IMPORTANT FACTORS OF COLD CHAIN MANAGEMENT IN SAMUT PRAKAN PROVINCE

BY

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Abstract

The objectives of this research were to identify the key factors influencing cold chain management in Samut Prakan Province and to examine the impact of demographic variables on its effectiveness. The study involved a sample of 225 individuals who work in, have experience with, or are connected to the cold chain business in the province. Data were analyzed using descriptive statistics, including percentage, mean, and standard deviation, along with inferential statistics through One-Way Analysis of Variance (One-Way ANOVA).

The findings revealed that the majority of respondents were male, over 50 years old, held undergraduate degrees, worked in companies with 20–50 employees, were engaged in cold storage businesses, and held senior supervisory or supervisory positions. Temperature Monitoring and Compliance with Industry Regulations were identified as the most critical factors for cold chain management in Samut Prakan Province, with mean scores of 4.61 (SD = 0.54) and 4.50 (SD = 0.68), respectively. Additionally, demographic factors such as gender, age, and education significantly influenced all aspects of cold chain management in the province, with a statistical significance level of 0.05. This study provides valuable insights into the demographic influences and critical factors for enhancing cold chain management efficiency, offering practical implications for industry improvement.

(Total 72 pages)

Keywords: Cold Chain Management Factors, Temperature Monitoring, Compliance with Industry Regulations, Demographic Factors

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CHAPTER 1

INTRODUCTION

1.1 Background and Significance of the Problem

TechSci Research (2024), said Thailand's cold chain logistics market was valued at USD 928.44 million in 2023 and is anticipated to project robust growth in the forecast period with a CAGR of 6.14% through 2029 as show on Table 1.1. Advancements in technology, such as IoT-enabled sensors, blockchain, and AI-driven analytics, are revolutionizing cold chain logistics management in Thailand. IoT sensors provide real-time monitoring of temperature humidity conditions during transportation and storage, ensuring compliance with temperature-sensitive requirements. Blockchain technology enhances transparency and traceability in supply chain operations, while AI-driven analytics optimize route planning, inventory management, and resource allocation, thereby improving operational efficiency and reducing waste.

Table 1.1 Thailand Cold Chain Logistics Market Segmented

Report Description	
Forecast Period	2024-2029
Market Size (2023)	USD 928.44 million
CAGR (2023-2029)	6.41%
Faster Growing Segment	Frozen
Largest Market	Central Region
Market Size (2029)	USD 13.65 billion

Source: TechSci Research, 2024

Cold chain management is an important part of logistics and supply chain operations in Thailand has been steady growth and this is expected to continue in the future. Thailand's cold chain logistics market mainly targeted the business to business

(B2B) segment, driven by food, pharmaceutical products and the expansion of convenience stores and restaurants.

However, during COVID-19, new demand for cold chain logistics in the B2C segment emerged because of lockdown policies forcing people to stay at home. Even though the adoption of cold chain logistics by the Thai government is in the early stage, there will be potential supporting projects to further develop this industry. This industry is considered more difficult to penetrate than other logistics industries because of various operation investments and management. An increase in technological adoption in this industry will enhance cold chain logistics efficiency and strengthen competitiveness.

In summary, the Thailand Cold Chain Logistics Market is driven by a combination of economic growth, technological innovation, regulatory support, and changing consumer expectations. These drivers underscore the importance of investing in robust cold chain infrastructure, adopting advanced logistics technologies, and aligning with regulatory requirements to meet the evolving needs of industries and consumers reliant on temperature-sensitive logistics solutions.

Cold chain management is an important part of logistics and supply chain operations, particularly the critical process of maintaining the temperature of sensitive products for quality and safety throughout transportation, storage, and handling from the point of production to the point of consumption. It is critical to ensure the integrity, safety, quality, and shelf life of perishable products, including pharmaceuticals, vaccines, food products, and certain chemical products. When it comes to the seafood industry, cold chain management is critical; without proper cold chain management, the quality of the product can deteriorate rapidly and lead to the colonization of bacteria and parasites, failing to ensure the freshness and safety of the product. Cold chain management enhances food safety, reduces the risk of foodborne infection, and prevents economic damage caused to producers because of spoilage and loss, and the related potential legal repercussions and consumer disappointment. Effective cold chain

management is essential to the standardization and stability of food industry (Lailossa, 2015; Mercier, Villeneuve, Mondor, & Uysal, 2017; Tsironi, Giannoglou, Platakou, & Taoukis, 2016).

Despite the logistical technology improvements, cold chain management is a complex logistic chain to manage effectively. This is due to the required constant temperature conditions, the implementation of advanced monitoring technologies, and compliance with strict health and safety standards. Furthermore, the cold chain established within the Thailand logistic system faces a unique challenge due to the country's tropical climate. Disruption of the cold chain leads quickly to spoiled products and loss of market value within the seafood industry. Effective cold chain management is not only vital for the industry that supports the local economy, but it also ensures that the produced goods are of high enough quality to be sold in the international market. In this way, the cold chain logistical management maintains the economic stability of the region dependent on the exported goods and consumer trust in Thai seafood (Han et al., 2021; Prompatanapak & Lopetcharat, 2020).

The efficiency of cold chain logistics poses significant risks not only to the local economy but also to public health. As a major food exporter, Thailand's reputation in the global market depends on its ability to maintain high standards of food safety and quality. The significance of this study lies in its potential to provide feasible insights for improving cold chain logistics in Samut Prakan Province. By identifying the key factors that affect the effectiveness of the cold chain, this research aims to facilitate the development of more efficient, reliable, and sustainable cold chain systems to support the region's growing food industry.

1.2 Research Objectives

Given the centrality of cold chain management in the Samut Prakan Province food industry, this study aims to analyze in depth and identify the key factors affecting its effectiveness. The objectives of the study are specified below:

1.2.1 To identify the important factors of cold chain management in the Samut Prakan province.

1.2.2 To find out the different key factors of demographic data were affected to cold chain management in the Samut Prakan province.

1.3 Research Questions

This study aims at addressing the following major issues:

1.3.1 What are the important factors of cold chain management in the Samut Prakan province?

1.3.2 What are the different key factors of demographic data that affect the efficacy of cold chain management in the Samut Prakan province?

1.4 Conceptual Framework

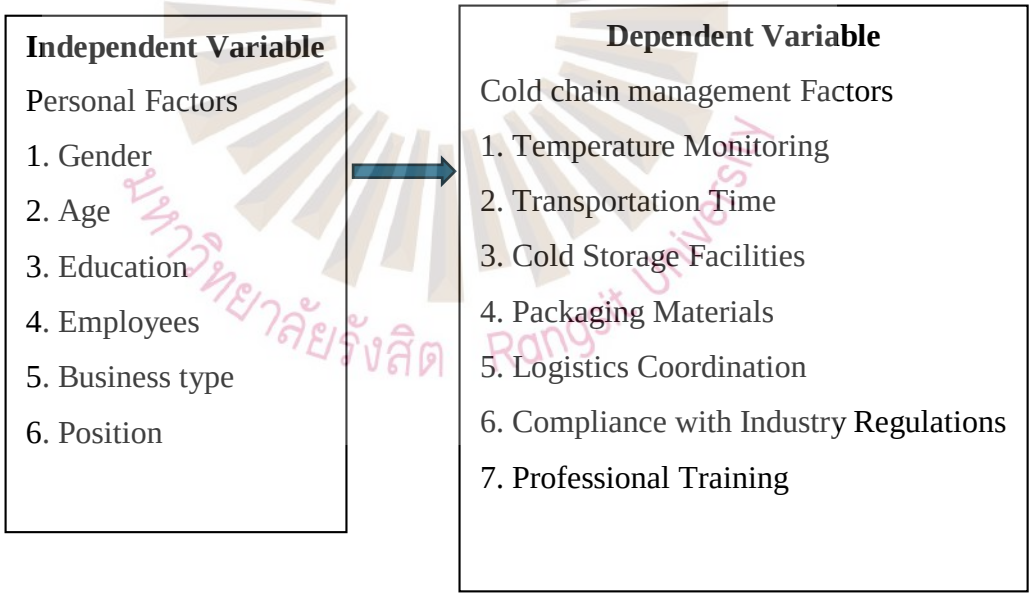

Figure 1.1 Conceptual Framework of Cold Chain Management

1.5 Definition of Terms

Cold Chain Management: This process involves the precise control of the temperature of perishable products throughout the supply chain, from the point of origin through the distribution chain to the final consumer, to ensure product quality and safety (Aung & Chang, 2014).

Temperature Monitoring: The monitoring system protects and regulates food safety to control the temperature of products in a particular environment.

Transportation Time: The amount of transportation time spent when moving goods from one point to another.

Cold Storage Facilities: The facility is to help and store temperature-sensitive products, often perishable goods to ensure their quality, proper air temperature, and extend their life.

Packaging Materials: Keeping temperature-sensitive products intact prevents contamination and ensures that food reaches the consumer in optimal condition.

Logistics Coordination: The safety and quality of perishable foodstuffs throughout the supply chain is ensured in cold chain management, minimizing waste and ensuring timely deliveries.

Compliance with Industry Regulations: To ensure product safety, the cold chain management operation must strictly comply with industry regulations and standards at every step of the process.

Professional Training: Receive specialized training to ensure that employees know key techniques, safety protocols, and compliance with relevant health and safety regulations.

1.6 Benefits of This Research

1.6.1 Know the important factors of cold chain management in the Samut Prakan province.

1.6.2 Know the different key factors of demographic data were affected by the important factors of cold chain management.

CHAPTER 2

LITERATURE REVIEW

This chapter will into the key factors of cold chain management in the food industry and provide a review of the relevant literature. The analysis is drawn from a variety of sources including academic journals, scholarly texts, industry reports, and case studies.

This chapter examines the following topics:

2.1 Overview of Demographic Data

2.1.1 Definition and Importance

Demographics is the analysis of the characteristics of populations and subsets of populations, such as age, race, and gender. Now considering a necessity in the advertising industry, demographics help businesses identify those consumers most likely to buy their products or services (Robert, 2020)

Demographic data is information about groups of people according to certain attributes such as age, sex, and place of residence. It can include socioeconomic factors such as occupation, family status, or income (Villegas, 2024)

2.1.2 Demographic Data Components

Demographics are important for analytics and collecting and gaining a deeper insight into the target group based on personal information. Demographic data is primarily used for strategic supply targeting and can also be used for business analysis and performance reporting. Some examples of data in a demographic survey:

Age: Age is one of the most important demographic factors. It is a good indicator of the groups of users that visit a web page, as well as the age groups that buy the most. Provides information about content that is interesting to a particular age group and where potential can be identified.

Gender: Gender information shows which parts of a website, or which products are more suitable for men or women. Classifying visits according to gender survey questions can serve as the basis for planning campaigns targeting men, women, and other.

Education: Data on education indicates, for example, whether users have attended university.

Income: Income information makes it easy for you to target high-income people, for example, to buy a high-end product.

Interests: The data on the interests of the users shows what interests the visitors of a web page and allows them to draw conclusions about the behavior of the consumers. For example, if there is an affinity for certain product categories on the part of users, marketers can create ads focused on these interests. (Villegas, 2024).

2.1.3 Previous research studies

Gottfredson and Daiger (1977) Study Using a Classification of Occupations to Describe Age, Sex, and Time Differences in Employment Patterns found that the categorizes occupations by age and gender from census data, showing a historical shift in employment patterns. Their analysis underscores an increase in gender diversity across occupations, although gender-based segmentation persists in specific fields.

Humpert and Pfeifer (2013) Study Explaining age and gender differences in employment rates: a labor supply-side perspective, found that age and gender's influence on employment rates, underscoring how these factors determine wage levels and employment stability. They found that both age and gender contribute significantly to differences in reservation and entry wages, impacting individuals' career satisfaction and decisions.

Corleto and Esparza (2021) Research Gender, engineering, and professional technical education, found that on gender within the workforce highlights significant inequalities, especially in male-dominated fields like engineering and technical education, where gender norms and a "masculine" work culture limit the participation and career progression of women.

Naafs (2013) Study Youth, gender, and the workplace Shifting opportunities and aspirations in an Indonesian industrial Town, found that educational background also impacts career trajectories and perceptions within the workforce. Research on Muslim youth in Indonesia illustrates how education, combined with cultural expectations around gender and family roles, influences both career aspirations and employment patterns.

2.2 Overview of Cold Chain Management

2.2.1 Definition and Importance

Cold chain management is the process by which the temperature of perishable items is regulated to preserve their quality and safety from the point of production to consumption. Food's susceptibility to spoilage requires strict temperature control; minor fluctuations can result in major spoilage, leading to health hazards and financial losses through reduced quality and increased waste (Mustafa, Navaranjan, & Demirovic, 2024).

The effective cold chain management is vital not only for meeting safety standards but also for preserving the nutritional value and taste of seafood, which are essential for consumer satisfaction and meeting international food safety standards. (Shashi, Centobelli, Cerchione, & Ertz, 2020).

2.2.2 The Component of Cold Chain Management

Cold chain management consists of the following key components to ensure the quality and safety of temperature-sensitive products such as food. These components can be divided into different stages of the supply chain:

1) Transportation and Storage

A key element of cold chain management involves maintaining proper temperature during both storage and transportation to prevent spoilage and maintain product quality. For example, in the dairy sector, ambient temperature control from storage to delivery is vital to prolong the shelf life of products such as milk and cheese (Shukla, 2021).

Technologies such as IoT sensors are becoming more common in these storage spaces to track environmental conditions continuously and guarantee that they stay within safe limits (Gonçalves & Blaha, 2010).

The transportation of temperature-sensitive items such as seafood, employing refrigerated trucks, container ships, and air freight. It emphasizes the vital importance of refrigerated transport in preserving the quality of perishable goods (Rodrigue, 2014).

2) Monitoring and Traceability Systems

Cold chain management systems often integrate advanced monitoring and traceability technologies, such as RFID (Radio Frequency Identification) and WSN (Wireless Sensor Networks). These technologies help ensure real-time temperature tracking and quality assurance throughout the supply chain (Aung, Liang, Chang, Makatsoris, & Chang, 2011).

One of the primary technologies used in cold chain monitoring is Radio Frequency Identification (RFID), which facilitates real-time tracking and quality control. RFID tags, combined with sensors and GPS, allow continuous monitoring of the temperature and location of goods, ensuring that products remain within the required temperature range during transportation and storage. For instance, RFID-based systems can record temperature variations and alert stakeholders if products are exposed to unfavorable conditions (Yan & Lee, 2009).

Another essential technology integrated into monitoring systems is Wireless Sensor Networks (WSN), which work in conjunction with RFID to offer a more dynamic and responsive system. These sensors are often used to collect temperature data at different stages of the cold chain, providing a robust mechanism to prevent spoilage. WSN-based systems are particularly effective in ensuring quality assurance by providing real-time alerts and comprehensive data records throughout the logistics process (Aung et al., 2011).

Real-time monitoring and data collection systems also play a significant role in enhancing traceability. Traceability systems enable stakeholders to track the movement of goods from production to consumption, ensuring that any issues, such as temperature deviations, can be identified and corrected promptly. In the food industry, RFID-based traceability systems ensure that fresh produce is handled properly, maintaining safety and quality from farm to table (Yan, 2015).

3) Time and Temperature Management

Another crucial component is the management of time and temperature conditions, particularly during the transportation phase and at retail outlets. Effective management can address significant weaknesses such as inadequate precooling, improper handling, and temperature fluctuations during display and transport (Mercier et al., 2017).

A review by Mercier et al. (2017) discusses several weaknesses in the cold chain, such as insufficient precooling and improper handling during transportation and storage. These shortcomings are often exacerbated by fluctuating temperatures during retail displays, which compromise the quality of perishable goods. Effective time

and temperature management helps address these challenges by maintaining consistent temperatures throughout the supply chain.

4) Regulatory and Legal

Cold chain management is also dependent on regulatory support, laws, and certifications that ensure food safety from farm to table. These regulatory and legal help maintain operational consistency and safety standards throughout the supply chain (An, Wang, & Lv, 2015).

Regulatory and Legal standards are critical for ensuring that goods maintain their quality and safety across borders. At the international level, organizations like the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) provide essential guidelines for cold chain operations, particularly in the pharmaceutical and food sectors. The Codex Alimentarius, a collection of international food standards, plays a significant role in regulating the cold chain for food products, setting maximum temperature requirements and hygiene standards (An et al., 2015).

5) Logistics and Infrastructure

The cold chain relies heavily on well-designed logistics systems, such as proper cold storage facilities and reliable temperature-controlled transportation. Poor infrastructure and lack of training among handlers are common barriers to effective cold chain operations (Chaitangjit & Ongkunaruk, 2019).

Cold storage design plays a fundamental role in ensuring product safety within the cold chain. The study highlights that poorly designed storage facilities can compromise the ability to maintain required temperature ranges, thereby increasing the risk of product spoilage. Moreover, transportation infrastructure, particularly temperature-controlled vehicles, is equally critical. These vehicles must be capable of maintaining constant temperature conditions throughout transit to preserve product integrity. This study, conducted in Thailand's foodservice industry, demonstrates that logistical challenges such as temperature deviations during transportation and storage can lead to significant quality loss (Chaitangjit & Ongkunaruk, 2019).

The importance emphasizes infrastructure availability, stating that the absence of reliable cold chain equipment is a major barrier to the system's efficiency. The study also identifies a lack of awareness and training among personnel as a contributing factor to poor logistics management. Without adequate infrastructure and trained handlers, even the most advanced monitoring systems may fail to ensure product safety (Khan, S., Khan, M., & Haleem, 2018).

6) Temperature Monitoring

The application of RFID technology has been instrumental in modern temperature monitoring systems. researcher describes an RFID-based system integrated with GPS and temperature sensors that enables real-time tracking of food products. This system ensures that temperature conditions are consistently monitored and can be adjusted as necessary during transportation, helping to mitigate risks associated with temperature fluctuations (Yan & Lee, 2009).

Mercier et al. (2017), studied the application of time–temperature management along the food cold chain, and the result was found, that temperature abuse that occurs during transportation and storage can lead to increased food waste and safety risks. They argue that efficient time-temperature management, facilitated by continuous monitoring, is essential to improving the global cold chain's effectiveness. By ensuring that products are kept within the specified temperature range, the cold chain can maintain the quality and safety of food products.

Meat is a perishable product with a short shelf life and therefore short selling times. as well as cold chain management in meat storage and distribution is crucial for preventing microbial growth and spoilage, which can occur if products are exposed to temperature fluctuations during transit. Therefore, monitoring of time-temperature profiles is very important for the overall success in the delivery of a product that will be accepted by the consumer for its freshness and safety levels (Nastasijević, Lakićević, & Petrović, 2017).

Ye, Chen, Fu, and Wang (2022), studied the application of nondestructive evaluation (NDE) technologies throughout cold chain logistics of seafood, and the result was found, that IoT-enabled devices can be integrated into

seafood packaging, allowing for continuous temperature monitoring from start to finish. This ensures adherence to food safety standards. Such thorough tracking is essential for preserving the freshness and nutritional content of the seafood, which are crucial for ensuring consumer health and satisfaction.

In summary, temperature monitoring is a crucial aspect of food cold chain management, directly impacting on the safety, quality, and shelf life of perishable products. The importance of maintaining optimal temperatures throughout the production-to-consumption process has driven significant technological advancements in monitoring systems, ensuring product integrity across the entire cold chain.

7) Transportation Time

Gonçalves and Blaha (2010), studied the application of cold chain in the seafood industry, and the results were found, that IoT sensors deliver real-time information on environmental conditions that impact the food during its journey. This data is crucial for quick decision-making to reduce risk and avoid spoilage. For example, if temperatures exceed a certain limit, logistics managers can immediately take action, such as remotely adjusting refrigeration settings or rerouting the cargo to a cooler facility.

Rodrigue (2014), studied the application of GPS in cold chain transportation time, and the results found that the use of GPS technology aids in optimizing delivery routes, which helps shorten travel times and decrease exposure to potentially harmful conditions. This not only preserves the quality of the food but also lowers carbon footprints and operational costs by enhancing fuel efficiency.

Asadi and Hosseini (2014), studied the application of GPS in cold chain transportation time, and the results found that GPS tracking provides an additional layer of security and efficiency, enabling companies to track the precise location of their shipments in real time. This feature not only assists in guaranteeing on-time deliveries but also enhances the management of logistics operations. For instance, should there be a delay or an unexpected route change in a shipment, logistics managers can assess the situation immediately and make decisions that help mitigate any potential deterioration in the quality of the food.

Igilar (2023), studied the application of perishable goods transportation, and the results found that another key challenge in the food cold chain industry is transportation. The researcher emphasized the importance of adopting GPS tracking systems and temperature sensors to reduce delays and prevent temperature fluctuations. The lack of real-time temperature monitoring during transportation often leads to spoilage, especially for perishable items such as seafood and dairy products.

In summary, cold chain management, the adoption of sophisticated monitoring technologies, such as Internet of Things (IoT) sensors and GPS tracking systems, is critical for improving the visibility and control of the logistics process.

8) Cold Storage Facilities

In action can be seen in the major seafood exporters utilizing IoT and GPS systems to enforce strict control over their products. These systems generate alerts and notifications when storage conditions fall outside the ideal range, allowing for immediate corrective actions. This proactive approach not only maintains the seafood's quality but also boosts the reputation of these companies for providing products of high standards (Nga, 2010).

Nastasijević et al. (2017), studied the application of cold chain management in meat storage, distribution, and retail, and the results found focus on the specific requirements of cold storage for meat products, where temperature control is vital to prevent the growth of pathogenic microorganisms. Their review highlights various storage options, such as chilled and frozen storage, and explores the use of wireless sensors to monitor temperature conditions during storage and transportation. This technology is crucial in ensuring that meat products remain safe for consumption throughout the cold chain process.

Chaitangjit and Ongkunaruk (2019), studied the application of cold storage and temperature-controlled transportation, and the results found focusing on a restaurant chain in Thailand, outlines how proper cold storage and temperature-controlled transportation systems are essential to maintain the safety and quality of perishable materials. They point out several logistical challenges, including the need for

better cold storage design and improvements in delivery platforms. These changes are critical to enhancing cold chain efficiency and minimizing food spoilage.

In summary, cold storage facilities are an indispensable component of the cold chain, ensuring food quality and safety while reducing waste by maintaining proper temperature conditions.

9) Packaging Materials

Zuo et al. (2022), studied the application of RFID (Radio Frequency Identification)-based sensing in smart packaging for food applications, and the results found that RFID sensors are more suitable for smart packaging both in terms of sensing ability and data transmission. A simpler, low-cost, more robust, and less power-demanding sensor network is the development direction of smart packaging in the future. Chipless RFID sensors have the potential to achieve these functions. But it still faces many challenges to be overcome. For example, biocompatible, cost, reading range, multi-tag collision, multi-parameter sensors, recycling issues, security, and privacy of RFID system should be solved.

Meng et al. (2023), studied the application of comparison of the environmental impact of typical packaging systems for food cold chain express based on life cycle assessment, and the results found that VIP packaging systems offer superior environmental performance due to their reusable nature, reducing waste and long-term environmental costs. In contrast, EPS, while widely used, contributes significantly to waste due to its disposability and limited recycling options.

In summary, packaging materials are a critical component of cold chain management in the food industry. They play a vital role in preserving the integrity of temperature-sensitive products, preventing contamination, and ensuring that food reaches consumers in optimal condition.

10) Logistics Coordination

Peng (2013), studied the application of the importance of improving cold chain logistics to enhance food safety in Chongqing, and the results found

highlights that outdated cold chain systems can cause food to deteriorate, leading to significant safety issues for consumers.

Zou, Xie, and Liu (2013), studied the application of the reliability allocation model for food cold chain logistics, and the results found this model aims to optimize food safety while reducing operational costs. Then highlighting efficient logistics coordination can reduce the risks of temperature deviations during transportation and storage, improving both safety and quality.

Yan (2015), studied the application of RFID technology in cold chain logistics for fresh produce, and the results found highlights traceability systems based on RFID can enhance food safety and quality by tracking products from farm to table. This approach addresses gaps in the existing cold chain infrastructure, which often fails to meet societal needs in food safety.

Du (2021), studied the application of cold chain logistics of fresh agricultural products, focusing on how intelligent supply chain solutions and technology can mitigate issues in temperature control, and the results found highlight the importance of scientific management practices in improving food safety and ensuring product quality during logistics operations.

In summary, logistics coordination in food cold chain management is crucial to ensuring the safety and quality of perishable foods throughout the supply chain. Proper management of temperature-sensitive goods, such as fresh produce, dairy products, and meat, can prevent microbial growth and extend product shelf life, thereby directly impacting food safety. Logistics coordination in cold chain management plays a vital role in maintaining product quality, reducing waste, and ensuring timely delivery.

11) Compliance with Industry Regulations

Peng (2013), studied the application of cold chain logistics of subsidiary agricultural products in Chongqing, and the results found that in regions like Chongqing, where outdated cold chain systems are prevalent, regulatory awareness among employees is key to ensuring that even in less advanced infrastructures, standards are consistently followed. The study suggests that regular re-training and updates on the

latest regulatory requirements are crucial for keeping employees informed and compliant.

Cold chain logistics systems, especially in the agricultural sector, require stringent management activities that follow established regulatory frameworks to safeguard the quality of food from production to consumption. These frameworks are supported by government agencies and industry associations that ensure consistent implementation of industry standards, such as temperature control, handling protocols, and storage guidelines. Consistent application of these regulations across various cold chain sectors is essential for maintaining the integrity of the entire process (An et al., 2015).

The growing significance of international standards, such as HACCP, within cold chain food logistics, especially during the COVID-19 pandemic. HACCP, in particular, plays a significant role in identifying potential hazards at critical points within the cold chain, allowing for preventive measures to be implemented. (Yang et al., 2022).

Wang, Q., Zhao, and Wang, Z. (2023), studied the application of the importance of international standards like HACCP in their study on risk assessment methods, and the results found that by integrating HACCP protocols into their risk assessment models, cold chain operators can more effectively prevent safety hazards. This ensures that every step of the cold chain process, from farm to table, complies with both local regulations and international standards.

In summary, food cold chain management, compliance with industry regulations is crucial for ensuring product safety and quality. This involves a focus on implementing industry standards, international protocols such as HACCP (Hazard Analysis Critical Control Point), and fostering regulatory awareness among employees.

12) Professional Training

Tsang et al. (2017), studied the application of the incorporation of Internet of Things (IoT)-based cargo monitoring systems into these training sessions, and the results found that the approach allows employees to gain hands-on experience in real-time tracking and managing temperature-sensitive products. Such training

ensures that employees become proficient in utilizing modern technologies essential for preserving the integrity of products across the supply chain.

The strategic design of training programs focuses on aligning employee development with the broader strategic objectives of the organization. And training framework that is consistent with good manufacturing practices and tailored to meet the unique risks and regulatory demands of the cold chain industry (Dasgupta, Routroy, Widell, Bhattacharya, & Thakur, 2019).

The necessity of incorporating automation and innovative methods into training initiatives. Training programs not only cover existing technologies but also prepare employees for future innovations and challenges in cold chain logistics (Singh, Gunasekaran, & Kumar, 2018).

In summary, professional training is critical to the success of cold chain management, especially in highly specialized industries such as food logistics. The literature highlights the importance of structured training programs tailored to the specific needs of the cold chain industry, focusing on technical skills, safety protocols, and regulatory compliance.

After doing a literature review, this study found that some factors of cold chain management had been related to another factor, so for this study, we would like to use seven factors of Cold chain management in terms of Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Material, Logistics Coordination, Compliance with Industry Regulations, and Professional Training.

CHAPTER 3

RESEARCH METHODOLOGY

The research title of the important factors in cold chain management in Samut Prakan Province has 6 parts of research methodology as follows:

3.1 Research Design

3.2 Population and Sample

3.3 Measures and Instruments

3.4 Quality control of the Instruments

3.5 Data Collection

3.6 Data Analysis

3.1 Research Design

This study uses quantitative research design by using an online questionnaire and onsite to collect data from respondents in the cold chain factory and who represent the stakeholders in the food cold chain in Samut Prakan Province.

3.2 Population and Samples

3.2.1 Population

The population for this study includes factories in the food cold chain in Samut Prakan Province, which has a total of 54 factories (Department of Industry Work, 2024). Random sampling techniques will be used to ensure an adequate representation of all relevant groups in the population.

3.2.2 Samples

Considering the diversity of the population and the complexity of the research question, the sample size for this study was taken from (Yamane, 1973) with a 95% confidence level and an acceptable error of ± 5%.

The formula is as follows:

$$S = \frac{\mathrm{N}}{1 + NE^2} \tag{3-1}$$

N is the number of populations.

S is sample size.

E is an acceptable error at ± 5% (0.05).

$$\mathrm{S} = \frac{54}{1 + 54 * 0.05^2}$$

$$\mathrm{S} = 47.58 \approx 48$$

Therefore, the sample size should be at least 48 factories. Since I know the exact number of factories in the food cold chain in Samut Prakan Province, the sample size will be 300 stakeholders to ensure that there is enough data for reliable statistical analysis.

3.3 Research Instruments

The instrument used in this study is a structured questionnaire to collect quantitative data on various aspects of food cold chain representation in Samut Prakan Province.

The data can be categorized into 8 sections as follows:

Part 1 Demographic data, consisting of gender, age, the highest level of education, number of employees, role in the food industry, and position in which the question will be closed-ended.

Part 2 Questionnaire relates to temperature monitoring using 5 level rating scale, in which 1 means strongly disagree and 5 being strongly agree.

Part 3 Questionnaire relates to transportation time using 5 level rating scale, in which 1 means strongly disagree and 5 being strongly agree.

Part 4 Questionnaire relates to cold storage facilities using 5 level rating scale, in which 1 means strongly disagree and 5 being strongly agree.

Part 5 Questionnaire relates to packaging materials using 5 level rating scale, in which 1 means strongly disagree and 5 being strongly agree.

Part 6 Questionnaire relates to logistics coordination using 5 level rating scale, in which 1 means strongly disagree and 5 being strongly agree.

Part 7 Questionnaire relates to compliance with industry regulations using 5 level rating scale, in which 1 means strongly disagree and 5 being strongly agree.

Part 8 Questionnaire relates to professional training using 5 level rating scale, in which 1 means strongly disagree and 5 being strongly agree.

This study will define the criteria for interpretation of mean score from data analysis as follows:

Mean score	Interpretation
1.00-1.49	Strongly disagree
1.50-2.49	Disagree
2.50-3.49	Neutral
3.50-4.49	Agree
4.50-5.00	Strongly agree

3.4 Quality Control of the Instruments

The instrument for this research is motivated from past research which derived from the literature review in Chapter 2 by selecting variables instrument as follows,

temperature monitoring, transportation time, cold storage facilities, packaging materials, logistics coordination, compliance with industry regulations, and professional training. This research tested the quality by checking the validity of the questionnaire and checking the reliability of the questionnaire, with details as follows:

3.4.1 Validity

The questionnaire obtained from studying related research documents was submitted to the advisor for consideration and for qualified persons/subject-specific experts to consider checking the content validity, which is checking the comprehensiveness of the measurement in the content of the thing to be measured, and checking the construct validity, which is measuring from various concepts and rules with the specified properties, totaling 3 persons.

Then, the suggestions received from experts were analyzed to find the content validity between the questions and the definitions (Index of Item-Objective Congruence: IOC) using a questionnaire that was created and specified as a multiple-choice format (Turner & Carlson, 2003). The scores were assigned instead of the answer values as follows:

1 means certain that the question can really relate to the stated objectives.

0 means not certain that the question can really relate to the stated objectives.

-1 means certain that the question cannot really relate to the stated objectives.

When the consistency assessment form was returned from the experts, The researcher calculated the Index of Consistency (IOC)

$$\text{IOC formula} = \frac{\sum R}{N} \qquad (3\text{-}2)$$

Where IOC represents the content validity

R represents the sum of all experts' scores

N represents the number of experts

By specifying that the acceptable content validity value must be at least 0.5, then the question is considered to have content validity (Turner & Carlson, 2003).

Selection of questions assessed by experts, checking the consistency between the questions and the definitions of each aspect on a case-by-case basis, checking and evaluating the content validity and constructing validity using the Index of Item-Objective Congruence (IOC) value of no less than 0.50. If any question has a value lower than 0.50, it is adjusted according to the suggestions before being tested (Try Out) with a sample group that is not the sample group in this study.

The results of the examination of each question by 3 experts are summarized as follows:

Part 1 Demographic data, statistical tool used will be frequency distribution and percentage. IOC calculation results 1.00, IOC analysis results are acceptable content.

Part 2 Perception on temperature monitoring, the statistical tool used is mean and standard deviation. IOC calculation results 0.93, IOC analysis results are acceptable content.

Part 3 Perception on transportation time, the statistical tool used is mean and standard deviation. IOC calculation results 1.00, IOC analysis results are acceptable content.

Part 4 Perception on cold storage facilities, the statistical tool used is mean and standard deviation. IOC calculation results 1.00, IOC analysis results are acceptable content.

Part 5 Perception on packaging materials, the statistical tool used is mean and standard deviation. IOC calculation results 1.00, IOC analysis results are acceptable content.

Part 6 Perception on logistics coordination, the statistical tool used is mean and standard deviation. IOC calculation results 1.00, IOC analysis results are acceptable content.

Part 7 Perception on compliance with industry regulations, the statistical tool used is mean and standard deviation. IOC calculation results 1.00, IOC analysis results are acceptable content.

Part 8 Perception on professional training, the statistical tool used is mean and standard deviation. IOC calculation results 1.00, IOC analysis results are acceptable content.

3.4.2 Reliability

To evaluate the internal consistency of the questionnaire used in this study, we collected 30 questionnaires to gather pretest data. The data for this section must be collected from a population with characteristics like those being studied. The criterion considered in this study is the Cronbach's alpha coefficient, which must have a value of 0.7 or higher, and the corrected item-total correlation value must be 0.3 or higher.

The results demonstrate excellent internal consistency, with a Cronbach's Alpha value of 0.938 for the questionnaire. When considering standardized items, Cronbach's Alpha further increased to 0.954, indicating a highly reliable set of questions.

Both values significantly exceed the acceptable threshold of 0.70, with scores above 0.90 generally considered indicative of outstanding reliability. This suggests that the questionnaire items are well-correlated and consistently measure the same underlying construction. The results of questionnaire reliability testing are shown in Table 3.1 and the results of questionnaire reliability for this study are shown in Table 3.2.

Table 3.1 Results of Questionnaire Reliability Test (pre-test) (n=30)

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.938	0.954	40

Table 3.1 shows that the results of questionnaire reliability for this study have Cronbach's Alpha 0.938.

Table 3.2 Results of Questionnaire Reliability for This Study (pre-test) (n=225)

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.949	0.956	40

Table 3.2 shows that the results of questionnaire reliability for this study have Cronbach's Alpha 0.945.

3.5 Data Collection

The data collection for this quantitative study will be carried out according to the following steps:

Step 1 The survey will be conducted with an online survey (questionnaires (Google Forms), and an onsite survey to collect data.

Step 2 Follow-up reminders will be sent to increase the response rate and incentives such as participation gifts will be offered to motivate participants.

Step 3 The number of returned questionnaires will be evaluated for completeness based on the designed questionnaire.

The researcher distributed the questionnaire by sending a link and QR code to some factories and by visiting the factories in person for respondents to scan and fill out the questionnaire, return collecting a total of 225 responses.

3.6 Data Analysis

Data analysis will be performed using SPSS statistical software. The analysis will include descriptive statistics to summarize the data, and inferential statistics to test hypotheses and determine relationships between variables.

The statistics used for data analysis are as follows:

Part 1 Demographic data, statistical tool used will be frequency distribution and percentage.

Part 2 Perception of the importance factors of cold chain management in terms of temperature monitoring, transportation time, cold storage facilities, packaging materials, logistics coordination, compliance with industry regulations, and professional training, the statistical tool used is mean and standard deviation.

Part 3 The different key factors of demographic data were affected by all cold chain management factors in the Samut Prakan province, the data using along with inferential statistics through One-Way Analysis of Variance (One-Way ANOVA).

CHAPTER 4

RESEARCH RESULTS

The research title of the important factors in cold chain management in Samut Prakan Province. The research results are presented in 3 parts as follows:

4.1 Demographic Data Analysis

4.2 Variables Data Analysis

4.3 Hypothesis Testing

4.1 Demographic Data Analysis

Demographic data includes gender, age, highest level of education, number of employees, type of business, and position in the company. Details are as follows:

Table 4.1 Results of Demographic Data Analysis (n=225)

	Variables	Frequency	Percentage
Gender			
	Male	147	65.3
	Female	68	30.2
	Third gender	10	4.4
	Total	225	100
Age			
	Less than 30 years	26	11.6
	30-40 years	61	27.1
	41-50 years	45	20
	Over 50 years	93	41.3
	Total	225	100
Highest level of education			
	High school	37	16.4
	Undergraduate	116	51.6

Table 4.1 Results of Demographic Data Analysis (n=225) (Cont.)

	Variables	Frequency	Percentage
	Bachelor's degree	55	24.4
	Master's degree or upper	17	7.6
	Total	225	100
Number of employees in the company			
	Less than 20 staffs	24	10.7
	20-50 staffs	72	32
	51-100 staffs	70	31.1
	101-200 staffs	14	6.2
	More than 200 staffs	45	20
	Total	225	100
Type of business			
	Cold storages	215	95.6
	Logistics service provider	6	2.7
	Buyer	4	1.8
	Total	225	100
Position in the company			
	Owner	6	2.7
	Director	6	2.7
	Manager / Assistant Manager	62	27.6
	Senior Supervisor / Supervisor	151	67.1
	Total	225	100

Analysis of the demographic data of the sample respondents using descriptive statistics from Table 4.1 found that most of the sample respondents were male, 147 people (65.3%), the rest were female, 68 people (30.2 %), and third-gender individuals, 10 people (4.4%).

Regarding age, it was found that most of the sample respondents were over 50 years old, 93 people (41.3%), followed by aged less than 30-40 years, 61 people (27.1%), followed by 41-50 years of age, 45 people (20%) and the least aged Less than 30 years, 26 people (11.6%).

Regarding the highest level of education, it was found that most of the samples that responded to the questionnaire had an undergraduate, 116 people (51.6%), followed by bachelor's degree, 55 people (24.4%), followed by a high school, 37 people (16.4%) and the least having the highest degree of master's degree or upper, 17 people (7.6%).

Regarding the employee numbers, among the questionnaire respondents, the largest proportion works in companies with 20-50 staff, with 72 people (32%). This is followed by companies with 51-100 staff, which account for 70 people (31.1%). Additionally, 45 people (20%) work in companies with more than 200 staff, while 24 people (10.7%) are from companies with less than 20 staff. The smallest number of people, 14 (6.2%), work in companies with 101-200 staff.

Regarding the type of business, it was found that most of the samples that responded to the questionnaire had cold storage, 215 people (95.6%), followed by logistics service provider, 6 people (2.7%), and the least having current role of buyer, 4 people (1.8%).

Regarding the position in the company, it was found that most of the samples that responded to the questionnaire had senior supervisor or supervisor, 151 people (67.1%), followed by manager or assistant manager, 62 people (27.6%), and the least having the position of the owners and directors, both at 6 people (2.7%).

Summarizing the results of the demographic analysis of the sample respondents revealed several key characteristics. Most of the group consists of a male, over 50 years old, with undergraduate education, employed in companies with 20-50 staff members, in cold storage businesses, and with senior supervisory or supervisory position.

4.2 Variables Data Analysis

In this part, the results of the analysis of descriptive statistics, namely the mean and the standard deviation of each variable consisted of 1) temperature monitoring, 2) transportation time, 3) cold storage facilities, 4) packaging materials, 5) logistics coordination, 6) compliance with industry regulations, and 7) professional training. The details are shown in table 4.2 – 4.8 as follows:

Table 4.2 Temperature Monitoring (n=225)

Variables	Mean	Standard deviation	Interpretation
Temperature Monitoring	4.61	0.54	Strongly agree
1. The continuous temperature monitoring and recording in cold chain management is the key to maintaining and protecting food product quality.	4.76	0.65	Strongly agree
2. The temperature monitoring system should have an automatic alarm function to take immediate action when there are temperature anomalies.	4.72	0.45	Strongly agree
3. The current temperature monitoring system can effectively prevent the impact of temperature fluctuations on food products.	4.24	0.63	Agree
4. The temperature monitoring system should have data storage and traceability functions to trace back and prevent issues when quality problems occur.	4.72	0.45	Strongly agree

The analysis results of temperature monitoring from Table 4.2 showed that the overall temperature monitoring was strongly agree with a mean of 4.61 and S.D. of 0.54. When considering the details of each question, it was found that the question "1. The continuous temperature monitoring and recording in cold chain management is the key to maintaining and protecting food product quality." had the highest mean of 4.76 and S.D. of 0.65, meaning that it was in strongly agree**.** Followed by the questions "2. The temperature monitoring system should have an automatic alarm function to take immediate action when there are temperature anomalies." and "4. The temperature monitoring system should have data storage and traceability functions to trace back and prevent issues when quality problems occur." Their mean was 4.72 and S.D. was 0.45, meaning that they were in strongly agree**.** The least was the question "3. The current temperature monitoring system can effectively prevent the impact of temperature fluctuations on food products." with a mean of 4.24 and S.D. of 0.63, meaning that it was in the agree.

Table 4.3 Transportation Time (n=225)

Variables	Mean	Standard deviation	Interpretation
Transportation Time	3.91	0.93	Agree
1. The shortening transportation time is a key factor in ensuring the freshness of food products.	3.95	0.86	Agree
2. The optimizing transport routes can significantly shorten transportation time.	4.54	0.69	Strongly agree
3. The using a combination of multiple transport methods can effectively shorten transportation time.	3.68	1.07	Agree
4. The real-time monitoring during transport can help optimize the transport process.	4.10	0.94	Agree
5. The shorten transportation time, the company should increase the number of transportation vehicles, even if this increases costs, it is worth it.	3.30	1.10	Neutral

The analysis results of transportation time from Table 4.3 showed that the overall transportation time was in the agree with a mean of 3.91 and S.D. of 0.93. When considering the details of each question, it was found that the question of "2. The optimizing transport routes can significantly shorten transportation time." had the highest mean of 4.54 and S.D. of 0.69, meaning that it was in the strongly agree. Followed by the question "4. The real-time monitoring during transport can help optimize the transport process." with a mean of 4.10 and S.D. of 0.94, meaning that it was in the agree. The next question was "1. The shortening transportation time is a key factor in ensuring the freshness of food products." with a mean of 3.95 and S.D. of 0.86, meaning that it was in the agree. Next was the question "3. The using a combination of multiple transport methods can effectively shorten transportation time." with a mean of 3.68 and S.D. of 1.07, meaning that it was in a agree. The least was the question "5. The shorten transportation time, the company should increase the number of transport vehicles, even if this increases costs, it is worth it." with a mean of 3.30 and S.D. of 1.10, meaning that it was in the neutral.

Table 4.4 Cold Storage Facilities (n=225)

Variables	Mean	Standard deviation	Interpretation
Cold Storage Facilities	4.42	0.56	Agree
1. The cold storage facilities play a crucial role in food cold chain management.	4.66	0.48	Strongly agree
2. The temperature control system in cold storage can effectively maintain a constant storage temperature.	4.50	0.50	Strongly agree
3. The humidity control system in cold storage is crucial for preserving food products.	4.12	0.58	Agree
4. The layout design of cold storage facilities can improve operational efficiency and product safety.	4.50	0.50	Strongly agree
5. The regular inspection and maintenance of cold storage facilities are necessary to ensure their long-term stable operation.	4.34	0.74	Agree

The analysis results of cold storage facilities from Table 4.4 showed that the overall cold storage facilities were in the agree with a mean of 4.42 and S.D. of 0.56. When considering the details of each question, it was found that the question of "1. The cold storage facilities play a crucial role in food cold chain management." had the highest mean of 4.66 and S.D. of 0.48, meaning that it was in the strongly agree. Followed by the questions "2. The temperature control system in cold storage can effectively maintain a constant storage temperature." and "4. The layout design of cold storage facilities can improve operational efficiency and product safety." Their mean was 4.50 and S.D. was 0.50, meaning that they were in strongly agree. The next question was "5. The regular inspection and maintenance of cold storage facilities are necessary to ensure their long-term stable operation." with a mean of 4.34 and S.D. of 0.74, meaning that it was in the agree. The least was the question "3. The humidity control system in cold storage is crucial for preserving food products." with a mean of 4.12 and S.D. of 0.58, meaning that it was in the agree.

Table 4.5 Packaging Materials (n=225)

Variables	Mean	Standard deviation	Interpretation
Packaging Materials	4.34	0.71	Agree
1. The packaging materials play an important protective role in the cold chain transportation of food products.	4.22	0.85	Agree
2. The thermal insulation performance of packaging materials has a significant impact on food product quality.	4.22	0.85	Agree
3. The choice of packaging materials directly affects the shelf life of food products during transport.	4.18	0.69	Agree
4. The satisfied with the performance of current packaging materials in preventing cross contamination of food products.	4.30	0.73	Agree
5. The choice of packaging materials needs to be customized according to different types of food products.	4.77	0.42	Strongly agree

The analysis results of packaging materials from Table 4.5 showed that the overall packaging materials was in the agree with a mean of 4.34 and S.D. of 0.71. When considering the details of each question, it was found that the question of "5. The choice of packaging materials needs to be customized according to different types of food products." had the highest mean of 4.77 and S.D. of 0.42, meaning that it was in strongly agree. Followed by the questions "4. The satisfied with the performance of current packaging materials in preventing cross contamination of food products." with a mean of 4.30 and S.D. of 0.73, meaning that it was in the agree. The next questions were "1. The packaging materials play an important protective role in the cold chain transportation of food products." and "2. The thermal insulation performance of packaging materials has a significant impact on food product quality." Their mean was 4.22 and S.D. was 0.85, meaning that they were in agree**.** The least was the question "3. The choice of packaging materials directly affects the shelf life of food products during transport." with a mean of 4.18 and S.D. of 0.69, meaning that it was in the agree.

Table 4.6 Logistics Coordination (n=225)

Variables	Mean	Standard deviation	Interpretation
Logistics Coordination	4.45	0.70	Agree
1. Logistics coordination is an important factor in ensuring product quality and quickly respond to the emergencies in cold chain management.	4.56	0.75	Strongly agree
2. The logistics coordination can optimize transport routes and improve overall economic efficiency to reduce unnecessary distances and time.	4.60	0.49	Strongly agree
3. The information-sharing mechanism within the logistics coordination system can improve collaboration efficiency between departments.	4.18	0.84	Agree

The analysis results of logistics coordination from Table 4.6 showed that the overall packaging materials was in the agree with a mean of 4.45 and S.D. of 0.70. When considering the details of each question, it was found that the question of "2. The logistics coordination can optimize transport routes and improve overall economic efficiency to reduce unnecessary distances and time." had the highest mean of 4.60 and S.D. of 0.49, meaning that it was in the strongly agree. Followed by the question "1. Logistics coordination is an important factor in ensuring product quality and quickly respond to the emergencies in cold chain management." with a mean of 4.56 and S.D. of 0.75, meaning that it was in the strongly agree. The least was the question "3. The information-sharing mechanism within the logistics coordination system can improve collaboration efficiency between departments." with a mean of 4.18 and S.D. of 0.84, meaning that it was in the agree.

Table 4.7 Compliance with Industry Regulations (n=225)

Variables	Mean	Standard deviation	Interpretation
Compliance with Industry Regulations	4.50	0.68	Strongly agree
1. The complying with industry regulations is a basic requirement for ensuring food product safety.	4.65	0.68	Strongly agree

Table 4.7 Compliance with Industry Regulations (n=225) (Cont.)

Variables	Mean	Standard deviation	Interpretation
2. Your company always complies with industry regulations and standards in cold chain management.	4.34	0.68	Agree
3. Your company's cold chain management policies fully reflect the requirements of industry regulations.	4.22	0.64	Agree
4. The regulatory compliance in your company can effectively prevent food safety incidents in the food industry.	4.50	0.70	Strongly agree
5. Your company strictly requires suppliers to comply with industry regulations when cooperating.	4.64	0.69	Strongly agree
6. Your company can be paid some cost for complying with industry regulations.	4.65	0.68	Strongly agree

The analysis results of compliance with industry regulations from Table 4.7 showed that the overall packaging materials were in strongly agree with a mean of 4.50 and S.D. of 0.68. When considering the details of each question, they found that the questions "1. The complying with industry regulations is a basic requirement for ensuring food product safety." and "6. Your company can be paid some cost for complying with industry regulations." Their highest mean was 4.65 and S.D. was 0.68, meaning that they strongly agree**.** Followed by the question "5. Your company strictly requires suppliers to comply with industry regulations when cooperating." with a mean of 4.64 and S.D. of 0.69, meaning that it was in the strongly agree. The next question was "4. The regulatory compliance in your company can effectively prevent food safety incidents in the food industry." with a mean of 4.50 and S.D. of 0.70, meaning that it was in the strongly agree. Next was the question "2. Your company always complies with industry regulations and standards in cold chain management." with a mean of 4.34 and S.D. of 0.68, meaning that it was in agreement. The least was the question "3. Your company's cold chain management policies fully reflect the requirements of industry regulations." with a mean of 4.22 and S.D. of 0.64, meaning that it was in the agree.

Table 4.8 Professional Training (n=225)

Variables	Mean	Standard deviation	Interpretation
Professional Training	4.26	0.80	Agree
1. The regular professional training for employees related to cold chain management is necessary.	4.18	0.84	Agree
2. After participating in professional training, employees' understanding and execution ability in cold chain management processes have significantly improved.	4.06	0.79	Agree
3. The training should cover the latest cold chain management techniques and equipment usage.	4.38	0.69	Agree
4. Evaluating and providing some refreshment training time by time to employees after training is necessary to ensure training effectiveness.	4.49	0.70	Agree
5. The training should include how to respond to emergencies and crises in cold chain management.	4.40	0.75	Agree
6. Your company can be paid some cost of training to improve employee ability.	4.06	1.05	Agree

The analysis results of professional training from Table 4.8 showed that the overall packaging materials were in agree with a mean of 4.26 and S.D. of 0.80. When considering the details of each question, it was found that the question of "4. Evaluating and providing some refreshment training time by time to employees after training is necessary to ensure training effectiveness." had the highest mean of 4.49 and S.D. of 0.70, meaning that it was in the agree. Followed by the question "5. The training should include how to respond to emergencies and crises in cold chain management." with a mean of 4.40 and S.D. of 0.75, meaning that it was in the agree. The next question was "3. The training should cover the latest cold chain management techniques and equipment usage." with a mean of 4.38 and S.D. of 0.69, meaning that it was in the agree. Next was the question "1. The regular professional training for employees related to cold chain management is necessary." with a mean of 4.18 and S.D. of 0.84, meaning that it was in a agree. The next question was "2. After participating in professional training, employees' understanding and execution ability in cold chain management

processes have significantly improved." with a mean of 4.06 and S.D. of 0.79, meaning that it was in the agree. The least was the question "6. Your company can be paid some cost of training to improve employee ability." with a mean of 4.06 and S.D. of 1.15, meaning that it was in the agree.

Summarizing the importance factor of cold chain management in Samut Prakan Province can show as table 4.9 as below:

Table 4.9 Results of Data Analysis on Variables (n=225)

Variables	Mean	Standard deviation	Interpretation
1. Temperature Monitoring	4.61	0.54	Strongly agree
2. Transportation Time	3.91	0.93	Agree
3. Cold Storage Facilities	4.42	0.56	Agree
4. Packaging Materials	4.34	0.71	Agree
5. Logistics Coordination	4.45	0.70	Agree
6. Compliance with Industry Regulations	4.50	0.68	Strongly agree
7. Professional Training	4.26	0.80	Agree

The analysis results of variables from Table 4.9 show that the importance of cold chain management factors was Strongly agree consensus on Temperature Monitoring (Mean = 4.61, S.D. = 0.54), and Compliance with Industry Regulations (Mean = 4.50, S.D. = 0.68). Agree consensus on Logistics Coordination (Mean = 4.45, S.D. = 0.70), Cold Storage Facilities (Mean = 4.42, S.D. = 0.56), Packaging Materials (Mean = 4.34, S.D. = 0.71), Professional Training (Mean = 4.26, S.D. = 0.80) and Transportation Time (Mean = 3.91, S.D. = 0.93).

Summarizing the importance factor of cold chain management in Samut Prakan Province were Temperature Monitoring and Compliance with Industry Regulations (Mean = 4.61, S.D. = 0.54 and Mean = 4.50, S.D. = 0.68).

4.3 Hypothesis Testing

The hypothesis testing using multivariate data analysis techniques for the analysis is as follows:

4.3.1 Normality test

Testing for data normality can be measured by the Skewness (SK: symmetrical distribution) and Kurtosis (KU: height of distribution) statistics. Nichelatti et al. (2014) stated that negative and positive values will show the direction of the data. The range of values of -3.0 to +3.0 will show the normal data distribution.

Table 4.10 Shows the Distribution Values of Data Used in the Study

Variables	Mean	Median	Mode	S.D.	Variance	SK	KU
Factor of Cold Chain Management							
Temperature Monitoring	4.50	4.00	4.00	0.50	0.25	0.01	-2.02
Transportation Time	3.95	4.00	3.00	0.86	0.74	0.10	-1.64
Cold Storage Facilities	4.50	4.00	4.00	0.50	0.25	0.01	-2.02
Packaging Materials	4.34	4.00	5.00	0.74	0.55	-0.63	-0.92
Logistics Coordination	4.44	5.00	5.00	0.76	0.57	-0.94	-0.61
Compliance with Industry Regulations	4.65	5.00	5.00	0.68	0.47	-1.71	1.32
Professional Training	4.34	4.00	5.00	0.68	0.47	-0.54	-0.77

From Table 4.10 the results of testing the distribution of data on factors of cold chain management, totaling 7 variables, found that the distribution of data on all 7 variables was normally distributed because the distribution value was symmetrical (Skewness) in the range of -3.0 to +3.0 and the height of the distribution (Kurtosis) in the range of -3.0 to +3.0.

4.3.2 Hypothesis test for variables

Hypothesis (1) Gender differences affect the factors of cold chain management at the significance level of 0.05. In this hypothesis analysis, the researcher analyzed the meaning of the independent variable which is a 2-choice group data. The dependent variable is quantitative data (Independent Sample F-test).

H_0: Gender differences affect the factors of cold chain management not differently.

H_1: Gender differences affect the factors of cold chain management differently.

Table 4.11 Results of the Comparison of Gender on Factors of Cold Chain Management

Factors of Cold Chain Management	Gender	N	$\bar{X}$	S.D.	F	Sig (2-tailed)
Temperature Monitoring	Male	147	4.49	0.497	5.441	0.005*
	Female	68	4.66	0.477		
	Other	10	4.40	0.516		
Transportation Time	Male	147	3.78	0.757	11.031	0.000**
	Female	68	4.34	0.940		
	Other	10	3.80	0.919		
Cold Storage Facilities	Male	147	4.42	0.497	5.441	0.005*
	Female	68	4.66	0.477		
	Other	10	4.40	0.516		
Packaging Materials	Male	147	4.20	0.785	10.239	0.000**
	Female	68	4.66	0.477		
	Other	10	4.10	0.877		
Logistics Coordination	Male	147	4.35	0.826	4.971	0.008*
	Female	68	4.67	0.417		
	Other	10	4.20	0.919		
Compliance with Industry Regulations	Male	147	4.78	0.490	11.438	0.000**
	Female	68	4.34	0.940		
	Other	10	4.90	0.316		
Professional Training	Male	147	4.33	0.538	0.301	0.000**
	Female	68	4.34	0.940		
	Other	10	4.50	0.527		

Note ** Statistically significant at 0.01 level

From Table 4.11 the results of the comparative analysis of Factors of Cold Chain Management of male, female, and other gender using the Independent Sample F-test at the significance level of 0.05 found that:

The results show that different departments have different opinions on Factors of Cold Chain Management of Gender in terms of Temperature Monitoring with a Sig. (2-tailed) value of 0.005, Transportation Time with a Sig. (2-tailed) value of 0.001, Cold Storage Facilities with a Sig. (2-tailed) value of 0.005, Packaging Materials with a Sig. (2-tailed) value of 0.001, Logistics Coordination with a Sig. (2-tailed) value of 0.008, Compliance with Industry Regulations with a Sig. (2-tailed) value of 0.001, and

Professional Training with a Sig. (2-tailed) value of 0.001, which means rejecting the primary hypothesis (H_0) and accepting the secondary hypothesis (H_1). Therefore, it can be concluded that different departments have different opinions on Factors of Cold Chain Management of Gender in terms of Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Materials, Logistics Coordination, Compliance with Industry Regulations and Professional Training with statistical significance at the 0.01 level.

Hypothesis (2) Age differences affect the factors of cold chain management at the significance level of 0.05. In this hypothesis analysis, the researcher analyzed the meaning of the independent variable which is a 2-choice group data. The dependent variable is quantitative data (Independent Sample F-test).

H_0: Age differences affect the factors of cold chain management not differently.

H_1: Age differences affect the factors of cold chain management differently.

Table 4.12 Results of the Comparison of Age on Factors of Cold Chain Management

Factors of Cold Chain Management	Age	N	$\bar{X}$	S.D.	F	Sig (2-tailed)
Temperature Monitoring	Less than 30 years	26	5.00	0.000	16.779	0.000**
	30-40 years	61	4.43	0.499		
	41-50 years	45	4.22	0.420		
	Over 50 years	93	4.54	0.501		
Transportation Time	Less than 30 years	26	5.00	0.000	26.059	0.000**
	30-40 years	61	3.84	0.986		
	41-50 years	45	3.40	0.720		
	Over 50 years	93	3.99	0.667		
Cold Storage Facilities	Less than 30 years	26	5.00	0.000	16.779	0.000**
	30-40 years	61	4.43	0.499		
	41-50 years	45	4.22	0.420		
	Over 50 years	93	4.54	0.501		
Packaging Materials	Less than 30 years	26	5.00	0.000	23.601	0.000**
	30-40 years	61	3.87	0.991		
	41-50 years	45	4.18	0.490		
	Over 50 years	90	4.54	0.501		

Table 4.12 Results of the Comparison of Age on Factors of Cold Chain Management (Cont.)

Factors of Cold Chain Management	Age	N	$\bar{X}$	S.D.	F	Sig (2-tailed)
Logistics Coordination	Less than 30 years	26	5.00	0.000	34.357	0.000**
	30-40 years	61	3.87	0.991		
	41-50 years	45	4.22	0.517		
	Over 50 years	93	4.77	0.420		
Compliance with Industry Regulations	Less than 30 years	26	5.00	0.000	61.730	0.000**
	30-40 years	61	5.00	0.000		
	41-50 years	45	3.76	0.957		
	Over 50 years	93	4.76	0.427		
Professional Training	Less than 30 years	26	5.00	0.000	38.662	0.000**
	30-40 years	61	4.43	0.499		
	41-50 years	45	3.62	0.834		
	Over 50 years	93	4.44	0.499		

Note ** Statistically significant at 0.01 level

From Table 4.12 the results of the comparative analysis of Factors of Cold Chain Management of Age using the Independent Sample F-test at the significance level of 0.05 found that:

The results show that different departments have different opinions on Factors of Cold Chain Management of Age in terms of Temperature Monitoring with a Sig. (2-tailed) value of 0. 0.001, Transportation Time with a Sig. (2-tailed) value of 0. 0.001, Cold Storage Facilities with a Sig. (2-tailed) value of 0. 0.001, Packaging Materials with a Sig. (2-tailed) value of 0.001, Logistics Coordination with a Sig. (2-tailed) value of 0.001, Compliance with Industry Regulations with a Sig. (2-tailed) value of 0.001, and Professional Training with a Sig. (2-tailed) value of 0.001, which means rejecting the primary hypothesis (H_0) and accepting the secondary hypothesis (H_1). Therefore, it can be concluded that different departments have different opinions on Factors of Cold Chain Management of Gender in terms of Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Materials, Logistics Coordination, Compliance with Industry Regulations, and Professional Training with statistical significance at the 0.01 level.

Hypothesis (3) Education differences affect the factors of cold chain management at the significance level of 0.05 In this hypothesis analysis, the researcher analyzed the meaning of the independent variable which is a 2-choice group data. The dependent variable is a quantitative data (Independent Sample F-test).

H_0: Education differences affect the factors of cold chain management not differently.

H_1: Education differences affect the factors of cold chain management differently.

Table 4.13 Results of the Comparison of Education on Factors of Cold Chain Management

Factors of Cold Chain Management	Education	N	$\bar{X}$	S.D.	F	Sig (2-tailed)
Temperature Monitoring	High school	37	4.27	0.450	6.867	0.000**
	Undergraduate	116	4.62	0.487		
	Bachelor's degree	55	4.36	0.485		
	Master's degree or upper	17	4.59	0.507		
Transportation Time	High school	37	3.54	0.767	5.000	0.002*
	Undergraduate	116	4.13	0.840		
	Bachelor's degree	55	3.85	0.870		
	Master's degree or upper	17	3.88	0.857		
Cold Storage Facilities	High school	37	4.27	0.450	6.867	0.000**
	Undergraduate	116	4.62	0.487		
	Bachelor's degree	55	4.36	0.485		
	Master's degree or upper	17	4.59	0.507		
Packaging Materials	High school	37	4.19	0.569	5.664	0.001*
	Undergraduate	116	4.48	0.728		
	Bachelor's degree	55	4.05	0.826		
	Master's degree or upper	17	4.59	0.507		
Logistics Coordination	High school	37	4.30	0.618	3.214	0.004
	Undergraduate	116	4.57	0.725		
	Bachelor's degree	55	4.24	0.902		
	Master's degree or upper	17	4.59	.507		
Compliance with Industry Regulations	High school	37	3.86	0.948	27.089	0.000**
	Undergraduate	116	4.79	0.536		
	Bachelor's degree	55	4.78	0.459		
	Master's degree or upper	17	5.00	0.000		
Professional Training	High school	37	3.68	0.784	18.042	0.000**
	Undergraduate	116	4.46	0.610		
	Bachelor's degree	55	4.42	0.534		
	Master's degree or upper	17	4.76	0.450		

Note ** Statistically significant at 0.01 level

From Table 4.13 the results of the comparative analysis of Factors of Cold Chain Management of Education using the Independent Sample F-test at the significance level of 0.05 found that:

The results show that different departments have different opinions on Factors of Cold Chain Management of Education in terms of Temperature Monitoring with a Sig. (2-tailed) value of 0.001, Transportation Time with a Sig. (2-tailed) value of 0.002, Cold Storage Facilities with a Sig. (2-tailed) value of 0.001, Packaging Materials with a Sig. (2-tailed) value of 0.001, Logistics Coordination with a Sig. (2-tailed) value of 0.004, Compliance with Industry Regulations with a Sig. (2-tailed) value of 0.001, and Professional Training with a Sig. (2-tailed) value of 0.001, which means rejecting the primary hypothesis (H_0) and accepting the secondary hypothesis (H_1). Therefore, it can be concluded that different departments have different opinions on Factors of Cold Chain Management of Education in terms of Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Materials, Logistics Coordination, Compliance with Industry Regulations, and Professional Training with statistical significance at the 0.01 level, and with statistical significance at the 0.05 level.

Hypothesis (4) Employees' differences affect the factors of cold chain management at the significance level of 0.05. In this hypothesis analysis, the researcher analyzed the meaning of the independent variable which is a 2-choice group data. The dependent variable is quantitative data (Independent Sample F-test).

H_0: Employees' differences affect the factors of cold chain management not differently.

H_1: Employees' differences affect the factors of cold chain management differently.

Table 4.14 Results of the Comparison of Employees on Factors of Cold Chain Management

Factors of Cold Chain Management	Employees	N	$\bar{X}$	S.D.	F	Sig (2-tailed)
Temperature Monitoring	Less than 20 staffs	24	4.79	0.415	2.910	0.052
	20-50 staffs	72	4.43	0.499		
	51-100 staffs	70	4.44	0.500		
	101-200 staffs	14	4.43	0.514		
	More than 200 staffs	45	4.56	0.503		
Transportation Time	Less than 20 staffs	24	4.29	0.806	2.173	0.073
	20-50 staffs	72	3.78	0.809		
	51-100 staffs	70	3.90	0.871		
	101-200 staffs	14	3.93	0.917		
	More than 200 staffs	45	4.11	0.885		
Cold Storage Facilities	Less than 20 staffs	24	4.79	0.415	2.910	0.052
	20-50 staffs	72	4.43	0.499		
	51-100 staffs	70	4.44	0.500		
	101-200 staffs	14	4.43	0.514		
	More than 200 staffs	45	4.56	0.503		
Packaging Materials	Less than 20 staffs	24	4.63	0.770	1.751	0.140
	20-50 staffs	72	4.21	0.786		
	51-100 staffs	70	4.32	0.692		
	101-200 staffs	14	4.29	0.726		
	More than 200 staffs	45	4.44	0.693		
Logistics Coordination	Less than 20 staffs	24	4.63	0.770	1.085	0.365
	20-50 staffs	72	4.32	0.819		
	51-100 staffs	70	4.45	0.715		
	101-200 staffs	14	4.43	0.756		
	More than 200 staffs	45	4.56	0.693		
Compliance with Industry Regulations	Less than 20 staffs	24	4.92	0.408	1.069	0.373
	20-50 staffs	72	4.61	0.723		
	51-100 staffs	70	4.62	0.708		
	101-200 staffs	14	4.57	0.756		
	More than 200 staffs	45	4.67	0.674		

Table 4.14 Results of the Comparison of Employees on Factors of Cold Chain Management (Cont.)

Factors of Cold Chain Management	Employees	N	$\bar{X}$	S.D.	F	Sig (2-tailed)
Professional Training	Less than 20 staffs	24	4.46	0.588	1.309	0.238
	20-50 staffs	72	4.19	0.664		
	51-100 staffs	70	4.37	0.705		
	101-200 staffs	14	4.34	0.745		
	More than 200 staffs	45	4.44	0.693		

Note ** Statistically significant at 0.01 level

From Table 4.14 the results of the comparative analysis of Factors of Cold Chain Management of Employees using the Independent Sample F-test at the significance level of 0.05 found that:

The results show that the different Employees have no different opinions on Factors of Cold Chain Management of Employees in terms of Temperature Monitoring, with a Sig. (2-tailed) value of 0.052, Transportation Time, with a Sig. (2-tailed) value of 0.073, Cold Storage Facilities, with a Sig. (2-tailed) value of 0.052, Packaging Materials, with a Sig. (2-tailed) value of 0.140, Logistics Coordination, with a Sig. (2-tailed) value of 0.365, Compliance with Industry Regulations, with a Sig. (2-tailed) value of 0.373, and Professional Training, with a Sig. (2-tailed) value of 0.238, which means that the main hypothesis (H_0) cannot be rejected. Therefore, it can be concluded that different Employees have no different opinions on Factors of Cold Chain Management of Employees in terms of Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Materials, Logistics Coordination, Compliance with Industry Regulations, and Professional Training.

Hypothesis (5) Business type differences affect the factors of cold chain management at the significance level of 0.05 In this hypothesis analysis, the researcher analyzed the meaning of the independent variable which is a 2-choice group data. The dependent variable is a quantitative data (Independent Sample F-test).

H_0: Business type differences affect the factors of cold chain management not differently.

H_1: Business type differences affect the factors of cold chain management differently.

Table 4.15 Results of the Comparison of Business Type on Factors of Cold Chain Management

Factors of Cold Chain Management	Business Type	N	$\bar{x}$	S.D.	F	Sig (2-tailed)
Temperature Monitoring	Cold storages	215	4.50	0.501	0.000	1.000
	Logistics service provider	6	4.50	0.548		
	Buyer	4	4.50	0.578		
Transportation Time	Cold storages	215	3.95	0.866	0.566	0.568
	Logistics service provider	6	3.67	0.817		
	Buyer	4	4.25	0.500		
Cold Storage Facilities	Cold storages	215	4.50	0.501	0.000	1.000
	Logistics service provider	6	4.50	0.548		
	Buyer	4	4.50	0.577		
Packaging Materials	Cold storages	215	4.34	0.742	0.097	0.907
	Logistics service provider	6	4.33	0.817		
	Buyer	4	4.50	0.577		
Logistics Coordination	Cold storages	215	4.44	0.758	1.161	0.315
	Logistics service provider	6	4.33	0.817		
	Buyer	4	5.00	0.000		
Compliance with Industry Regulations	Cold storages	215	4.66	0.685	0.102	0.903
	Logistics service provider	6	4.67	0.817		
	Buyer	4	4.50	0.577		

Table 4.15 Results of the Comparison of Business Type on Factors of Cold Chain Management (Cont.)

Factors of Cold Chain Management	Business Type	N	$\bar{X}$	S.D.	F	Sig (2-tailed)
Professional Training	Cold storages	215	4.34	0.685	0.023	0.795
	Logistics service provider	6	4.17	0.753		
	Buyer	4	4.25	0.500		

Note ** Statistically significant at 0.01 level

From Table 4.15 the results of the comparative analysis of Factors of Cold Chain Management of Business type using the Independent Sample F-test at the significance level of 0.05 found that:

The results show that the different Business type have no different opinions on Factors of Cold Chain Management of Business in terms of Temperature Monitoring with a Sig. (2-tailed) value of 1.000, Transportation Time with a Sig. (2-tailed) value of 0.568, Cold Storage Facilities with a Sig. (2-tailed) value of 1.000, Packaging Materials, with a Sig. (2-tailed) value of 0.907, Logistics Coordination, with a Sig. (2-tailed) value of 0.315, Compliance with Industry Regulations, with a Sig. (2-tailed) value of 0.903, and Professional Training, with a Sig. (2-tailed) value of 0.907, which means that the main hypothesis (H_0) cannot be rejected. Therefore, it can be concluded that different Business have no different opinions on Factors of Cold Chain Management of Business in terms of Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Materials, Logistics Coordination, Compliance with Industry Regulations, and Professional Training.

Hypothesis (6) Position differences affect the factors of cold chain management at the significance level of 0.05 In this hypothesis analysis, the researcher analyzed the meaning of the independent variable which is a 2-choice group data. The dependent variable is quantitative data (Independent Sample F-test).

H_0: Position differences affect the factors of cold chain management not differently.

H_1: Position differences affect the factors of cold chain management differently.

Table 4.16 Results of the Comparison of Position on Factors of Cold Chain Management

Factors of Cold Chain Management	Position	N	$\bar{X}$	S.D.	F	Sig (2-tailed)
Temperature Monitoring	Owner	6	4.50	0.548	1.128	0.338
	Director	6	4.67	0.516		
	Manager/Assistant Manager	62	4.58	0.497		
	Senior Supervisor/Supervisor	151	4.46	0.500		
Transportation Time	Owner	6	4.00	1.095	1.150	0.330
	Director	6	4.00	0.894		
	Manager/Assistant Manager	62	4.11	0.832		
	Senior Supervisor/Supervisor	151	3.87	0.859		
Cold Storage Facilities	Owner	6	4.50	0.548	1.128	0.338
	Director	6	4.67	0.516		
	Manager/Assistant Manager	62	4.58	0.498		
	Senior Supervisor/Supervisor	151	4.46	0.500		
Packaging Materials	Owner	6	4.50	0.548	2.850	0.038
	Director	6	4.50	0.837		
	Manager/Assistant Manager	62	4.55	0.564		
	Senior Supervisor/Supervisor	151	4.24	0.790		
Logistics Coordination	Owner	6	4.50	0.548	2.952	0.034
	Director	6	4.50	0.837		
	Manager/Assistant Manager	62	4.68	0.536		
	Senior Supervisor/Supervisor	151	4.34	0.817		
Compliance with Industry Regulations	Owner	6	5.00	0.000	1.610	0.188
	Director	6	4.67	0.817		
	Manager/Assistant Manager	62	4.77	0.525		
	Senior Supervisor/Supervisor	151	4.5894	0.74181		
Professional Training	Owner	6	5.00	0.000	6.043	0.061
	Director	6	4.17	0.753		
	Manager/Assistant Manager	62	4.57	0.590		
	Senior Supervisor/Supervisor	151	4.23	0.695		

Note ** Statistically significant at 0.01 level

From Table 4.16 the results of the comparative analysis of Factors of Cold Chain Management of Position using the Independent Sample F-test at the significance level of 0.05 found that:

The results show that the different Business have no different opinions on Factors of Cold Chain Management of Position in terms of Temperature Monitoring with a Sig. (2-tailed) value of 0.338, Transportation Time with a Sig. (2-tailed) value of 0.330, Cold Storage Facilities with a Sig. (2-tailed) value of 0.338, Packaging Materials, with a Sig. (2-tailed) value of 0.038, Logistics Coordination, with a Sig. (2-tailed) value of 0.034, and Compliance with Industry Regulations, with a Sig. (2-tailed) value of 0.188, and Professional Training with a Sig. (2-tailed) value of 0.061.which means that the main hypothesis (H_0) cannot be rejected. Therefore, it can be concluded that different Business have no different opinions on Factors of Cold Chain Management of Position in terms of Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Materials, Logistics Coordination, and Compliance with Industry Regulations and Professional Training.

Summarizing the results of the comparative analysis of differences in demographic data towards factors of Cold Chain Management, using the One-Way Analysis of Variance (One-Way ANOVA) or F-test, it was found that different of Gender, Age, and Education were related to factors of Cold Chain Management in terms of Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Materials, Logistics Coordination, Compliance with Industry Regulations, and Professional Training, with difference in statistical significance at the 0.05 level.

CHAPTER 5

CONCLUSION, DISCUSSIONS AND RECOMMENDATIONS

The last chapter of this thesis consists of three basic sections including the 1) conclusion of study, 2) discussions of findings, and 3) recommendations for further research.

5.1 Conclusions of Study

This study explores seven key factors in cold chain management within the food industry in Samut Prakan Province, Thailand: temperature monitoring, transport time, cold storage facilities, packaging materials, logistics coordination, compliance with industry regulations, and professional training. Data was collected through online questionnaires distributed via Google Forms and on-site surveys from September to October 2024. The sample group used 225 people, who work or have experience or relation to cold chain business in Samut Prakan province found that,

1) The demographic analysis, most of the group consists of a male, over 50 years old, with undergraduate education, employed in companies with 20-50 staff members, in cold storage businesses, and with senior supervisory or supervisory positions.

2) The analysis of important factors in cold chain management in Samut Prakan Province indicates that Temperature Monitoring and Compliance with Industry Regulations were the importance factors of cold chain management in Samut Prakan Province with mean scores of 4.61 (S.D. = 0.54) and 4.50 (S.D. = 0.68), respectively.

3) The comparative analysis using One-Way ANOVA or F-test revealed that the different key factors of demographic data in term of gender, age, and education were affected to all cold chain management factors in the Samut Prakan province, include Temperature Monitoring, Transportation Time, Cold Storage

Facilities, Packaging Materials, Logistics Coordination, Compliance with Industry Regulations, and Professional Training, with statistically significant differences observed at the 0.05 level.

5.2 Discussions of Findings

This study provides an understanding of the key factors in cold chain management within the food industry in Samut Prakan Province, Thailand.

5.2.1 Demographic Data of the Respondents

The demographic analysis of the sample group reveals that respondents are predominantly male, over 50 years old, and hold undergraduate degrees. They mainly work in companies with 20-50 staff members, within the cold storage industry, and occupy senior supervisory or supervisory positions. This demographic profile provides essential context for understanding respondent perspectives on cold chain management, as individual characteristics can heavily influence these perceptions, according to previous research studies by Gottfredson and Daiger (1977), found that, demonstrating increased gender diversity across occupations while emphasizing the persistence of gender segmentation in specific fields, which is consistent with Humpert and Pfeifer (2013), who noted that factors like age and job position shape career satisfaction and job perceptions, while Naafs (2013) highlighted the role of educational background and cultural expectations in shaping professional outlooks, and also consistent with Corleto and Esparza (2021) found the significance of gender inequalities in engineering and technical education, where masculine work cultures and gender norms hinder women's participation and career advancement.

Therefore, these demographic factors contribute to prioritizing certain cold chain elements among different respondent groups, underscoring the significance of personal backgrounds in shaping views on cold chain management practices.

5.2.2 The Important Factors in Cold Chain Management

The analysis of important factors in cold chain management in Samut Prakan Province reveals that

1) The temperature monitoring was the first important factors of cold chain management in Samut Prakan Province with a mean of 4.61 and standard deviation of 0.54, according to previous research studies by Yan and Lee (2009) demonstrated the importance of RFID-based systems integrated with GPS and temperature sensors, which enable real-time tracking and adjustment of temperature conditions during transportation. This aligns with the need for precise temperature control to mitigate risks. Similarly, Mercier et al. (2017) highlight temperature control as essential for preserving product quality and preventing spoilage across the supply chain, while Nastasijevic et al. (2017) underscored the role of temperature monitoring in preventing microbial growth and spoilage, particularly for perishable products like meat, where even minor temperature fluctuations can compromise safety and freshness. Further supporting these findings, which is consistent with Chaitangjit and Ongkunaruk (2019) emphasize the role of transportation and cold storage infrastructure in maintaining temperature stability, reflecting respondent concerns, and consistent with Ye et al. (2022) also underscore the significance of IoT-enabled temperature monitoring systems in modern cold chains, noting that real-time monitoring allows prompt corrective actions to ensure product safety.

2) The compliance with industry regulations was the second important factors of cold chain management in Samut Prakan Province with a mean of 4.50 and standard deviation of 0.68, according with previous research, Peng (2013) found that the importance of regulatory awareness among employees, particularly in regions with outdated systems, emphasizing that consistent training ensures adherence to standards even under less advanced conditions, which is consistent with An et al. (2015) found that the critical role of regulatory frameworks in maintaining food quality from production to consumption, stressing the necessity of consistent application of standards, including temperature control and handling protocols, and consistent with Yang et al. (2022) and Wang et al. (2023) found the demonstrated the growing

significance of international standards like HACCP in identifying hazards and implementing preventive measures within cold chain processes. These studies collectively affirm that strict adherence to regulations is vital for maintaining the integrity, safety, and quality of cold chain operations, supporting the conclusion that compliance is a priority for respondents.

In summary, this academic perspective underscores the criticality of stringent temperature control and regulatory compliance as foundational elements of effective cold chain management and emphasizes their interconnected roles in optimizing cold chain management for perishable products.

5.2.3 The Different Key Factors of Demographic Data were Affected to the Important Factors of Cold Chain Management

The different key factors of demographic data in terms of gender, age, and education were affected by all cold chain management factors in the Samut Prakan province, with a statistical significance of 0.05, including Temperature Monitoring, Transportation Time, Cold Storage Facilities, Packaging Materials, Logistics Coordination, Compliance with Industry Regulations, and Professional Training. According to previous research studies by Humpert and Pfeifer (2013) found demonstrate how demographic factors like age and gender influence employment patterns and wage levels, underscoring the relevance of these variables to workforce dynamics in cold chain operations. Similarly, Naafs (2013) highlights how education shapes career trajectories, particularly in contexts with gender and cultural expectations, reinforcing the role of demographic characteristics in professional development, which is consistent with the connection between demographics and professional performance is further emphasized in Corleto and Esparza (2021) research, which examines gender disparities in technical education and workforce participation, a critical factor in industries reliant on specialized training like cold chain management, while The findings align with the importance of structured training programs, as highlighted by Singh et al. (2018) which prepare employees for technological advancements and

regulatory compliance. Higher education levels and managerial roles correlate with a greater emphasis on logistics coordination and regulatory compliance, aligning with An et al. (2015), who found that experienced or senior personnel tend to prioritize compliance to mitigate operational risks due to their greater knowledge of industry regulations. Moreover, the integration of IoT systems in cold chain logistics, as discussed by Tsang et al. (2017), requires workforce proficiency, which varies across demographic groups.

Therefore, demographic data is not only essential for understanding the dynamics of cold chain management but also critical for tailoring strategies to enhance efficiency and compliance across its components. These studies collectively validate the significant relationship between demographic factors and key aspects of cold chain management.

5.3 Recommendations for Future Research

Based on the insights from this study, future research could explore additional variables that may impact cold chain management in Thailand. For instance, examining the role of emerging technologies such as blockchain or advanced data analytics could provide valuable information on further strengthening cold chain operations. Expanding the scope to include other industries heavily reliant on cold chain logistics, such as the pharmaceutical industry, would offer a comparative perspective and broaden the understanding of cold chain challenges across different sectors.

Methodologically, future research could benefit from incorporating qualitative research methods, such as interviews or focus groups, to gain more nuanced perspectives and experiences from cold chain stakeholders. Additionally, exploring cold chain management across multiple provinces or regions could enhance the generalizability of findings and provide a more comprehensive view of the cold chain landscape in Thailand.

REFERENCES

An, J., Wang, L., & Lv, X. (2015). Research on Agri-Food Cold Chain Logistics Management System: Connotation, Structure and Operational Mechanism. *Journal of Service Science and Management, 8*(6), 894-902. https://doi.org/10.4236/jssm.2015.86090

Asadi, G., & Hosseini, E. (2014). Cold supply chain management in processing of food and agricultural products. *Scientific Papers. Series D. Animal Science, LVII*, 223-227. Retrieved from https://animalsciencejournal.usamv.ro/pdf/2014/art42.pdf

Aung, M. M., & Chang, Y. S. (2014). Temperature management for the quality assurance of a perishable food supply chain. *Food Control, 40*, 198-207. https://doi.org/10.1016/j.foodcont.2013.11.016

Aung, M. M., Liang, F. W., Chang, Y. S., Makatsoris, C., & Chang, J. (2011). RFID- and WSN-based intelligent cold chain management. *International Journal of Manufacturing Research, 6*(2), 91. https://doi.org/10.1504/IJMR.2011.040005

Chaitangjit, P., & Ongkunaruk, P. (2019). The Study of Cold Storage and Temperature Controlled Transportation: A Case Study of a Chain Restaurant in Thailand. *Pamukkale University Journal of Engineering Sciences, 25*(9), 1014-1019. https://doi.org/10.5505/pajes.2019.81231

Corleto, A. G. B., & Esparza, H. M. M. (2021). Género, ingeniería y educación técnica profesional. *Education Policy Analysis Archives, 29*(August-December). https://doi.org/10.14507/epaa.29.5170

Dasgupta, M. S., Routroy, S., Widell, K. N., Bhattacharya, S., Thakur, M. (2019). A Strategy for improved temperature control in the supply and processing stages of Surimi cold chain in India. In *Proceedings of the 25th IIR International Congress of Refrigeration* (pp. 3590-3597). http://dx.doi.org/10.18462/iir.icr.2019.0131

Department of Industry Work. (2024). *Industrial Factory Information*. Retrieved from https://www.diw.go.th/webdiw/search-factory/

REFERENCES (CONT.)

Du, D. (2021). Investigation of cold chain logistics of fresh agricultural products in Xi'an based on CSI analysis. In *2021 3rd International Academic Exchange Conference on Science and Technology Innovation (IAECST)* (pp. 1299-1303). https://doi.org/10.1109/IAECST54258.2021.9695893

Gonçalves, A. A., & Blaha, F. (2010). Cold chain in seafood industry. In *Refrigeration: Theory, Technology and Applications* (pp. 287-367). New York: Nova Science Publishers.

Gottfredson, G. D., & Daiger, D. C. (1977). Using a classification of occupations to describe age, sex, and time differences in employment patterns. *Journal of Vocational Behavior, 10*(2), 121-138. https://doi.org/10.1016/0001-8791(77)90049-5

Han, J. -W., Zuo, M., Zhu, W. -Y., Zuo, J. -H., Lü, E. -L., & Yang, X. -T. (2021). A comprehensive review of cold chain logistics for fresh agricultural products: Current status, challenges, and future trends. *Trends in Food Science & Technology, 109*, 536-551.

Humpert, S., & Pfeifer, C. (2013). Explaining age and gender differences in employment rates: A labor supply-side perspective. *Journal for Labour Market Research, 46*(1), 1-17. https://doi.org/10.1007/s12651-012-0108-8

Igilar, C. (2023). Analysis of Perishable Goods Transportation. *European Journal of Business and Innovation Research, 11*(7), 35-72. https://doi.org/10.37745/ejbir.2013/vol11n73572

Khan, S., Khan, M. I., & Haleem, A. (2018). Towards Effective Management of Cold Chain: A DEMATEL Approach. *IOP Conference Series: Materials Science and Engineering, 404*(1), 012019. doi:10.1088/1757-899X/404/1/012019

Lailossa, G. W. (2015). The new paradigm of cold chain management systems and it's logistics on Tuna fishery sector in Indonesia. *AACL Bioflux, 8*(3), 381-389.

REFERENCES (CONT.)

Meng, T., Wang, Y., Fu, L., Wang, Y., Zhang, N., Wang, Z., & Yang, Q. (2023). Comparison of the environmental impact of typical packaging systems for food cold chain express based on life cycle assessment. *Journal of Cleaner Production, 430*, 139756. https://doi.org/10.1016/j.jclepro.2023.139756

Mercier, S., Villeneuve, S., Mondor, M., & Uysal, I. (2017). Time–Temperature Management Along the Food Cold Chain: A Review of Recent Developments. *Comprehensive Reviews in Food Science and Food Safety, 16*(4), 647-667. https://doi.org/10.1111/1541-4337.12269

Mustafa, M. F. M. S., Navaranjan, N., & Demirovic, A. (2024). Food cold chain logistics and management: A review of current development and emerging trends. *Journal of Agriculture and Food Research, 18*, 101343. https://doi.org/10.1016/j.jafr.2024.101343

Naafs, S. (2013). Youth, gender, and the workplace: Shifting opportunities and aspirations in an indonesian industrial town. *The ANNALS of the American Academy of Political and Social Science, 646*(1), 233-250. https://doi.org/10.1177/0002716212469927

Nastasijević, I., Lakićević, B., & Petrović, Z. (2017). Cold chain management in meat storage, distribution and retail: A review. *IOP Conference Series: Earth and Environmental Science, 85*(1), 012022. https://doi.org/10.1088/1755-1315/85/1/012022

Nga, M. T. T. (2010). *Enhancing quality management of fresh fish supply chains through improved logistics and ensured traceability* (Doctoral dissertation, University of Iceland). Retrieved from https://www.matis.is/media/utgafa/krokur/Nga-Mai_PhD-dissertation-June2010.pdf

Nichelatti, M., Nordio, M., Maggiore, U., Postorino, M., Limido, A., & Napoli, A. D. (2014). La distribuzione normale - parte II: Un esempio pratico. *Giornale di Clinica Nefrologica e Dialisi, 26*(2), 196-198. https://doi.org/10.33393/gcnd.2014.888

REFERENCES (CONT.)

Peng, J. (2013). Research on Cold Chain Logistics of Subsidiary Agricultural Products in Chongqing Based on SWOT Analysis. *Advanced Materials Research, 671-674*, 3011-3015. https://doi.org/10.4028/www.scientific.net/AMR.671-674.3011

Prompatanapak, A., & Lopetcharat, K. (2020). Managing changes and risk in seafood supply chain: A case study from Thailand. *Aquaculture, 525*, 735318.

Robert, L. (2020). *What is demographics? Definition, usage, examples in advertising*. Retrieved from https://www.thoughtco.com/what-are-demographics-and-how-are-they-used-38513

Rodrigue, J. -P. (2014). *Reefers in North American Cold Chain Logistics: Evidence from Western Canadian Supply Chains*. Canada: The Van Horne Institute.

Shashi, Centobelli, P., Cerchione, R., & Ertz, M. (2020). Food cold chain management: What we know and what we deserve. *Supply Chain Management: An International Journal, 26*(1), 102-135. https://doi.org/10.1108/SCM-12-2019-0452

Shukla, I. (2021). Cold Chain Supply in Dairy Industry in India. *International Journal for Research in Applied Science and Engineering Technology, 9*(VII), 2108-2118. https://doi.org/10.22214/ijraset.2021.36671

Singh, R. K., Gunasekaran, A., & Kumar, P. (2018). Third party logistics (3PL) selection for cold chain management: A fuzzy AHP and fuzzy TOPSIS approach. *Annals of Operations Research, 267*(1), 531-553. https://doi.org/10.1007/s10479-017-2591-3

TechSci Research. (2024). *Thailand Cold Chain Logistics Market*. Retrieved from https://www.techsciresearch.com/report/thailand-cold-chain-logistics-market/14655.html

Tsang, Y., Choy, K., Wu, C., Ho, G., Lam, H., & Koo, P. (2017). An IoT-based cargo monitoring system for enhancing operational effectiveness under a cold chain environment. *International Journal of Engineering Business Management, 9*, 1-13. https://doi.org/10.1177/1847979017749063

REFERENCES (CONT.)

Tsironi, T., Giannoglou, M., Platakou, E., & Taoukis, P. (2016). Evaluation of Time Temperature Integrators for shelf-life monitoring of frozen seafood under real cold chain conditions. *Food Packaging and Shelf Life, 10*, 46-53. https://doi.org/10.1016/j.fpsl.2016.09.004

Turner, R. C., & Carlson, L. (2003). Indexes of Item-Objective Congruence for Multidimensional Items. *International Journal of Testing, 3*(2), 163-171. https://doi.org/10.1207/S15327574IJT0302_5

Villegas, F. (2024, November 1). Demographic data: What it is, how to get it & free examples [Web log message]. Retrieved from https://www.questionpro.com/blog/demographic-data/

Wang, Q., Zhao, Z., & Wang, Z. (2023). Data-Driven Analysis of Risk-Assessment Methods for Cold Food Chains. *Foods, 12*(8), 1677. https://doi.org/10.3390/foods12081677

Yamane, T. (1973). *Statistics: An introductory analysis*. New York: Harper and Row.

Yan, B., & Lee, D. (2009). Application of RFID in cold chain temperature monitoring system. In *2009 ISECS International Colloquium on Computing, Communication, Control, and Management* (pp. 258-261). https://doi.org/10.1109/CCCM.2009.5270408

Yan, Q. (2015). Research on Fresh Produce Food Cold Chain Logistics Tracking System Based on RFID. *Advance Journal of Food Science and Technology, 7*(3), 191-194. https://doi.org/10.19026/ajfst.7.1292

Yang, H., Li, N., Huang, Y., Mou, S., Wu, F., & Li, X. (2022). Traceability Analysis of Cold Chain Food under COVID-19 Based on Block Chain Technology. In *5th International Conference on Crowd Science and Engineering* (pp. 61-67). https://doi.org/10.1145/3503181.3503192

Ye, B., Chen, J., Fu, L., & Wang, Y. (2022). Application of nondestructive evaluation (NDE) technologies throughout cold chain logistics of seafood: Classification, innovations and research trends. *LWT, 158*, 113127. https://doi.org/10.1016/j.lwt.2022.113127

REFERENCES (CONT.)

Zou, Y., Xie, R., & Liu, G. (2013). Safety reliability optimal allocation of food cold chain. *Agricultural Sciences, 4*(9), 70-75. https://doi.org/10.4236/as.2013.49B012

Zuo, J., Feng, J., Gameiro, M. G., Tian, Y., Liang, J., Wang, Y., . . . He, Q. (2022). RFID-based sensing in smart packaging for food applications: A review. *Future Foods, 6*, 100198. https://doi.org/10.1016/j.fufo.2022.100198

APPENDICES

APPENDIX A

QUESTIONNAIRE

Questionnaire

Important Factors in Cold Chain Management in Samut Prakan Province

Dear Respected Respondent

Subject: Requesting assistance in answering the questionnaire

I am a master's degree student, faculty of science (management in logistics), at Rangsit University. I'm doing a thesis on the topic of important factors in cold chain management in Samut Prakan Province.

Data collection is a very important step in supporting this thesis. I would like to request your assistance in, which I would like to disturb your time to answer the questionnaire. This thesis would not have been possible without your help and support.

I certify that the information you answer to the questionnaire will be kept confidential. In addition, data analysis is done in an overview so that the results will not affect individual assessments.

With great respect

(Junbo Yang)
Master's degree student
Faculty of Science
Management in Logistics
Rangsit University

Part 1: General Information

Please fill in the space or write ✓ in the □ that matches you.

1. Gender

☐ Male ☐ Female ☐ Other

2. Age

☐ Less than 30 years ☐ 30-40 years ☐ 41-50 years

☐ Over 50 years

3. Highest level of education

☐ High school ☐ Undergraduate ☐ Bachelor's degree

☐ Master's degree or upper

4. Number of employees in the branch

☐ Less than 20 staffs ☐ 20-50 staffs ☐ 51-100 staffs

☐ 101-200 staffs ☐ More than 200 staffs

5. What is your current role (Type of business) in the food industry?

☐ Cold storages ☐ Logistics service provider

☐ Farmer or supplier ☐ Buyer

☐ Trader ☐ Other (please specify)

6. What is your position?

☐ Owner ☐ Director

Manager / Assistant Manager ☐ Senior Supervisor / Supervisor

Part 2: Temperature monitoring assessment questions

Instructions: Please mark ○ around the number that you find most appropriate.

Strongly Disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly Agree (5)	**Opinion Level**				
1. The continuous temperature monitoring and recording in cold chain management is the key to maintaining and protecting food product quality.	1	2	3	4	5
2. The temperature monitoring system should have an automatic alarm function to take immediate action when there are temperature anomalies.	1	2	3	4	5
3. The current temperature monitoring system can effectively prevent the impact of temperature fluctuations on food products.	1	2	3	4	5
4. The temperature monitoring system should have data storage and traceability functions to trace back and prevent issues when quality problems occur.	1	2	3	4	5

Part 3: Transport time assessment questions

Instructions: Please mark ○ around the number that you find most appropriate.

Strongly Disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly Agree (5)	**Opinion Level**				
1. The shortening transport time is a key factor in ensuring the freshness of food products.	1	2	3	4	5
2. The optimizing transport routes can significantly shorten transport time.	1	2	3	4	5
3. The using a combination of multiple transport methods can effectively shorten transport time.	1	2	3	4	5
4. The real-time monitoring during transport can help optimize the transport process.	1	2	3	4	5
5. The shorten transport time, the company should increase the number of transport vehicles, even if this increases costs, it is worth it.	1	2	3	4	5

Part 4: Cold storage facilities assessment questions

Instructions: Please mark ○ around the number that you find most appropriate.

Strongly Disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly Agree (5)	**Opinion Level**				
1. The cold storage facilities play a crucial role in food cold chain management.	1	2	3	4	5
2. The temperature control system in cold storage can effectively maintain a constant storage temperature.	1	2	3	4	5
3. The humidity control system in cold storage is crucial for preserving food products.	1	2	3	4	5
4. The layout design of cold storage facilities can improve operational efficiency and product safety.	1	2	3	4	5
5. The regular inspection and maintenance of cold storage facilities are necessary to ensure their long-term stable operation.	1	2	3	4	5

Part 5: Packaging materials assessment questions

Instructions: Please mark ○ around the number that you find most appropriate.

Strongly Disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly Agree (5)	**Opinion Level**				
1. The packaging materials play an important protective role in the cold chain transportation of food products.	1	2	3	4	5
2. The thermal insulation performance of packaging materials has a significant impact on food product quality.	1	2	3	4	5
3. The choice of packaging materials directly affects the shelf life of food products during transport.	1	2	3	4	5

Strongly Disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly Agree (5)	Opinion Level				
4.The Satisfied with the performance of current packaging materials in preventing cross contamination of food products.	1	2	3	4	5
5.The choice of packaging materials needs to be customized according to different types of food products.	1	2	3	4	5

Part 6: Logistics coordination assessment questions

Instructions: Please mark ○ around the number that you find most appropriate.

Strongly Disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly Agree (5)	Opinion Level				
1. Logistics coordination is an important factor in ensuring product quality and quickly respond to the emergencies in cold chain management.	1	2	3	4	5
2. The logistics coordination can optimize transport routes and improve overall economic efficiency to reduce unnecessary distances and time.	1	2	3	4	5
3. The information-sharing mechanism within the logistics coordination system can improve collaboration efficiency between departments.	1	2	3	4	5

Part 7: Compliance with industry regulations assessment questions

Instructions: Please mark ○ around the number that you find most appropriate.

Strongly Disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly Agree (5)	Opinion Level				
1. The complying with industry regulations is a basic requirement for ensuring food product safety.	1	2	3	4	5
2. Your company always complies with industry regulations and standards in cold chain management.	1	2	3	4	5
3. Your company's cold chain management policies fully reflect the requirements of industry regulations.	1	2	3	4	5
4. The regulatory compliance in your company can effectively prevent food safety incidents in the food industry.	1	2	3	4	5
5. Your company strictly requires suppliers to comply with industry regulations when cooperating.	1	2	3	4	5
6. Your company can be paid some cost for complying with industry regulations.	1	2	3	4	5

Part 8: Professional training assessment questions

Instructions: Please mark ○ around the number that you find most appropriate.

Strongly Disagree (1) Disagree (2) Neutral (3) Agree (4) Strongly Agree (5)	**Opinion Level**				
1. The regular professional training for employees related to cold chain management is necessary.	1	2	3	4	5
2. After participating in professional training, employees' understanding and execution ability in cold chain management processes have significantly improved.	1	2	3	4	5
3. The training should cover the latest cold chain management techniques and equipment usage.	1	2	3	4	5
4. Evaluating and providing some refreshment training time by time to employees after training is necessary to ensure training effectiveness.	1	2	3	4	5
5. The training should include how to respond to emergencies and crises in cold chain management.	1	2	3	4	5
6. Your company can be paid some cost of training to improve employee ability.	1	2	3	4	5

APPENDIX B

STATISTICAL VALUES

Frequency Table

Results of demographic data analysis (n=225)

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	147	52.3	65.3	65.3
	Female	68	24.2	30.2	95.6
	Other	10	3.6	4.4	100.0
	Total	225	80.1	100.0	

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 30 years	26	9.3	11.6	11.6
	30-40 years	61	21.7	27.1	38.7
	41-50 years	45	16.0	20.0	58.7
	Over 50 years	93	33.1	41.3	100.0
	Total	225	80.1	100.0	

Education					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High school	37	13.2	16.4	16.4
	Undergraduate	116	41.3	51.6	68.0
	Bachelor's degree	55	19.6	24.4	92.4
	Master's degree or upper	17	6.0	7.6	100.0
	Total	225	80.1	100.0	

Employees					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 20 staffs	24	8.5	10.7	10.7
	20-50 staffs	72	25.6	32.0	42.7
	51-100 staffs	70	24.9	31.1	73.8
	101-200 staffs	14	5.0	6.2	80.0
	More than 200 staffs	45	16.0	20.0	100.0
	Total	225	80.1	100.0	

Businees					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cold storages	215	76.5	95.6	95.6
	Logistics service provider	6	2.1	2.7	98.2
	Buyer	4	1.4	1.8	100.0
	Total	225	80.1	100.0	

Position					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owner	6	2.1	2.7	2.7
	Director	6	2.1	2.7	5.3
	Manager / Assistant Manager	62	22.1	27.6	32.9
	Senior Supervisor / Supervisor	151	53.7	67.1	100.0
	Total	225	80.1	100.0	

BIOGRAPHY

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