

## The Development of a Conceptual Rural Logistics System Model to Improve Products Distribution in Indonesia

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### Abstract:

**Purpose:** The role of speculators in distributing products across rural areas is increasing the poverty rate in Indonesia. Therefore, this study aims to develop a conceptual framework of the rural logistics system model to influence the welfare and sustainability of farmers.

**Design/methodology/approach:** Conceptual framework was used to evaluate logistics and supply chain networks. The method consists of developing stages based on four components, namely network structure, management, resources, and business processes. Furthermore, it also proposed the management function of the rural logistics system models.

**Findings:** The model of a rural logistics system obtained in this study consists of 1) a trade related to the network of business, 2) a freight, related to the flow of goods, and 3) management functions related to crucial activities in rural logistics management.

**Research limitations/implications:** This model is conceptual, therefore future studies must accommodate optimizing models to predict the performance of rural logistics systems when they are applied in Indonesia.

**Practical implications:** This study promotes the actors in intermediaries of the rural logistics system to synergize the distribution of goods effectively and efficiently. It also reduces the role of speculators in product distribution in form of availability and price in rural areas.

**Social implications:** This model is a strategy to achieve the Rural Sustainable Development Goals (Rural-SDGs) agenda and complements the Blueprint of The National Logistics System.

**Originality/value:** There are fewer studies in rural logistics compared to other fields such as agricultural logistics, food logistics, disaster logistics, etc. Therefore, this study organizes the actors in the rural logistics network and plans management functions for the efficient distribution of products across Indonesia. It also raises the awareness of logistics management to improve the welfare of rural communities.

**Keywords:** rural logistics, welfare, distribution, farmers, rural community, actors

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## 1. Introduction

The sustainable development goals are a normative framework driving the improvement strategies globally after The United Nations General Assembly emerged the Sustainable Development Goals (SDGs) Agreement in September 2015 (Kumi, Yeboah & Kumi, 2020). SDGs documents consist of 17 goals, 169 targets, and 230 indicators designed to address underdevelopment in countries before 2030. This agenda is prepared to answer a wide range of issues, including traditional Millennium Development Goals (MDGs) areas such as poverty alleviation, malnutrition, poor health, low education, and gender inequality. It also provides solutions to new topics, namely infrastructure, economic growth, employment, social inequality, cities, rural, sustainable consumption and production, energy, climate change, and world peace (World Bank, 2014).

Based on the main objective of the SDGs agenda, several developing countries have made efforts to improve the standard of living of people in extreme poverty. This condition significantly hinders sustainable rural development and triggers land degradation, thereby hampering agricultural development, revitalizing rural areas, and increasing the rapid flow of urbanization. This challenge, can be effectively overcome by sustainable economic development through rural engineering strategies such as reclamation, restoration, reallocation, land consolidation, cropping systems, and construction of facilities (Liu & Wang, 2019). In rural areas, economic development issues are associated with agricultural products, farmers, price stability, and the welfare of the community (Yin, Chen & Li, 2022). Moreover, the improvement of agricultural production and distribution is also related to achieving the SDGs target in 2030, especially eradicating poverty and hunger.

Generally, the reduction of poverty and hunger is the use of agricultural products as a source of staple food for human life (Dhahri & Omri, 2020). The global demand for food materials from agriculture has increased due to the world population growth. However, farmers face many hardships such as minimum productivity from labor, low profits, financial constraints and environmental problems, causing a decline in agricultural production (Amanullah, Lakhan, Channa, Magsi, Koondher, Wang et al., 2020; Mishra, Singh & Rana, 2022). The scarcity of food materials is due to farm areas and disruptions in the distribution of products from the source to consumers because of the speculators who control prices and supply (Wen, Khalid, Mahmood & Zakaria, 2021).

Farmers are usually faced with a reduction in the quality and price of agricultural products after harvesting, which makes it difficult to maximize products even during shipping to the customer point (Huhtamaa & Helama, 2017). Meanwhile, there are still obstacles in the preservation cycle, inadequate transportation facilities, and scattered locations of consumers (Wu & Haasis, 2018), which can cause price volatility of agricultural commodities. A previous study has discovered that the sudden rise in agricultural prices increases the risk of national food security, poverty rate, and income inequality among farmers (Hunt, Femia, Werrell, Christian, Otkin, Basara et al., 2021).

Local economic development is crucial because rural logistics has become a high potential target market of the logistics business, specifically manufactured products. Current practice in rural areas has the disadvantage of a dispersed population, which is due to poor topography (Yang, Dai & Ma, 2020). The recent development of the digital technology sector has changed lifestyles and economic practices globally, leading to the online operation of social, recreational, commercial, and administrative activities (Philip & Williams, 2019). The government also needs to enhance adequate connectivity because the provision of digital infrastructure and capabilities in many remote areas in developed countries is still lagging. The Indonesian government is facing a similar situation. Therefore, it attempts to improve product distribution and welfare of community in the rural areas.

In Indonesia, most people in the rural areas are typically farmers, therefore, the agribusiness sectors' contribution to the economy is enormous, by increasing employment opportunities and strengthening food security. Although the country has a relatively large agricultural area, there is a continuous increase in the poverty rate, according to the data released by Indonesian Statistics in May 2021. In urban areas, the percentage of poor people is higher, however, the unemployment rate is lower in rural communities, as shown in Table 1.

Purchasing power in rural area is low because currently, approximately 38% of the Indonesian population works in the agricultural sector and most of them live in rural areas. The statistics in 2021 classified around 12,635 of the remote areas as disadvantaged, while 5,649 as the most disadvantaged.

Parameters	Indonesia	Urban areas	Rural areas
Indonesia's population in extreme poverty (%)	4.00	1.32	2.67
The population in poverty (%)	10.14	7.89	13.10
Unemployment (%)	12.11	8.00	4.11
Poverty line based on Purchasing power parity per capita per month (\$)	31.50	32.66	30.01

Table 1. Poverty in urban-rural areas in 2021 (Statistics Indonesia, 2021)

Based on the Farmer Term of Trade (FTT) indicator, it was discovered that the welfare level of farmers is decreasing. In January 2021, the FTT index reached 112, however, it experienced a decline of 6.84% and decreased to 104.34. This is due to the decline in farmers' income because they are trapped in the game of selling prices of agricultural products by speculators, bearing high costs to meet their needs and capital for farming. The emergence of the Covid-19 pandemic in Indonesia at the beginning of 2020 further exacerbated the welfare of farmers due to losses in the sale of crops. This occurs because several main markets were closed based on the government's policy on Large-Scale Social Restrictions and the Implementation of Restrictions on Community Activities.

The government has also set reducing extreme poverty to zero percent by 2024 as a top priority. The Ministry of Village, Development of Disadvantaged Regions, and Transmigration of Indonesia compiled the Rural-SDGs in 2020 to manifest the SGD's agenda in 2015 for the rural level. This Rural-SDGs Agenda is a strategy to achieve the National Sustainable Development Goals for rural areas to be free from poverty and hunger and also the growth of the rural economy. Furthermore, the agenda aims to improve the welfare of the people and the sustainability of food.

Improvement of rural welfare can be achieved by increasing agricultural productivity and innovation in farming support such as the development of post-harvest technology, and capital assistance to improve the trading system as well as the distribution network. Meanwhile, agricultural productivity is influenced by the availability of supporting products such as seeds and fertilizers. Rural communities, including farmers, also need the products supplied by industrial companies for survival.

In Indonesia, the causes of poverty in rural areas are the dominance of speculators, poor infrastructure and farming facilities, as well as the inability to maintain post-harvest quality. A strategy needs to be developed to reduce the role of speculators and enhance product distribution channels in rural areas. Therefore, this study aims to develop a rural logistics system model that guarantees product availability and increases farmers' welfare.

A rural logistics system model suitable for rural areas was developed in different stages are arranged based on various aspects related to products distribution, actors, logistics networks, and regulations. The study structures were: section 2 described the theoretical framework of rural logistics, and section 3 shows the methodology. Meanwhile, sections 4, 5, and 6 present the developed rural logistics system model, discussion, analysis, and implications, respectively. The final part shows the conclusions and suggestions for other policy approaches.

## 2. Theoretical Framework

The development of rural logistics is an approach that can be taken to overcome the problem of product distribution in Indonesia. Rural logistics refers to the distribution of agricultural and manufacturer's products needed by the community as well as other economic activities such as providing transportation, packaging, processing, and storage in rural areas (Yu, Zhou & Liu, 2020). Moreover, the model development is carried out to eliminate the dominance of speculators in product distribution through the development of rural logistics systems. It also aims to improve logistics efficiency, reduce product transportation costs, increase farmers' income, reduce the gap between urban and rural areas, improve farmers' quality of life, promote market development, encourage integrated urban-rural development and create new markets (Gong, 2019; Xu & Huang, 2014; Yuan & Chen, 2020).

The logistics network is responsible for ensuring the availability of products and services to consumers and providing financial success to intermediaries. The management of a supply chain network is related to the flow of material and information of an entity with specific characteristics, often conflicting goals, with a high level of

product distribution and supply, adding to its complexity (Barbosa-Póvoa, 2014). The design of a logistics network is a strategic supply chain management platform for efficient and effective product distribution that usually involves multiple goals such as resource balance, cost/profit, and customer responsiveness (Dutta, Mishra, Khandelwal & Katthawala., 2020). This showed that the availability of products in the distribution network is disrupted due to the critical role of speculators. The development of an integrated urban-rural logistics system has also been proven effective in balancing the flow and setting coordinated operations (Gong, 2019). Therefore, a strategy is needed to redesign the supply chain system from the source point to the end consumer or from manufacturing to rural areas.

The Asian Development Bank, in its book entitled “Promoting Logistics Development In Rural Areas,” stated that the development of rural logistics can ensure the availability, safety, and quality of food ingredients, reduce costs and provide quality consumer products at affordable rates (Asian Development Bank-ADB, 2017). When rural increase product distribution efficiency and reduce distribution costs, its application will create a better socio-economic structure and decrease detrimental phenomena to communities (Vitale & Cotella, 2020).

This study focused on the flow of agricultural products and manufactured products that are needed by the rural community according to existing conditions. It further develops a rural logistics system model for Indonesia and explains the contributions and challenges in the management to organize actors and overcome challenges. This model organizes inventory and transportation of the agricultural product from farmers’ fields to customers’ locations. The system also arranged the distribution of supporting farming products from industries to rural areas.

The product market share that is increasingly expanding during globalization encourages all entities involved in the production and distribution of products to use the available infrastructure and resources professionally. Logistics and supply chain management is among the most established sciences in managing distribution by effective and efficient coordination of activities with all outsourcing in the distribution network (CSCMP-Council of Supply Chain Management Professionals, 2013). It is also concerned with handling reliable delivery processes, which aim to anticipate sources of risk due to poor quality, time delays, availability, and low levels of service.

Several studies have discussed the linkage of farmers in a logistics network and supply chain, especially in the agriculture and food sector. However, there are limited reports that describe farmers as the consumer part of the network (Liu, Cavaye & Ariyawardana, 2022). Previous investigation has also shown the pattern of supply chain systems, while others further developed urban logistics models. Rural logistics is one of the focuses of manufacturers to benefit from rural economic development to increase the business’s profits.

Rural logistics is proliferating in agrarian nations such as China and several countries in Asia. The State Council Information Office (SCIO) in 2019 reported that the Chinese government had adopted a strategy to encourage logistics companies and construct a more efficient network in rural areas to support the Rural Revitalization Plan based on a sharing system (Yang et al., 2020). The application of coordination in the distribution network increased the logistics network’s effectiveness. In India, the supply chains handle two kinds of products, namely food and clothes, toys, leather products, and playthings (Viswanadham, 2007). An Input-Output representation model was also developed to plan a strategic alliance of integrated rural supply chains in designing, manufacturing, and delivering quality products and services to customer groups to overcome the competition with cooperating networks. The manufacturers and food industry are located close to urban areas or surroundings customer centers. The country also developed a tracking system at various levels of the network hierarchy, which includes suppliers, distributors, and customers to secure the supply of goods along the rural supply chain (Sharma, Subramanian & Brewer, 2008). Technical production for agricultural products in rural networks requires proper support for agricultural logistics infrastructure, information systems development, and adequate quality of human resources (Yu et al., 2020).

In China, studies were carried out on the development of the center for rural logistics activities such as production, acquisition, processing, storage, reservation, sales and distribution activities, as well as providing market information for agricultural products (Fang, 2014). Furthermore, a distribution center development was provided to increase the circulation of goods in a modern rural logistics system that serves, serving two types of goods flow. Meanwhile, the aspect that needs to be considered when building a Logistics Terminal Distribution facility that connects rural and urban areas are the number of product flows, technology platforms, and operating conditions to improve product

distribution efficiency (Cai & Chen, 2015). Several efforts were also applied to increase the capability in Hebei Province by developing a network of retail and wholesale markets (Liu & Fu, 2015). Postal logistics networks have also been used as a strategy to improve distribution efficiency in Shandong Province (Wang & Fu, 2015). A study related to determining the location of a logistics center in Yunnan Province, China was carried out using the Fuzzy TOPSIS method, considering the limited information in the rural area (Zhang, Zhang, Li, Liu & Yang, 2017).

Rural logistics is always associated with the flow of agricultural products in rural areas. This is because agricultural supply chains can create economic value to improve collective product marketing (Liu, Cavaye et al., 2022). This shows collaborative commercial farming through a pooling of resources by actors in the network to maximize their benefits. The credibility of information on organic agricultural products always hinders disruptions in participation in the Organic Agricultural Supply Chain (OASC) such as monopoly, centralization, and asymmetry. These are becoming information non-transparency problems, causing a severe crisis of confidence among consumers (Hu, Huang, Huang & Su, 2021). Meanwhile, the emergence of blockchain and edge computing technologies can overcome cost and efficiency imperfections, especially for geographically distributed small and medium-sized farms in rural areas.

Internet access through the rapid adoption of smartphones has allowed global online shopping to be a significant force for a range of activities, including assisting in avoiding the problems of universal payment, insecurity, transaction mean, limitation of product, and reverse logistics (Liu, Osewe, Shi, Zhen & Wu, 2022). The information system plays a significant role in the success of product distribution within the rural logistics scope, which has been applied in cross-border e-commerce development. China has also built an e-commerce business that considers multi objective mixed-integer linear programming models for rural logistics networks from farmers to markets and the flow of recycling products (Zhuang, Zhao, & Zhang, 2016), and designed a reverse logistics network of rural e-commerce in Anhui Province (Cao, Guo & Liang, 2017). An integrated urban and rural logistics information platform was also developed (Yiming & Jia, 2016). Moreover, Bangladesh designed a rural supply chain network to distribute various products related to mitigation and adaptation efforts in case of weather disturbances in rural areas (Hossain, Hossain, & Hossain, 2013).

An optimization model on a dual-direction logistics network between urban-rural was also developed using a three-node index-based formulation for location routing problems with simultaneous pick-up and delivery (Xuefeng, 2011). Prediction of product demand to determine the magnitude of rural logistics needs was carried out using the Back Propagation (BP) neural network method (Zhang & Shang, 2011). This model aims to reduce the logistics return rate and waste of resources based on e-commerce (Qiao, Wang, Meng, Yu, Li, Xu et al., 2019). A model was also developed to minimize costs and vehicle travel time in the agribusiness supply chain type forward-reverse logistics network based on rural e-commerce (Zhuang et al., 2016) and maximize customer satisfaction in the reverse supply chain for online products (Cao et al., 2017). The development of rural logistics used a crowdsourcing approach that combines three nodes of the county and village in China and an integration platform of e-commerce by analyzing the construction of the current logistics network, road construction, and information platform (Zhai, Gao, Xiao, Zhao & Sun, 2018). There is a need for scientific prediction models to reflect the changing rule more accurately and comprehensively (Yang, 2018). Furthermore, a collaborative rich vehicle routing problem was developed to allocate cost savings (Yang et al., 2020). A route optimization model was also constructed for RECL's (Rural E-Commerce Logistics) last-mile distribution to maximize the profit of logistics enterprise, which is subsidized by the government (Liu, 2020). As shown in Table 2, the optimization model development of the rural logistics and supply chain is helpful for efficient and effective measurement, however, it is limited when compared to the conceptual model.

No	Authors	Logistics Initiative	Discussion Area	Category	Solution Method
1	Ji & Huang (2009)	Facility planning	Network structure	Conceptual	–
2	Cui-Hong (2010)	Information system	Inventory & service	Conceptual	–
4	Xuefeng (2011)	Facility planning	Network structure	Optimization	Genetic Algorithm

No	Authors	Logistics Initiative	Discussion Area	Category	Solution Method
5	Zhang & Shang (2011)	Operation management	Marketing	Optimization	BP neural
6	Hossain et al. (2013)	Facility planning	Network structure	Conceptual	–
7	Tao (2014)	Facility planning	Network structure, inventory & service	Conceptual	–
8	Xu & Huang (2014)	Facility planning	Network structure	Conceptual	–
9	Cai & Chen (2015)	Facility planning	Network structure & inventory	Conceptual	–
10	Liu & Fu (2015)	Facility planning	Service	–	Fuzzy Metter Element
11	Wang & Fu (2015)	Facility planning	Inventory, transportation, & service	Optimization	Grey Correlation
12	Yiming & Jia (2016)	Facility planning	Network structure & service	–	Conceptual
13	Zhuang et al. (2016)	Facility planning	Network structure, inventory, & transportation	Optimization	Non-Dominated Sorting Genetic Algorithm (GA) II
14	Zhang et al. (2016)	Facility planning	Location	Optimization	Fuzzy Topsis
15	Cao et al. (2017)	Information system	Network structure & service	Conceptual	2-phase Nesting GA
16	Zhai et al. (2018)	Facility planning	Network structure & Transportation	Optimization	Crowdsourcing Model
17	Yang (2018)	Operation management	Marketing	Optimization	Gray Neural Network Model
18	Qiao et al. (2019)	Information system	Network structure	Optimization	Cloud Distribution Information Platform
19	Yang et al. (2020)	Facility Planning	Transportation	–	Branch-price & cut algorithm
20	Liu (2020)	Facility planning	Transportation	Optimization	Ant Colony Optimization
21	Liu, Osewe et al. (2022)	Information system	Network structure	Optimization	e-commerce development

Table 2. Study developments related to rural logistics

### 3. Methodology

The rural logistics system model was developed to improve the efficiency and effectiveness of product distribution in rural areas. This model will affect the increase in farmers' income, reduce the cost of living, and improves the community welfare. Moreover, developing a model requires a scientific theoretical framework to build hypotheses followed by an empirical approach through a design.

The logistics network system consists of several actors that work in product distribution, where each actor has different goals, methodology, and strategies affecting joint decision-making. Therefore, various theories can be used to develop a conceptual representation of the rural logistics system model.

Mota, Makhoulfi, Abdel and Scala (2019) stated that the interaction of logistics network components within the organization, institution, transportation, environment, social, technology, and financial spheres increases efficiency and sustainability. Meanwhile, this study proposes a conceptual framework to analyze and construct a rural logistics system by considering the characteristics of the components discussed by Van der Vorst, Beulens and Beek (2005), including products, actors, processes, resources, and management. The strength of this framework is to describe the developmental steps of a rural logistics system model as shown in Figure 1.

#### 4. Result

Rural logistics is the desire for activities to provide production, packaging, inventory, loading and unloading, transportation, and all related daily life activities to deliver products and services in rural areas. Meanwhile, the selection of the types of products to be distributed through the model is essential to obtain an appropriate solution, and develop the logistics network, and management system in overcoming market behavior.

Agricultural products that will be distributed in the rural logistics system model are raw goods or commodities such as groups of vegetables, fruits, horticulture, and grains. These commodities are a source of community food for export or as raw material for various industries, especially the food industry. The products are perishable, therefore, require quality integration with the supply chain and managerial implications to improve product quality when it reaches consumers.

Moreover, the types of products that are important to be distributed through the system include 1) raw agricultural products or commodities such as vegetables, fruits, horticulture, and grains, 2) agricultural supporting such as fertilizers seeds, and equipment, 3) consumers product, including flour, sugar, clothes, and electronics equipment. Meanwhile, the characteristics of products to be distributed by a rural logistics system in Indonesia are described in Table 3.

The identification of logistics system components or stakeholders involved in product distribution in rural areas is very important in the design of a relevant network structure relevant. Based on field observations, the entities of the rural logistics system related to the activities of providing and distributing agricultural commodities from rural to urban areas and from manufacturers to rural areas can be identified in six prominent actors as shown in Table 4.

The design of the network structure in this model is carried out based on the level of administrative subdivisions in Indonesia. This was followed by the determination of the various entities needed in the logistics network of each administrative subdivision. Subsequently, select the flow of agricultural and industrial products required by rural communities and develop e-commerce. The logistics system developed in this study also considers the flow of supporting products for farming, and the communities need (Fang, 2014), and extends to the information technology trust with additional concepts including constancy, safety, and reliability (Hu et al., 2021). However, the flow of recycled products was not considered because the condition is not a situation in the farm market. The results of determining the network entities, function, and location for the rural logistics system model are based on the steps and the comparison as shown in Table 5.

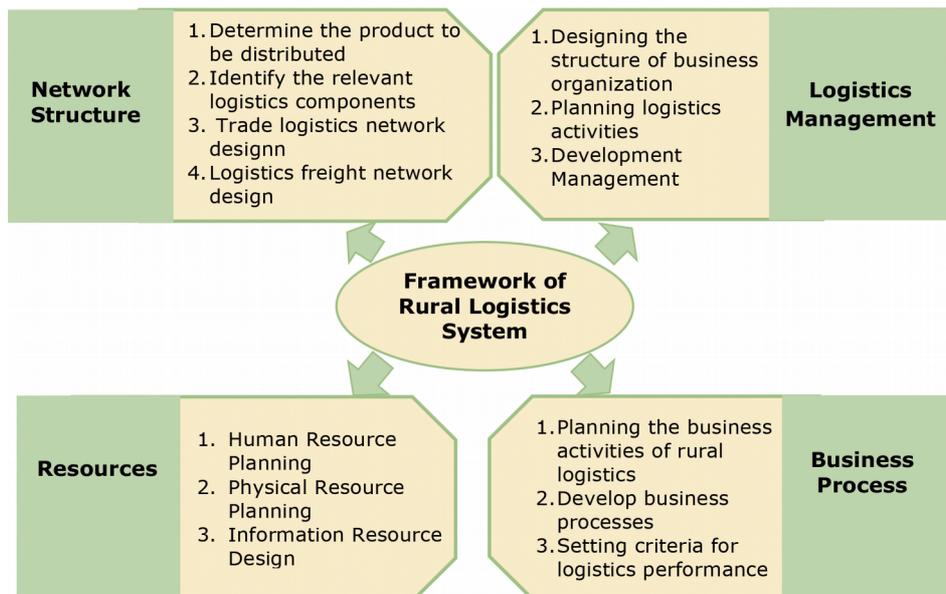


Figure 1. The conceptual framework of the rural logistics system model

Types of Products	Agricultural Commodities	Manufactured Products	
		Agricultural Supporting Product	Consumer Products
Category	Rice, vegetables, fruits and horticulture	Seeds, fertilizers, and planting equipment	Clothing, food, and consumer goods
Product nature	Perishable	Non-perishable	Non-perishable
Production type	Seasonal (depending on the cropping cycle to harvest)	throughout of year	throughout of year
Availability	Harvest is stored all year with special treatment related to processing and storage	According to factory production capacity	According to factory production capacity
Actor domination	Collectors	Distributors	Producers and Distributors
Nature of market	Perfect competition	imperfect competition with regulations	Perfect competition
Business governance	Role in agricultural extension activities, providing facilities and infrastructure to support agriculture and assisting in marketing through the local government	The government's role in improving seed quality	–
Government regulation	1. Law No. 19 of 2013 concerning the Protection and Empowerment of Farmers 2. Regulation of Agriculture Minister of the Republic of Indonesia No. 67/PERMENTAN/SM.050/12/2016 concerning Farmer Institutional Development	1. Regulation of the Minister of Agriculture No. 15/Permentan/HR.060/5 of 2017 concerning the import and export of horticultural seeds 2. Regulation of the Minister of Agriculture No. 15/Permentan/HR.060/5 of 2017 concerning the import and export of horticultural seeds	–

Table 3. Product description to be distributed in the rural logistics system Model

No	Logistics Network Elements	Actors/ Stakeholders	Description
1	Producer	Farmers	Producers of agricultural commodities
		Manufacturers	Producers of manufactured products needed by rural communities
2	Agricultural commodity distributors	Collector Cooperative of Farmers Speculator Agribusiness Terminal	Actors involved in the distribution of agricultural commodities from rural communities to consumers in urban areas
3	Manufactured Products Distributors	Outlet/ shop Central market Distributor Exporter	As entities involved in the distribution of manufactured products from rural communities to consumers in urban areas
4	Business partners	Transportation partners Milling partners Packing partners	As entities that help intermediaries distribute goods, including transportation, product processing, packaging, and information provision
5	Business supporting	Banking Guarantee agency Government agencies	As an entity that supports farmers in the development of agricultural commodities such as capital, loss insurance, and training in agriculture
6	Consumers	Local consumers Food industry Overseas consumers	As a user of agricultural commodities for consumption or processing into other products
		Rural communities	Consumers of manufactured products

Table 4. The results of the identification of logistics components in rural areas

The next stage is to reconfigure the network structure in a rural logistics system. In this study, the structure of the designed model was divided into two parts, namely (1) based on ownership of products in business networks, trade logistics, and (2) the flow of product from the source to the consumer, freight logistics. The flow of trade logistics reflects the business practices that will be carried out between entities related to financial flows due to the exchange of goods' ownership. Meanwhile, the flow of freight logistics is related to the movement of goods from one actor to another. Although the flow of ownership of goods and the physical movement of goods are in the same logistic network, they are not identical because product warehouses are not identical to the company's location.

Origin	Location	Entity functions related to the flow of agricultural products	Entity functions related to the flow of manufactured products
Farmers/rural communities	hamlet/village	As a supplier of agricultural products	As a consumer of a manufacturer's product
Rural shop	Rural area	As a collector of agricultural products from farmers to be distributed to Terminal Logistics	As a direct distributor of manufactured products to rural communities
Logistics Sub-terminal	Sub-district/County/	Assisting the Logistics Terminal in the distribution of agricultural products to Logistics Terminal	As a distributor of factory products from Terminal Logistics to Rural Shop
Logistics Terminal	District Capital/Regency	As a distributor of agricultural products from rural shops to distributors, exporters, industries, or consumers in urban areas	As a distributor of manufacturer's products directly to the rural shop or to be forwarded to rural community
Distributor, Exporter	City/Urban	As an intermediary with consumers of agricultural products in urban areas	Intermediaries in logistics network between rural and urban areas
Consumer (household, exporter, and food industry)	City/Urban	Functioning as a producer of manufactured products to be distributed to rural areas	Buyers or users of agricultural products
Manufacturer		As producer of products that rural communities' needs	Serves as a supplier of manufacturer's products to Terminal Logistics

Table 5. Network entities used in the rural logistics system

#### 4.1. Trade Logistics Network

The design of the trade logistics network for the rural logistics system is composed of two alternatives. This includes the building of a conventional logistics trade and building a business network model with an e-commerce platform. In Indonesia, the conventional networks are suitable for rural conditions because digital technology infrastructure in rural areas is under-developed. However, global competition leading to the e-commerce market shows that alternative models with e-commerce platforms are also being considered, although support is needed to improve internet facilities.

Farmers and rural communities are called individual partners and are the biggest beneficiaries of implementing the logistics system. As a business organizer, all decisions taken by the Logistics Terminal management should consider this individual partner's limitations. This is because their products are sold to the rural shop and also purchase products they needed.

The rural shop is a business partner from the Logistics Terminal operating that can be played by collectors, agents, cooperatives, or stalls. Although the shop is a business unit under coordinating the terminal, it has the same authority in setting business rules. The agricultural products are purchased by rural shops, while farmers buy manufactured products.

The Logistics Terminal in the district capital acts as a business organizer, the center for managing the rural logistics system, from rural-owned enterprises or private companies. It also buys agricultural products from Rural Shops and

distributes manufactured products. Furthermore, it oversees sub-terminal entities located in sub-districts in rural areas. The sub-terminal at the sub-district level can be used as a representative when the capital is very far.

Manufacturers produce and supply products directly to Rural Shops through a rural logistics network. Their position in the organizations is called business partners that need to get the best services and impact the model's profits.

Rural e-Commerce is a platform of information and business communication facilities in the rural logistics system that receives, processes, and shares data needed by all business partners in the system. In business organizations, it is an information partner, which can be from start-up companies whose shares are owned by private entities. Furthermore, it can also be referred to as a form of transformation of Logistics Center 4.0, which is linked to a traditional logistics platform to manage required activities and competencies (Yavas & Ozkan-Ozen, 2020). The building and sustainable management of a platform that maps the trade logistics network is an innovation to reach success in service. In this process, the three factors that need to be considered are interaction reciprocity between platform and business environment, convenient strategy among the actors, appropriate value creation, cooperation, and dynamic configuration (Lin, Chen, Yin, Li, Zhu & Luo, 2021).

The distributors/exporters in the rural logistics system are business agents who act as intermediary agents for agricultural products to consumers or the food industry (business client). Therefore, the Logistics Terminal needs to build ideal cooperation with this business agent for the best service to consumer groups and the food industry. The results of determining the trade logistics network actors for the rural system in Indonesia are shown in Figure 2.

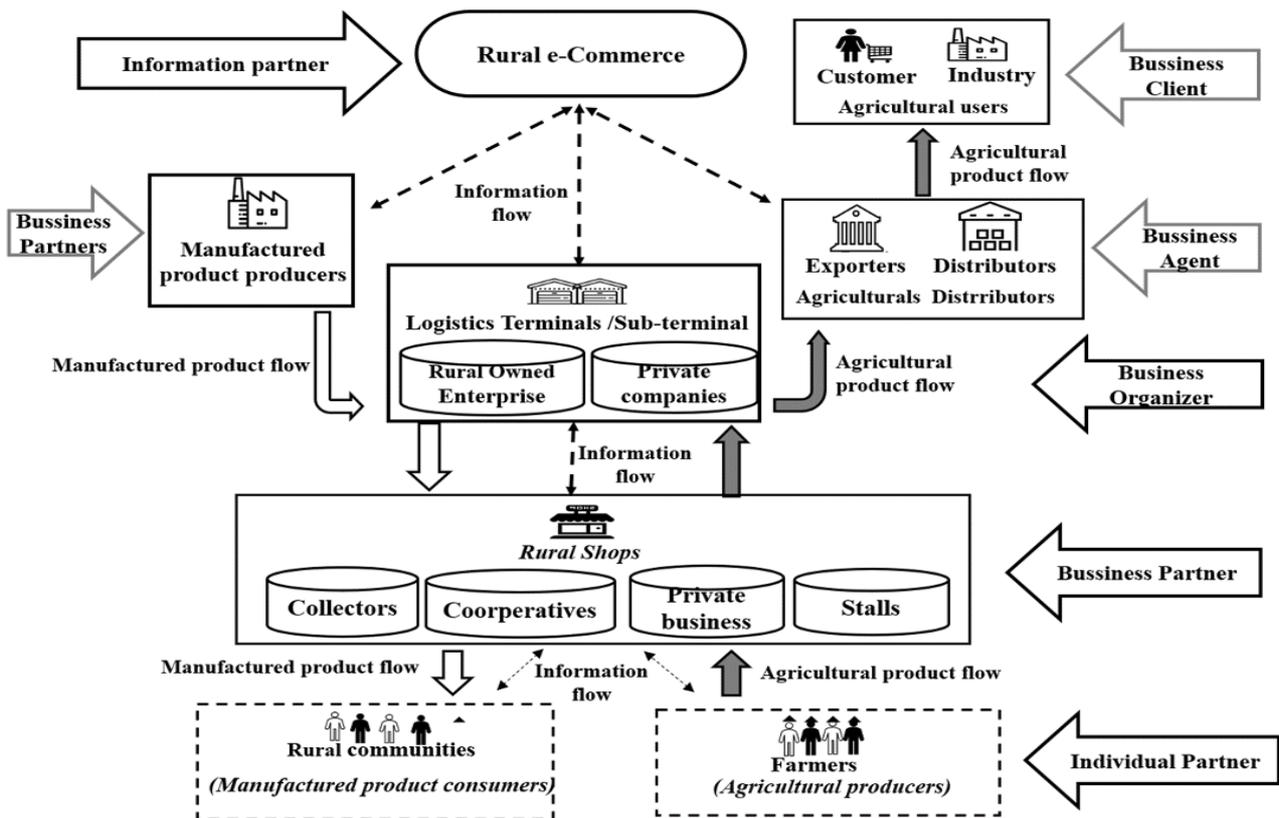


Figure 2. The actors of trade logistics network for rural logistics system model

#### 4.2. Freight Logistics Network

The freight logistics network starts from farmers to Rural Shops, Logistics Terminals/Sub-Terminals before being distributed to urban areas by distributors and exporters. Based on the distribution of manufactured

products, the institutional structure is organized from manufacturers to rural communities through Logistics Terminals/Sub-Terminals. The freight logistics network is shown in Figure 3.

In the rural logistics system model, agricultural activities involve primary members, namely farmers, rural shops, and terminal/sub-terminal logistics. The agricultural commodities will be harvested according to types of products and schedule planting determined. The sorting and packaging process properly does not damage the product at the shop. Subsequently, the products are stored in a room with a refrigeration device to maintain the quality before they are distributed to the distributor using a pick-up car provided by the rural shops. The Logistics Terminal/Sub-Terminal only distributes the products to distributors and exporters. The manufacturers also distribute their products directly for efficient transportation costs and delivery times. Meanwhile, the products sent from manufacturers are based on requests from Rural Shops through Rural e-commerce according to their needs.

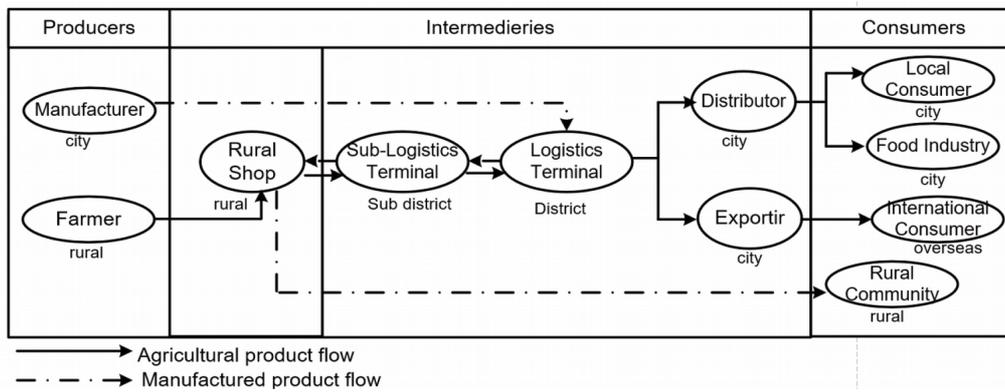


Figure 3. The freight logistics network for rural logistics system model

### 4.3. Management Functions of Rural Logistics System

In logistics and supply chain management, several activities that are being carried out include transporting goods, location, handling materials, inventory, information processing, and sharing information with intermediaries in distributing products (Lin et al., 2021; Ross, Khajehnezhad, Otieno & Aydas, 2017; Yavas & Ozkan-Ozen, 2020). This function is a continuous and interrelated process that supports each other, which requires coordination and integration efforts for proper administration. The management functions in the logistics system identified five crucial activities in rural areas, namely distribution, process, storage, information, filtration, and transportation (Asian Development Bank-ADB, 2017; Hossain et al., 2013; Ji & Huang, 2009; Xuefeng, 2011; Yuan & Chen, 2020).

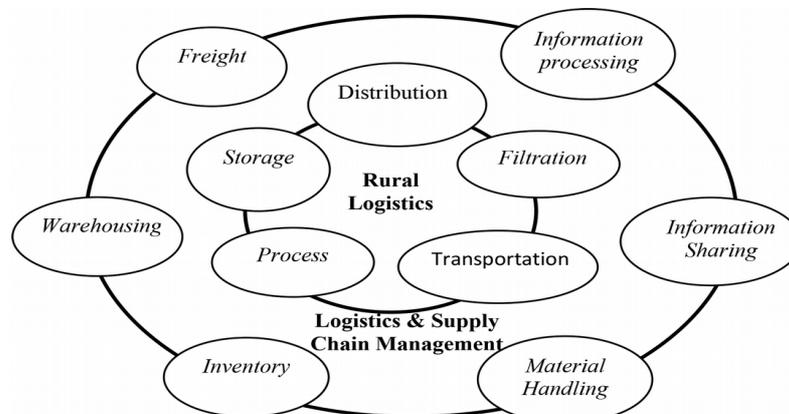


Figure 4. The management functions of the rural logistics system

The description of the management functions of the rural logistics system is as follows:

#### **4.3.1. Function of Distribution**

According to Ji and Huang (2009), the distribution function is related to preparing product orders, inventory availability, and developing procurement plans. It can also be called the function of planning and meeting product requirements, which aims to meet consumer demand submitted to the logistics terminal via e-commerce. Moreover, entities, distributors, industries, and exporters, as well as local consumers can access e-commerce to enter requests for agricultural products to rural shops through the network provided. The Logistics Terminal selects the entity to fulfill the request by considering the location, mileage considerations, product availability, and priority scale. Through e-commerce, the distribution function of the rural logistics system will be carried out more quickly and cost-effectively.

#### **4.3.2. Function of Storage**

Rural areas are prone to natural disasters, which can lead to crop failure or delays in product delivery, causing product scarcity and higher prices. Hossain et al. (2013) stated that this condition is anticipated by storing agricultural products in intermediates close to direct users. Based on the network formed, agricultural products should be stored in the Logistics Terminal warehouse, while those needed by the rural community such as foods, clothes, and medicines are stored in the rural shop.

Inventory of agricultural products is divided into three types, namely fast distribution, high demand period and peak prices situation, and buffer stock. Storage for sales in peak prices and particular high demand situation is a product entrusted to terminal logistics by farmers. The system uses a voucher as proof of the length of time farmers have left the product until sold and are charged a rental fee.

#### **4.3.3. Function of Process**

The process function is product processing such as ripening, milling, drying, cleaning, weighing, sorting and packaging, and maintenance to ensure product quality conforms to consumer demand (Ji & Huang, 2009). The processing should be carried out at the farmer level with the standards expected by consumers for product uniformity, even when it is supplied by farmers from different regions.

Agricultural products require a quality assurance process to maintain freshness during storage. Meanwhile, some types of horticulture require a process such as coating to preserve the acceleration of spoilage, pest, and disease control to prevent microbes or larvae from developing on the harvested fruit. This process should be carried out at the logistics terminal level and under Indonesian National Standard. The Logistics Terminal is expected to provide process technology and resources, following the superior products of rural areas under the coordination of the logistics terminal. The function of the process for manufactured products along the rural logistics network is almost non-existent and was not discussed at this stage because the products are generally ready for consumption.

#### **4.3.4. Function of Filtration**

This function aims to monitor the safety and quality of agricultural products distributed through rural logistics networks. This level of safety is crucial because it will affect the nutritional content in the product and the body that directly consumes the products. Furthermore, the perishable nature of the product makes it vulnerable to damage caused by physical and chemical activities. Product safety and quality in the rural logistics system model can be managed by two alternative courses of action, namely (a) Monitoring activities on the facilities and infrastructure used in the rural logistics system model and (b) Providing facilities in the warehouse that can protect products from bacteria and insects such as rats and termites.

#### **4.3.5. Function of Information**

According to Cui-Hong (2010), information technology in rural logistics includes integrating all available information resources in rural areas. This function focuses on ordering, procurement, sales, payment, and transportation arrangements using the internet network. It is also related to public information for financing, market opportunities, training, and education that farmers can easily apply to improve their sales, product quality, and availability of agricultural products.

The use of information technology is increasing in global competition, where its integration into urban and rural logistics rapidly improves the economy (Liu, Osewe et al., 2022; Yuan & Chen, 2020). This function focuses on information processing related to ordering, procurement, sales, payment, and transportation using computer networks. It also provides public information about financing, market opportunities, training, and education that farmers can use to improve product quality and the availability of agricultural products. (Han, Zuo, Zhu, Zuo, Lü & Yang, 2021) also stated that information technology will be the main driving force to improve the quality maintenance and collaborative supervision of upstream and downstream effectively and efficiently. It can also be used to enhance market competitiveness, improve construction, and application models of dynamic agricultural prediction.

This function can be applied in rural areas due to the continuous development of information technology in the marketing and distribution of products in Indonesia. Moreover, it requires support to improve the infrastructure and resources in rural areas. When the information network is not possible, it can be inputted into e-commerce manually through the officers at the Logistics Terminal.

#### **4.3.6. Function of Transportation**

The transport function plays an essential role in the rural logistics system model. Transportation is the movement of products from rural communities to consumers in urban areas (forward flow) and the direction of manufactured products from industry in urban centers to rural areas (backward flow). Meanwhile, the effective and efficient management of transportation activities will ensure that the company's goods are delivered to customers on time, in the correct quantity, quality, and recipient.

The choice of transportation policy in rural areas must consider the type of product transported, location and distance, infrastructure conditions, as well as environmental sustainability. Although Xuefeng (2011) suggested that rural logistics cooperate with third party logistics (3PLs) to save transportation costs, this strategy is not yet suitable in Indonesia. Rural areas have not been fully supported by transportation infrastructure, therefore, 3PLs companies are not yet fully willing to operate. This condition forces the rural logistics system to have many vehicles to pick up agricultural products. The reduction in costs is better by selecting a relatively efficient means of transportation under the farmers' harvest capacity.

The three resource chains that need to be considered in the implementation of a rural logistics system include human, physical, and technological resources. Human resources are the main element in an organization because a sophisticated operational system without qualified individuals will not achieve its goals. Physical resources are related to the infrastructure, technology, and equipment used for operation. Meanwhile, information technology resource planning is the e-commerce platform for integrated rural logistics.

### **5. Discussion and Analysis**

The rural logistics system is also a form of macro logistics strategy that can increase people's income and reduce product distribution costs in rural areas. It facilitates product distribution, cuts off the speculators, and reduces costs together with distribution time to increase the farmers' income. The implementation supports the government's efforts to effectively and efficiently realize national competitiveness in regional and global markets and also improve people's welfare, as written in the Indonesia Blueprint of the National Logistics System and Rural-SGDs Agenda.

The implementation of rural logistics requires improving the internet network, especially in remote areas. Transaction through the internet is expected to enhance safety, speed, and accuracy. Meanwhile, in a rural system, a trade logistics network with an e-commerce platform has some characteristics, which include (a) prioritization of website development over business places such as offices or buildings (2) easily accessible within 24 hours. (3) The payment system is authorized by the specified payment service provider, (4) Delivery of products using logistics services, when necessary, is enough to rent from a third party, and (5) Transaction costs are cheaper than the conventional system. The rural logistics model can serve both direct payment and online transactions. Therefore, farmers, rural communities, and consumers choose the type of transaction according to their current situation and constraints.

Product distribution strategies based on the freight logistics network are (1) Selecting transportation modes, (2) forms of cooperation with 3PL, and (3) vehicles route. In the rural logistics system, this network is expected to decrease delivery times, reduce transportation costs, and ensure product quality during the delivery process. Analysis of the advantages and disadvantages of the trade logistics network are shown in Table 6.

Network advantages	Network disadvantages
<ul style="list-style-type: none"> <li>• The provision of physical facilities for logistics distribution from rural areas will offer an alternative place for marketing agricultural products apart from speculators.</li> <li>• Rural communities have a place for buying and selling transactions, directly purchasing their daily necessities products through rural shops and e-commerce access.</li> <li>• The government and rural logistics system managers can coordinate directly with all network entities by using e-commerce features to improve product and service quality.</li> <li>• The actors work together to distribute products to make the amount of supply larger. This condition gives farmers greater power to face price competition.</li> <li>• Farmers get the best-selling price for their harvest.</li> <li>• Facilitate buying and selling transactions and payment systems for farmers and customers</li> <li>• All actors in the system regulate the mutual availability of products throughout the year.</li> </ul>	<ul style="list-style-type: none"> <li>• Increase investment and coordination costs, especially in developing rural e-commerce</li> <li>• The dependence on information and communication technology is a challenge that the government needs to prepare properly</li> <li>• The distance between rural shops and consumers requires a transportation network that can maintain product quality and smooth delivery.</li> <li>• The manager of the rural logistics system must have a moral hazard to help farmers and rural communities consistently</li> <li>• There is a cultural challenge for the rural community that rejects electronic commerce because it is prone to fraud and online crime.</li> <li>• Product quality may be different from the display on the website</li> </ul>

Table 6. Analysis of rural logistics network

## 6. Implication

The development of rural communities is lagging behind the urban areas, leading to a slower economic growth rate. This makes it difficult to achieve welfare and sustainability issues as written in the SGDs agenda. In Indonesia, rural logistics implementation offers a significant opportunity to improve the economy, especially the trade and distribution of deteriorating products. Moreover, the three categories of issues faced by agriculture products in rural areas include the availability of farming products, distribution to customers in urban areas, and marketing problem. Some challenges are also related to the availability of products needed by rural communities, which are generally supplied by industry in urban areas. By developing the rural logistics system, all issues of products distribution across rural areas can be solved simultaneously. The rural logistics system is expected to be interconnected with the city logistics network. Subsequently, it becomes a subsystem supporting the National Logistics System as shown in Figure 5.

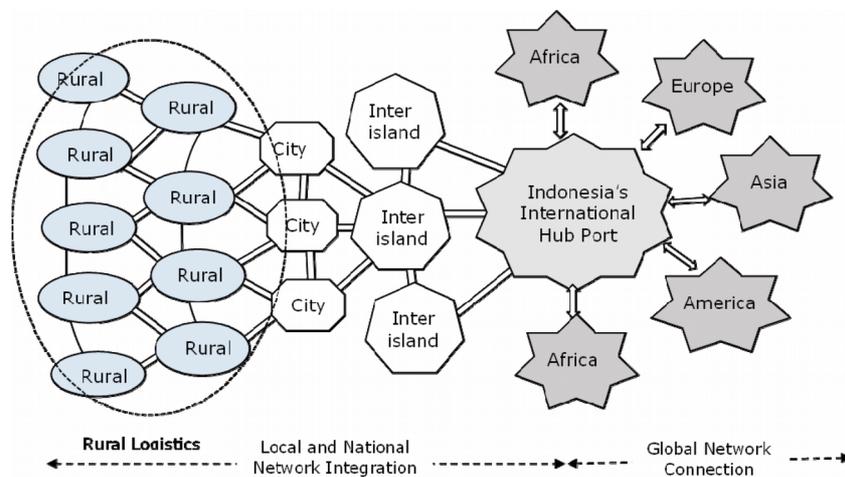


Figure 5. Indonesia Blueprint of National Logistics System

## 7. Conclusion

This study proposed a rural logistics system model and is expected to become part of the National Logistics System in Indonesia. The model of trade logistics network successfully formed a structure according to the construction of the rural area by grouping the actors involved at each regional level. It also considers rural e-commerce as an information partner to facilitate online transactions. It was discovered that e-commerce operates in rural areas to enhance accessible communication, information sharing, and transactions between the actors of the logistics system.

Moreover, a freight logistics network model was also developed to describe the flow of products from farmers to users and manufacturers to rural communities. All actors involved have the same goal of increasing product flows in rural areas, minimizing the role of speculators in regulating the flow of goods, and reducing logistics costs.

The application of the rural logistics system model is expected to increase income and reduce the cost of farming and the livelihood of people. It will also reduce the poverty rate, ensure product availability, and price stability to improve welfare and sustainability, as stated in the Rural-SDGs agenda of Indonesia. Meanwhile, it is necessary to develop an operational model to optimize the rural logistics system efficiency compared to the previous condition.

## Declaration of Conflicting Interests

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