, Chon Thanh to Duc Hoa...) (baogialai.com.vn, 2023).

Table 3. Road Infrastructure Planning in the Central Highlands to 2030

Project	Description	Completion Time	Impact on Agricultural Products
Khanh Hoa – Buon Ma Thuot Expressway	117.5 km long, connecting Dak Lak to Khanh Hoa	2026–2027	Reduces transport time for agricultural goods from the Central Highlands to seaports
Quy Nhon – Pleiku Expressway	Connecting Binh Dinh and Gia Lai	Planned	Enhances regional connectivity
Quang Ngai – Kon Tum Expressway	Connecting Quang Ngai and Kon Tum	Planned	Improves regional and seaport access
National Highway 29	Upgraded to 4 lanes, speed 60–80 km/h	Under implementation	Reduces road transport cost and time
Buon Ma Thuot – Tuy Hoa Railway	Connects Central Highlands to seaports	Planned	Supports bulk transportation of goods

Source: Ministry of Industry and Trade – Vietnam Logistics Report (2023)

The 2021–2030 road transport network planning prioritizes investment in high-capacity expressways to form an interconnected highway network. To ensure synchronization, connector segments are planned as local or dedicated roads linking interprovincial systems. The scale and alignment of these connectors are decided in provincial planning and are considered priority investment projects.

4.3. Achievements, Limitations, and Causes

4.3.1. Achievements

The government has a detailed logistics infrastructure development plan, both nationally and specifically for the Central Highlands, along with proposed budgets and funding sources, encouraging private sector participation to reduce the burden on public finances.

Infrastructure investment has been prioritized: Several transport infrastructure projects have been completed or are under implementation, facilitating regional connectivity and agricultural export development. This enhanced infrastructure investment has contributed to Vietnam's improved rankings in infrastructure quality globally. According to the Ministry of Science and Technology (2024), Vietnam ranked 52nd out of 185 economies in the Quality of Infrastructure (QI) Index in 2023.

Agricultural products are being carefully studied in terms of their specific characteristics that affect value chains from production to consumption. Optimization strategies for production, transportation, and marketing have been implemented based on a

deep understanding of factors such as perishability, seasonality, bulkiness, inconsistent quality, irregular supply, dispersed production, and processing requirements.

4.3.2. Limitations

Despite its vast agricultural potential, the Central Highlands faces significant challenges in transport infrastructure and logistics, which directly affect the efficiency of agricultural distribution and export. Key issues include:

- Due to geographical limitations - lacking access to seaports and railways - the Central Highlands depends heavily on road transport. However, the current road system does not sufficiently meet freight transport needs. Around 80% of goods in the region are transported by road, leading to high costs and long delivery times, especially given the region's distance from major seaports and urban centers. A primary cause is the lack of integrtion across transport modes and inadequate infrastructure synchronization (Vi N.T., 2023).

- *High logistics costs*: According to the Ministry of Industry and Trade (2024), logistics costs in Vietnam account for approximately 16.8% of GDP, much higher than the 10- 11% average in developed countries. For agricultural goods, this cost is even higher- ranging from 12% to 38% of product prices- reducing competitiveness compared to other countries in the region. The perishability and seasonality of agricultural products demand solutions such as cold storage, rapid transportation, and post-harvest preservation technologies. Their bulkiness and dispersed production require improvements in transport infrastructure and collection systems.

A survey assessing the logistics challenges faced by 241 enterprises in Vietnam, using a 5-point Likert scale (1 = No difficulty, 5 = Very difficult), showed that "increased logistics costs" had the highest average score of 3.2, marking it as the most significant challenge faced by businesses.

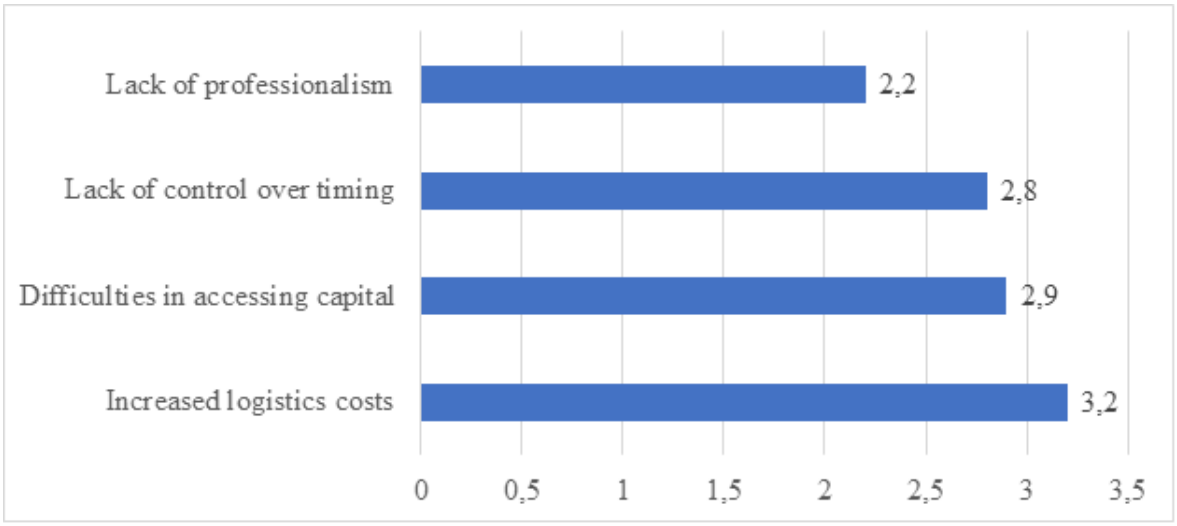


Figure 2. Evaluation Results on the Difficulties in Self-Providing Logistics Services by Enterprises

Source: Ministry of Industry and Trade (2024)

The inconsistency in agricultural product quality due to small-scale production requires strategies for standardization and market forecasting. Moreover, agricultural processing demands investment in technology and the establishment of value chain linkages among farmers, enterprises, and markets.

- *Lack of production–consumption linkage*: The disconnection between farmers, enterprises, and consumption markets leads to fragmented production, making it difficult to meet international market demands.

- *Weak post-harvest technology*: Preservation and processing technologies after harvest remain limited, resulting in significant losses in the quality and value of agricultural products.
- *Underutilized role of air transportation*: Although the East–West Economic Corridor is a strategic route connecting the region to ASEAN economies, it still faces many infrastructure quality limitations (Ministry of Agriculture and Rural Development, 2023).

5. Proposed Solutions for Developing Transportation and Logistics Infrastructure in Association with Key Agricultural Products in the Central Highlands

To sustainably develop logistics associated with agriculture in the Central Highlands, the following synchronized solutions need to be implemented:

- *Accelerate investment in key transportation infrastructure*, particularly regional expressways such as Gia Nghĩa – Chơn Thành, Khánh Hòa – Buôn Ma Thuột, and Quy Nhơn – Pleiku, to shorten delivery times and improve market access (baogialai.com.vn, 2023).
- *Promote the formation of cooperatives*, large farms, or inter-regional fruit and vegetable production associations to establish specialized cultivation zones. Develop traceability systems to enhance competitiveness and provide assurance to customers when purchasing and consuming products.
- *Develop local agricultural logistics hubs*, including preliminary processing areas, packaging centers, cold storage, and irradiation centers, especially in districts that are key producers of coffee and pepper. Localities in the region should make the most of their advantageous values and state incentive policies to accelerate investment attraction into industrial clusters; this will serve as a driving force for developing high value-added and competitive industrial and service sectors.
- *Encourage enterprises to invest in logistics technologies*, particularly smart warehouse management systems (WMS), transport route optimization using AI, and automated delivery solutions.
- *Strengthen linkages between logistics enterprises and agricultural cooperatives* to create seamless value chains from production to consumption, thereby reducing costs and risks in the supply chain. The Ministry of Industry and Trade should collaborate with Central Highlands provincial authorities to hold annual trade fairs to promote trade. These fairs would provide local businesses the opportunity to showcase their products to domestic and international enterprises and serve as a platform to bring markets directly to local businesses.
- *Invest in centralized logistics hubs*: Develop large-scale logistics centers at key transportation intersections to efficiently support the storage, preservation, and distribution of

agricultural products. These centers should be well-equipped and well-connected with enterprises and production cooperatives.

- In terms of **long-term solutions**, the development and connection of raw material zones for both fresh export and deep processing is a top priority for the crop sector in the Central Highlands. Therefore, prioritizing investment in, completion of, and construction of transportation infrastructure—particularly inter-regional, cross-border, seaport, and border-gate connections—is considered essential.

6. Conclusion

Logistics infrastructure and agricultural development have a closely intertwined and mutually reinforcing relationship. A modern and sustainable logistics system not only enhances the efficiency of agricultural value chains but also improves market access, reduces post-harvest losses, and raises product quality. The study on "The Current Status of Transportation and Logistics Infrastructure in Association with the Development of Key Agricultural Products in the Central Highlands" provides a comprehensive view of the critical role logistics infrastructure plays in agricultural development.

One of the key findings of the study is that the logistics infrastructure in the Central Highlands still faces many limitations, despite significant progress over the past decade. To transform Vietnamese agriculture from "quantity" to "quality," and from a "production-oriented" to a "market-oriented" approach, logistics must be placed at the center of the national agricultural development strategy.

Logistics infrastructure in the Central Highlands is characterized by its heavy reliance on roads, with no railway system, limited air, sea, and waterway transport; high costs; long transportation times; and poor connectivity. Storage and logistics services, including warehousing and distribution systems, are not yet developed in alignment with the seasonal and volume needs of agricultural products. The lack of synchronization and coordination in logistics infrastructure planning and development among localities also poses a major obstacle to the comprehensive development of agriculture in the Central Highlands. Future research could focus more specifically on each component of logistics infrastructure, individual localities or regions, or particular agricultural commodities.

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