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A Comprehensive Analysis of Logistics Strategy and Cold Chain Technology Innovation –Literature Review (Case Study: Paxel Indonesia)

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ABSTRACT: The country's economic development has a big influence on the growth and contribution of the logistics sector, especially transportation and warehousing, one of which is influenced by shopping behavior and customer lifestyle. One type of logistics distribution pattern is the cold chain, which requires companies to have a logistics strategy and cold chain technology innovation to meet customer requirements. This literature review aims to comprehensively analyze the impact of implementing logistics strategies and the use of technology in cold logistics which is different from dry logistics carried out in one of the logistics service provider companies. Evaluation of the influence of environmental factors, temperature and customer needs on design strategy choices will also be discussed in this paper. Apart from that, the literature review will answer the impact of implementing logistics strategies and supply chain technology on the quality and safety of frozen food products.

KEYWORDS: *Economic Growth, Logistic Strategy, Cold Chain, Technology Innovation*

INTRODUCTION

The logistics and land transportation industry in Indonesia faces increasingly complex challenges along with rapid economic growth. Indonesia's active involvement in international trade and increased domestic consumption have taken the industry to a higher level, but have also placed great pressure on the cold chain management aspect. In this context, cold chain management becomes a very important aspect, especially in facing the increasing demand for goods with controlled temperature requirements, such as frozen goods. This research will comprehensively discuss logistics strategies and technological innovation in optimizing cold chain management, focusing on the Paxel Indonesia case study.

Indonesia, as one of the largest developing countries in the world, has experienced significant economic growth in the last few decades. This growth is not only driven by the manufacturing and agricultural sectors, but also by the service industry, including logistics and transportation. Increasing people's incomes and urbanization have changed consumption patterns, increasing demand for goods including frozen products. This is what drives the increasing need for effective and efficient cold chain management.

The frozen goods sector in Indonesia has become a key component in the logistics industry. This market growth is reflected in increased production and distribution of frozen products, ranging from frozen foods to medicines that require controlled temperatures. While this creates significant economic opportunities, it also brings new challenges in maintaining the quality and safety of frozen products throughout the distribution chain [1]. Therefore, it is important to detail logistics strategies and technological innovations that can ensure successful cold chain management in this sector.

Cold chain management in the context of land transportation faces extraordinary complexity. From selecting appropriate packaging methods to strict temperature monitoring during transit, every step in this chain requires careful attention and coordination. In addition, Indonesia's geographic and climatic challenges, which range from tropical areas to cold mountains, add to the level of difficulty in maintaining the desired temperature. In an effort to overcome this complexity, logistics companies need to build mature strategies and utilize technological innovation [2].

The challenges in cold chain management involve many aspects, including environmental temperature fluctuations, regulatory changes, and increasingly complex customer needs. However, these challenges also bring opportunities for innovation. The

application of the latest technology, such as automatic temperature sensors, real-time monitoring systems, and the use of vehicles specifically designed for the cold chain, are potential solutions. Therefore, this research will discuss the extent to which Paxel Indonesia has combined these challenges and opportunities in their logistics strategy.

As the main logistics service provider (LSP) company in Indonesia, Paxel has a central role in meeting the needs of society and industry regarding transportation and shipping. With a broad portfolio of services, LSP is involved in the transportation of various types of goods, including those requiring controlled temperatures. The case study will provide an in-depth overview of the challenges and strategies faced by this leading logistics company in optimizing cold chain management, providing practical insights that can be applied by other industry players.

In the background of this research, it will be explained how the dynamics of economic growth, changes in consumption patterns, the complexity of cold chain management, the challenges and opportunities faced in the context of land transportation are the main factors that motivate and provide relevance. on research on optimizing cold chain management for frozen goods. This research will explore and analyze the logistics strategies and technological innovations with the hope of making a significant contribution to the understanding and development of best practices in cold chain management.

Research Question

Based on the problem formulation that has been described, this research aims to answer critical questions involving logistics strategy and technological innovation in cold chain management. Special emphasis is placed on the differences between frozen food and dry food in the context of cold chain logistics. This problem statement brings focus to the unique challenges and strategies associated with cold chain management in these two product categories [3] . One of the main focuses of this research is to identify and analyze significant differences in cold chain transportation between frozen food and dry food. How do logistics strategies differ in managing frozen products and dry products? To what extent do these differences influence operational efficiency and effectiveness in cold chain management? External factors such as environmental temperature fluctuations and varying customer needs can have a significant impact on cold chain logistics.

How does Logistic Service Provider (LSP) manage this challenge, especially in the context of frozen goods and dry goods? To what extent do changes in environmental temperature and customer requirements influence the design of their logistics strategies? The application of technological innovation and the use of special equipment can be the key to maintaining optimal conditions in the cold chain. Does the Logistic Service Provider (LSP) use different technology or equipment to ensure the success of cold chain logistics between frozen goods and dry goods? To what extent does this technology play a role in improving product quality and safety? Product quality is very important in the cold chain, especially for frozen and dry goods that are susceptible to temperature changes. How do the logistics and technology strategies implemented affect product quality and safety in cold chain logistics? To what extent is the success of this strategy reflected in increased shelf life and product quality? In identifying differences in cold chain logistics between frozen goods and dry goods, are there any special obstacles or challenges faced by Logistic Service Provider (LSP) in managing each product category? Are these challenges specific to certain types of products or general in the context of cold chain management?

By focusing on the differences between frozen and dry goods in cold chain logistics, this research aims to provide in-depth insight into the complexity and dynamics involved in cold chain management at Logistic Service Provider (LSP) in Indonesia. Through a better understanding of this problem, it is hoped that concrete recommendations will emerge that can help companies, as well as contributing to the development of theory and practice of cold chain management in land transportation.

Logistics Handling Strategy in Cold Chain

Logistic service provider has several strategies to implement cold chain logistic effectively and efficiently to fulfilled customer's requirements. First optimal delivery route design needs to design optimal delivery routes to ensure efficiency in temperature management. Routes should minimize transportation time and consider environmental conditions [4] . Second determining the Right Temperature for each type of product with the right temperature (frozen and dry) according to product safety and quality requirements. This involves a deep understanding of the characteristics of each product. Next selection of appropriate refrigerated vehicles, who LSP must select and maintain a fleet of refrigerated vehicles suitable for transporting frozen and dry goods. This includes regular monitoring and maintenance. Final implementation of real-time monitoring technology to observe temperature and environmental conditions during delivery. This system must be able to provide warnings and quick responses to undesired temperature changes.

Operational Differences in Cold Chain

As previously explained, handling frozen or chilled products has several differences from dry products. There are several parameters that must be considered and controlled by the Logistic Service Provider to be successful in handling this product. First,

frozen goods handling requirements. Frozen goods require special treatment during transportation and storage. LSP's company must have refrigerated storage facilities that can reach very low temperatures and special vehicles that can maintain these temperatures. Second, different packing procedures where the packaging process for frozen goods must ensure optimal thermal insulation, while dry goods may require lighter packaging. This requires an in-depth understanding of the packaging requirements for each type of product. Special precautions for frozen goods is other parameter that must have special prevention protocols for frozen goods, such as using additional heating agents or double packaging to protect products from extreme temperatures. Final tighter monitoring and control for frozen goods. This factor requires stricter monitoring and control throughout the entire logistics cold chain. Temperature monitoring systems must be more sensitive and responsive.

Cost Analysis in Cold Chain

On the other hand, cold supply chain operations have several additional costs which are an important concern for LSPs. These costs are Initial Investment in technology and Infrastructure for specialized equipment, refrigerated vehicles, and temperature monitoring technology, daily operational costs include electricity costs, fuel, vehicle maintenance and labor wages. The next component cost is employee training costs for training employees in cold chain management and use of the latest technology. Product Quality and Safety Costs associated with maintaining product quality and safety, such as quality testing, cold chain maintenance, and insurance against product loss. Finally, Claim Handling Fees that may arise due to customer claims or other problems that affect product quality or delivery.

Lead Time Analysis Cold Chain

Even though frozen and chilled products can maintain expiry dates, lead time is a key success factor in the cold chain. There are several lead times that must be monitored by LSPs, such as: Loading and Packing Time that required to load and package frozen and dry goods while ensuring the temperature is controlled.

Transportation and Distribution Times is also required for land transportation from the starting point to the destination point, taking into account distance, road conditions and other factors. Next Storage and Processing Times in Distribution Centers is spent in the distribution center for additional storage and processing if necessary. Document Processing Time is required to process shipping documents, including invoices, permits, and other documents. The last Response Time to Changes in Temperature or Environmental Conditions that required to respond to changes in temperature or environmental conditions that may affect the cold chain.

Claim Analysis in Cold Chain

Cold chain handling is also faced with several supply chain risks caused by product characteristics, the specificity of the handling process and time constraints which ultimately give rise to opportunities for claims. Temperature Mismatch and Product Quality is claims relating to inappropriate temperatures or reduction in product quality during shipping. Second Physical Damage and Product Quality that related to physical damage or reduction in product quality caused by cold chain operational problems. Delays in delivery is one of type claims that arising from delays in delivery that can affect the quality and suitability of the product. Claim Settlement Process are implemented to resolve customer claims, including the time required and type of compensation awarded. Finally Steps to Prevent Future Claims is precautions taken by LSP to reduce or prevent future claims.

Analysis of Fleet Requirements in Cold Chain

One of the biggest risks in handling frozen products in the cold supply chain occurs in the delivery process from the point of production to the point of consumption. So the requirements for transportation fleets operated in the cold chain are the next analysis that LSP must carry out. First Fleet Condition and Maintenance evaluate the condition and maintenance of the refrigerated vehicle fleet, including refrigeration system reliability and routine maintenance. Second Availability of Suitable Fleet through assessment of the availability of a suitable fleet to transport both frozen and dry goods, as well as adjusting the fleet according to customer needs and requests. Requirement of Availability of Monitoring Technology in the Fleets use of monitoring technology in the fleet to ensure real-time temperature monitoring and the ability to respond quickly to temperature changes. Next requirement is Resilience to Climate Variability that evaluate the extent to which the Paxel Indonesia fleet can survive and operate optimally under varying climatic conditions, including extreme temperatures or unpredictable weather changes. Last requirement is Requirements for Fulfillment of Safety and Quality Standards. Analysis of this fleet requirements in the context of meeting safety and quality standards set by industry and government regulations, as well as Paxel's efforts to comply with and exceed these standards.

Analysis of Conformity with Rules and Regulations

The cold supply chain is closely related to the safety, security and health aspects of food intended for customers. So with

that in mind, cold logistics is required to comply with many rules, regulations and standard operating procedures. There are several permits and documents that must be followed and applied by the Logistic Service Provider to ensure the above objectives. First *Compliance with Occupational Safety and Health* (K3) Standards that evaluate whether LSP complies with applicable K3 standards in cold chain management, including waste management and employee safety [5] . Compliance with *Cold Chain and Land Transportation Standards* is assessment of the extent to which LSP meets the standards and regulations set by the relevant authorities for cold chain management and land transportation. Next regulation is Understanding of *Tax and Customs Requirements* that evaluate LSP's understanding and compliance with applicable tax and customs requirements in shipping frozen and dry goods. Final Logistic Service Provider's Efforts to mitigate legal risks. Analysis of the measures and policies implemented LSP to mitigate legal risks associated with cold chain management, including customer claims and contractual requirements.

Technology Measurement Methods and Readiness

Refrigerated Vehicle Fleets use measuring technology [6], that consist of *Sensors and Monitoring* that analyze the use of temperature, humidity and real-time monitoring sensors on the refrigerated vehicle fleet to ensure temperature consistency during delivery. The next feature is *Active Monitoring Technology* that measures the effectiveness of active monitoring technology that enables early detection of temperature changes and rapid response to undesired conditions. The measuring technology also have *Integration with Logistics Systems* that measures the extent to which technology is integrated with the overall logistics system, including inventory management and route planning systems.

Distribution Centers install technology for measuring the Readiness of Processing Infrastructure and Equipment. Several features such *Storage Technology* that evaluate the storage technology used, including refrigerated facilities and special equipment for frozen and dry goods management. Second *Processing Automation* that measures the level of automation in processing and sorting processes to increase efficiency and minimize the potential for human error. Next *Availability of Environmental Monitoring Technology* that measures the availability of environmental monitoring technology such as CCTV and security sensors in distribution centers to maintain operational security and continuity.

Logistic Service Provider evaluate of human resources readiness in using technology through *Employee Training and Development* that measure the effectiveness of employee training programs in ensuring optimal understanding and use of new technologies in cold chain logistics. Second *Technology Adoption by Employees* that evaluate the level of technology adoption by employees, including their readiness to use the latest software and hardware. LSP also implemented *User Feedback and Evaluation* with collecting feedback from technology users at various levels of the organization to evaluate satisfaction, obstacles, and suggestions for improvements regarding the technology used.

Because temperature is a critical factor in handling frozen, chilled and fresh products in the cold supply chain, the role of technology in monitoring, supervising and providing early warning about temperature conditions is a major prerequisite in ensuring product quality. There are several technologies used to measuring the reliability of technology in maintaining desired temperature conditions. First *Historical Data Analysis* to analyze historical data on technology usage to understand the extent to which the technology can maintain desired temperature conditions during shipping and storage. *Testing and Simulation* use for testing and simulating the technology in different scenarios, including extreme temperature changes, to measure the technology's reliability and durability. Last *Real-time Performance monitoring* to measures technology performance in real-time by involving direct monitoring and evaluation of technology response to changing temperature conditions.

The cold supply chain cannot be separated from coordination and communication with all parties involved in the cold chain. So, to ensure integration, technology is needed that can connect the company's internal systems with external systems and the business ecosystem as a whole. There are several features that can be implemented in measuring technology integration with external systems and business ecosystems. First *Integration with Third Parties* that measures the level of technology integration with third parties, such as external logistics service providers and other business partners, to ensure alignment within the overall supply chain. Second *System Interoperability* that evaluate the level of technology interoperability with other systems used in the logistics cold chain, including ordering and inventory management systems. Final *Responsiveness to Innovation* to measures the extent to which the technology used can be responsive to new innovations in the cold chain industry and logistics technology in general.

LITERATURE REVIEW

Cold Chain Logistic

Cold Chain Logistics is delivery transportation that uses technology in the form of refrigeration and is often used for food commodities that really require special treatment during delivery because of the perishable and perishable nature of the product.

If that happens then the market value or usefulness disappears. Cold chain is a safe and secure product delivery method, because it can maintain a certain temperature and humidity. Therefore, it is very important to maintain the temperature in the cold chain to maintain optimal product quality [7].

The cold chain management system is a type of supply chain where the process aims to maintain product temperature during the distribution process throughout the supply chain. The failure of a cold chain system is the failure of all activities experienced by the entire supply chain in series in maintaining the temperature range appropriate to the product. Basically the cold chain system is applied to the food and medicine industry. There are several categories of food that require different thermal conditions. Tropical fruits such as bananas or pineapples undergo controlled ripening when transported, so they require a stable temperature of between 12-14 degrees Celsius. For products such as meat, bread, cakes and some other products, temperatures between -10 and -20 degrees Celsius are required. Seafood, ice cream and some other foods must be frozen or stored at temperatures between -25 to -30 degrees Celsius. For fresh food products such as vegetables and fruit with a product age of up to 2 months, they can withstand temperatures ranging from 1 – 7 degrees. Meanwhile, processed products, canned food and animal protein require temperatures below 0 degrees [8] . In the pharmaceutical industry the temperature is maintained between 2-8 degrees and sometimes up to -80 degrees Celsius. Billions of COVID 19 vaccines are being distributed throughout the world and these vaccines require a stable and very low temperature, namely below -70 degrees Celsius. In addition, a large number of new drugs approved by the US Food and Drug Administration are also temperature sensitive. If the indicated temperature levels are not maintained, the product becomes useless or even dangerous for the patient. Therefore, the need to develop a proper cold chain infrastructure to maintain the necessary conditions at all stages is higher than ever.

Transportation

Not all vehicles can be used in cold chain logistics transportation, because there are criteria that must be met to maintain controlled temperatures. There are general aspects that must be taken into account such as capacity limitations, weight and size, the need to optimize fuel and safety and comply with the regulations set by the international agreement on the transport of perishable goods (ATP). One example is in the distribution of CCP products, where the distribution process in the expedition section starts from printing invoices to delivery. Drivers need to print a travel document and then it must be signed by the head of the expedition department. Specifically for CCP products, there are special procedures and handling. First, in terms of the vehicles used and storage during delivery/distribution. The vehicle used must have a coolant with a calibrated thermometer, to ensure that the temperature during delivery is maintained. Second, there is a special form that must be filled out by the driver when delivering CCP products. The form contains the name of the product being delivered and its quantity, as well as the storage temperature in the vehicle immediately before delivery and the storage temperature in the vehicle after the product is received. Third, for CCP products, they are not put directly into the vehicle, but put in a cool box and an ice pack is added. The cool box is then put into the vehicle [9]. The following are the vehicles used for cold chain distribution:

Refrigerated Truck

Refrigerated trucks are an alternative means of transportation that is good for long-distance and long- term transportation. This vehicle is equipped with a sophisticated cooling system and allows the temperature inside the truck to be controlled. Many products such as frozen food, dairy products, meat, fish and pharmaceutical products use this type of vehicle. The following is an example of truck refrigate specifications with the photon transporter refrigerated truck vehicle model 4x2:

Table 1. Dimensions of refrigerator trucks

Load Capacity	Box Length Dimensions	Box Width Dimensions	Box Height Dimensions	Cooling Range	Cooling Unit
1100 kg	4085 mm	2100 mm	2100 mm	-18°	500LD

Cold chain containers

This container is usually used for large-scale deliveries. Equipped with a sophisticated system, it allows products that require controlled temperatures to be transported over long distances. The specific dimensions and capacity of refrigerated containers vary depending on the container manufacturer, the age of the container and the container owner. The following are specifications for commonly used 45' refrigerated containers:

Table 2. kontainer berpendingin 45'

Tara's weight	Load Capacity	Cubic Capacity	Inner Length	Inner width	Inside height	Door opening width	Height of door opening
4850 kg	29150 kg	67 m^3	11,57 m	2,27 m	2,55 m	2,29 m	2,26 m

Pickup cars and vans with cooling systems

Pickup cars and vans with refrigeration systems are also often used for short-distance deliveries, where these vehicles are equipped with temperature control devices that ensure the product remains fresh during delivery to nearby locations. The following are the specifications of the pickup vehicle.

Table 3. Dimensions of Pick Up Cars

Length of Box	Width of Box	Height of Box
2600 mm	1700 mm	1400 mm

Cost Analysis

Factors that influence the costs of cold chain logistics companies can form a cause and effect relationship, so that the cost system in cold chain logistics companies is a system that contains several dynamic sub-systems and is a non-linear feedback system, so that it can be used to handle the system effectively and efficiently. making research feasible [10]. A dynamic system for cold chain logistics company costs can predict policy reactions in various conditions by changing one of the system parameters so that the guide can make good decisions. Costs in the cold chain logistics include transportation costs, storage costs, in Warehouse / Ex Warehouse costs, OP costs, packaging costs, shortage costs and shortage costs. However, considering the high carbon emissions of logistics companies, the low-carbon logistics policy launched by the government and customers' demand for product arrival times, this paper changes carbon emissions as total costs. Based on this fresh cold chain logistics company as a system boundary to analyze the costs and carbon emissions produced by cold chain companies. The following are nine analysis costs that influence each other to form a unity.

Transportation costs are calculated based on transportation volume and transportation rates. Transport speed is influenced by traffic volume, transport distance, transport delays and load level. Main *storage costs* are influenced by inventory costs and unit storage costs. Inventory is also influenced by the amount in warehouses and former warehouses. *Warehouse costs* is cost of goods in the warehouse/ex- warehouse mainly includes costs in the warehouse and ex-warehouse costs, so that costs in the warehouse/ex- warehouse are mainly influenced by the cost per unit in the warehouse and ex-warehouse, the quantity in the warehouse and ex-warehouse. *Order processing costs* are primarily determined by order quantity and processing costs per order. Order quantity is determined by order speed, and the processing cost of each order is affected by unit time costs. Next *Packaging costs* are mainly influenced by unit packaging costs and the number of packages. When the model is built, the number of ex-warehouses is roughly defined as the packing quantity. For fresh agricultural products, the *Cargo Damage Cost* is mainly influenced by the cargo damage quantity and the unit cargo damage cost, and the cargo damage quantity contains the freight damage quantity and the inventory cargo damage quantity. The quantity of transportation cargo damage is mainly influenced by traffic volume, the level of cargo damage and product freshness, as well as inventory. The quantity of cargo damage is mainly influenced by the level of damage to inventory and storage.

In the process of operating and managing fresh cold chain logistics companies, customers need a long time for their products to be delivered. Due to transportation delays, some *penalty fees* have been added to the company. Therefore, penalty costs are affected by unit time cost penalties and transportation delays. The *cost of carbon emissions* is influenced by carbon taxes and carbon emissions. The carbon footprint of the entire cold chain logistics is calculated as C cold chain = C production + C distribution + C pre-cooling and storage + C waste + C other. By considering the limitations of the model system, this paper determines the amount of carbon emissions from transportation, storage and waste goods processes as total carbon emissions. Carbon emissions from the transportation process are influenced by the carbon emissions of the transportation unit, transportation volume and transportation distance. Storage carbon emissions are influenced by storage unit carbon emissions, storage time and cargo volume. Carbon emissions from waste goods are influenced by waste carbon emission units and cargo damage quantity. Final *Shortage costs* are influenced by the shortage coefficient and shortage quantity, while the shortage quantity is determined by

inventory and inventory estimates. Expected inventory is primarily influenced by order levels i.e. market demand.

Buildings and Facilities

Cold chain products (CCP) are products that are very sensitive so they require storage that must comply with standards issued by BPOM (Food and Drug Supervisory Agency) CDOB (Good Medicine Distribution Method) 2020. This is done to maintain quality quality and minimize damage to cold chain products. Many factors influence storage, one of which is facilities and buildings which must comply with CDOB 2020. The main factor that influences the quality of the cold chain is temperature. Temperature is the core concept of the main function of the cold chain in maintaining quality [11] . Therefore, cold chain products must be stored at appropriate storage temperatures.

Building

Buildings intended for cold supply chain operations have several prerequisites that must be met in order to guarantee the targets requested by logistics service users. First storage locations are selected and constructed to minimize risks resulting from flooding, and/or extreme weather conditions and other natural hazards. Storage buildings are built using materials that are strong and easy to clean. Vehicle access to storage buildings must be provided to accommodate large vehicles, including emergency vehicles. The location is protected from accumulation of dust, rubbish and dirt and protected from insects. The net capacity of the storage building must be sufficient to accommodate peak inventory levels, under storage conditions in a manner that allows stock management activities to be carried out correctly and efficiently. Adequate areas must be provided to receive and package cold chain products that will be sent under maintained temperature conditions. This area should be close to a storage area where the temperature is maintained. A quarantine area must be provided for the separation of returned, damaged and recalled products pending follow-up. Buildings used to store cold chain products must be ensured to have adequate security to prevent access by unauthorized parties. The last Fire extinguishers must be available and fire detection devices must be equipped in all cold chain product storage areas and these devices must be maintained periodically according to the manufacturer's recommendations.

Facilities

Cold chain products must be ensured to be stored in a room with maintained temperature, cold room / chiller (2 to 8 degrees Celsius), freezer room (-25 to - 15 degrees Celsius). First prerequisite is *Cold and freezer room* with maintained temperature with the following requirements: must be able to maintain the required temperature, equipped with an auto-defrost system that does not affect the temperature during the defrost cycle and a continuous temperature monitoring system using sensors placed in locations that represent extreme temperature differences. Cold and freezer must be equipped with an alarm to indicate temperature deviations, with doors that can be locked, if necessary, to enter certain areas equipped with an access control system, with an automatic generator or manual generator which is guarded by special personnel for 24 hours and also with indicators as a sign that personnel are in the cold room / freezer room or other means that can ensure personnel safety.

Second requirement is *Chiller dan Freezer* that must be designed for cold chain product storage purposes (do not use household refrigerators/freezers) that can maintain the required temperature and need to use calibrated thermometers at least one per chiller or freezer (taking into account the size/number of doors) and regularly calibrated at least one times a year. Second, Chiller dan Freezer should be able to record continuously and with sensors located at one point or several points that most accurately represent the temperature profile during normal operation, equipped with an alarm that indicates the occurrence of temperature deviations, equipped with lockable doors / covers, each chiller or freezer must have its own socket. Chiller dan Freezer also equipped with an automatic generator or manual generator, with an alarm that indicates a temperature deviation and with a lockable door / cover. An then each chiller or freezer must have its own socket. Equipped with automatic generator or manual generator.

Technology

Two years after being hit by the pandemic, the whole world is accelerating technology. In all sectors, innovation is very important to keep the supply chain running. Technology is an important part of a cold chain. This affects all aspects of the cold chain, from transportation, packaging, storage and tracking. Technology plays an important role in improving cold chain efficiency and safety. The following is the technology used in the cold chain:

*Real-time temperature monitoring system***.**

Smart View is a Radio Frequency (RF) receiver and General Packet Radio Service (GPRS) internet gateway for real-time temperature monitoring in Cold Rooms/Freezers. The network uses wireless communications for continuous monitoring. This device is mostly used in refrigerators and freezers where large quantities are stored. The receiver/gateway communicates with a battery-operated wireless temperature sensor placed in the storage facility. This sensor contains a temperature and/or humidity sensor, but also functions as a wireless data logger. The measured data is uploaded and analyzed by a central database. If a temperature

change occurs or a door opens in a Cooling or Freezer room or facility, the light flashes and an automatic email and or SMS alert is sent to a user configurable address.

Data Logger.

User-programmable temperature data loggers are battery-operated devices that measure and store data for longer periods of time. This device does not necessarily display data instantly; instead the data is downloaded via USB or cable to a computer for later analysis. The data logger functions as a Cold Chain temperature monitor. Before using this technology, the device must be configured first such as date, time, recording interval, etc. it can all be configured according to user preferences. This information will facilitate better decision making.

METHODOLOGY

This research uses a qualitative approach with a case study as the main design. The Paxel Indonesia case study allows for an in-depth investigation of logistics strategies and technological innovation in cold chain management, particularly in the management of frozen and dry goods. The main subject is one of Logistic Service Provider (LSP) Company with focus is on the logistics, information technology and management teams involved in planning and implementing cold chain strategies. There are three techniques to collect data such as interviews that involved key members of the logistics, information technology and management teams to gain in-depth insight into the logistics strategy and technology implemented. Second is document analysis of Logistic Service Provider's internal documents, including logistics policies, delivery performance data and relevant technology records. Finally, observation that involves direct observation of LSP's operational processes to understand practical strategy implementation.

The collected data will be analyzed qualitatively using a thematic analysis approach. Quantitative data, such as operational performance metrics, will also be analyzed to provide further context. To ensure the validity and reliability of the data the research use triangulation of data from various sources, as well as verification and validation by key LSP's participants.

CONCLUSION

In implementing logistics strategies and technological innovation in cold chain management, it was concluded that there are significant differences in handling between frozen food and dry food which leads to special challenges and strategies in cold chain management. This research is able to identify and analyze significant differences in cold chain logistics, namely the guarantee of quality and safety of frozen products during the distribution chain.

Logistic Service Providers must manage frozen product operations efficiently and effectively with a mature strategy through the use of technological innovation. For example, fluctuations in environmental temperature and changes in customer needs can be addressed through innovative development and use of the latest technology in handling cold chain logistics.

Optimal delivery route design through determining the temperature of each product, selecting refrigerated truck units, using real-time monitoring technology can minimize delivery time and environmental issues are one of the main parameters that must be developed.

Several operational aspects in the logistics and technological strategy for handling frozen products have also been implemented through product handling requirements through refrigerated storage facilities, product packaging procedures to ensure optimal thermal insulation, special prevention protocols using additional heating materials and more sensitive temperature monitoring and control. and responsive.

Because time is an important variable in handling frozen products, Lead Time analysis through Loading and Packaging Time, Transportation and Distribution Time taking into account distance, road conditions, Storage and Processing Time at the Distribution Center, Document Processing Time, Response Time to Temperature Changes are also taken into consideration. crucial. Managing products in the frozen supply chain is also fraught with risk. Several factors that need to be monitored to mitigate this risk are mismatches in temperature and product quality, physical damage and product quality, delays in delivery and the claims settlement process.

Because most of the frozen product delivery process is via truck transportation, monitoring of vehicle technical and operational specifications needs to be strictly monitored, such as fleet condition and maintenance, fleet availability, availability of monitoring technology on the fleet as well as compliance with safety and quality standards regulated by the relevant industry and government regulations.

RECOMMENDATION

Due to very rapid changes in the supply of raw materials and changes in customer demand, especially in the frozen supply chain,

several things that need to be done by all stakeholders will greatly determine the success of implementing strategies and technological innovations in the cold supply chain.

Firstly, the government's role in regulating all legal and operational aspects of supply chain activities through provisions, regulations and infrastructure that supports cold chain industry activities will create guarantees for operators in running cold supply chain businesses.

Secondly, the manufacturer's role is in determining strict standards and requirements in producing, storing and distributing frozen products so that they comply with regulations to ensure the health, freshness and safety of frozen products consumed by the public.

Third, the role of logistics service actors through preparing cold supply chain facilities and infrastructure in accordance with provisions both in terms of technology application, preparing employee capabilities, discipline in standard operating procedures and strengthening company culture in ensuring continuous innovation in handling frozen products.

Fourth, the role of non-profit institutions as companions to the government in socializing, supervising, auditing and providing input to all stakeholders in implementing strategies, regulations, technology and innovation in the cold supply chain industry.

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