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Guidelines for logistics system and supply chain management for environment in industrial business

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A B S T R A C T

Industry plays a vital role in developing Thailand and supporting and driving businesses. The increase in industry benefits the national income. However, it also affects the environment. Industrial companies must adapt to reduce problems by developing organizational infrastructure, such as logistics activities or operations, which are the major systems and causes of environmental issues. Therefore, this study aims to study guidelines for logistic system and supply chain management for the environment in industrial business and develop a structural equation model (SEM). The study used a mixed-method research design; the qualitative method, in-depth interviews with nine experts and a focus group with 11 experts were used. Concerning the quantitative method, a questionnaire survey was used with 500 green industries. Descriptive statistics, inference statistics, and multivariate analysis were also used to analyze the data. The study found four essential aspects: (1) Customer orientation, (2) Green network, (3) Logistic process, and (4) Organization management. Finally, the hypothesis testing results found that in medium- and large-sized industries, the importance of the variables of the logistic system and supply chain management for the environment had no statistically significant difference at 0.05. The results from the analysis of the structural equation model found that the study passed the evaluation and was relevant to empirical data with a chi-square probability level of 0.066, a relative chi-square of 1.133, a goodness of fit index of 0.954, and root mean square error of approximation equal to 0.016.

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1. Introduction

Thailand is considered a country with a geographical advantage, serving as a crucial economic hub in the ASEAN region that connects industries and trade. Industrial businesses operate in diverse manners, relying on logistics to drive business and the economy. Logistics, therefore, plays an essential role and acts as an infrastructure that helps develop and support the country's economic growth towards becoming a prosperous and sustainable nation (Ruksasri et al., 2020). This process involves creating value through innovation and creativity, driven by technology and eco-friendly innovations aligned with the BCG (Bio-Circular-Green) model. The BCG model, outlined in the 20-year Thai industrial development strategy (2017-2036), focuses on critical elements linked to the circular economy, which emphasizes maximizing the reuse of materials, and the green economy, which aims to solve pollution issues to reduce the impact on the planet sustainably. However, the expansion and growth of the industrial economy also highlight problems and effects that arise. Chawari et al. (2019) pointed out the increase in waste from industrial businesses, production processes, processing, pollution, storage, and transportation issues. Tubtimsri (2015) noted that resource and energy issues are consequences stemming from the industrial sector.

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Based on data from the Energy Policy and Planning Office, Ministry of Energy, for the years 2011-2021, it was found that the growth of the industrial sector has contributed to the increase in greenhouse gas emissions, which damage ecosystems and the environment due to raw material processing. As shown in Fig.1, the industrial sector's emissions trend increases yearly.

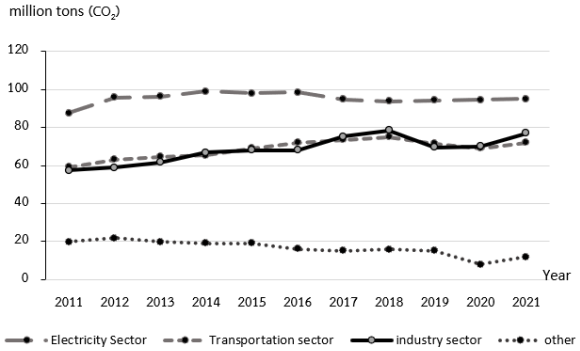

Fig. 1. Greenhouse gas emission rates by industry type

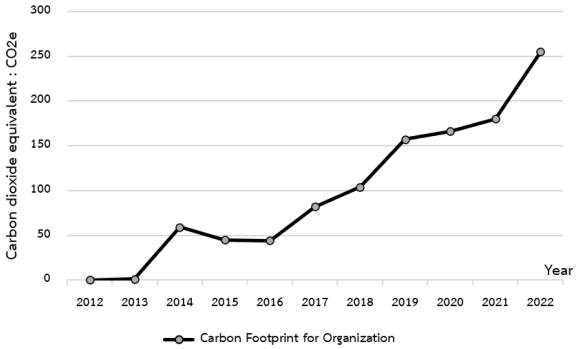

Fig. 2. Greenhouse gas emission rates

When broken down by industry type, it was found that the greenhouse gas emission rates in Thailand's industrial sector have shown a continuous increase in the carbon footprint. Additionally, Fig. 2. depicts the amount of waste generated by the industrial sector, which from 2012 to 2022 has increased by an average of 30-40 million tons per year. Previous studies have found that the shift in focus from traditional concepts that prioritize cost advantages, quantity, reuse, and recycling without considering the lost advantage is no longer central to the development of industrial processes. Banomyong et al. (2020) proposed that the development of the industrial sector must rely on policy-driven logistics systems as a fundamental infrastructure to achieve the goals. Therefore, the researcher is interested in studying the research on logistics and supply chain management approaches for environmental sustainability in industrial businesses.

2. Objectives

The purposes of this study are (1) to study the general structure and operations of industrial businesses that logistics system and supply chain management for environment, (2) to investigate the elements of guidelines for logistic system and supply chain management for environment in industrial business and (3) develop a structural equation model (SEM) for logistics system and supply chain management for environment in industrial business.

3. Theoretical and Literature Review

3.1. Logistics Process

Boon-Itt (2015) states that supply chain management is a critical discipline in business management that aims for business excellence. Business operations under volatile conditions impact costs and operational efficiency, and thus, a good supply chain enables businesses to achieve excellence. Banomyong et al. (2019) state that efficient logistics and supply chain infrastructure must align with government policies and positively impact the country. Vo (2024) suggests that SCM (Supply Chain Management) is crucial for businesses and may affect the environment, but developing good infrastructure can enhance business operations and reduce costs. Hoan et al. (2024) highlight those moving goods from production areas to customers in different regions involves various stages and geographical features, necessitating appropriate management techniques in transportation, processing, storage, distribution, and retail. Furthermore, Wong et al. (2021) studied the operational cycle of supply chain stakeholders by evaluating awareness, monitoring, and social and environmental impacts, demonstrating the outcomes of organizational responsibility towards the supply chain to align organizations to the same standards.

3.2. Organization Management

Banomyong et al. (2019) state that efficient infrastructure must align with government policies and positively impact the country. The research by Podhurska et al. (2019) suggests planning according to standards such as ISO, which helps reduce greenhouse gas emissions and environmental impact and lower energy costs through systematic energy resource management for social responsibility, thereby increasing economic investment attractiveness. Singkaimook et al. (2015) indicate that creating and defining clear environmental policies by organizations directly impact the effectiveness of reducing industrial pollution in Thailand. Pisitsaksem (2022) mentions that integrating circular economy planning with logistics and supply chain management, such as just-in-time systems, economic order quantities, material requirements planning, and lean management, affects the environment and resource utilization. Sareekham et al. (2022) state that green supply chain management plays a significant role in business planning and is a strategy for enhancing competitive capabilities in current and future scenarios. Additionally, the research by Sareekham et al. (2022) highlights that policy formulation and guidelines from the government, along with a commitment to environmental operations, are crucial factors for effective green supply chain management.

3.3 Customer Orientation

Creating an organizational culture, attitudes, and behaviors necessary for adding value to customers and continuously improving business performance to achieve sustainable competitive advantage consists of three elements: 1) Customer orientation, 2) Competitor orientation, and 3) Inter-departmental coordination. Efforts should be made to find the best ways to share value with customers, focus continuously on the market to seek sustainable competitive advantage (Supapon & Sukhawatthanakun, 2023; Sukhawatthanakun, 2023; Thatrak, 2020), and add value to customers now and in the future. Maintaining long-term profitability and building mutually beneficial relationships between the organization and customers are essential. Marketing should be developed to satisfy customers by offering superior value compared to competitors. Rodsaard et al. (2019) state that market orientation, comprising customer orientation, competitor orientation, and interdepartmental coordination, positively influences environmental innovation, which in turn significantly impacts the performance of new product development in terms of cost, speed, and environmental considerations. Kultangwatana et al. (2023) note that market orientation, customer focus, and learning orientation directly affect innovation capabilities and the performance of medium-sized industrial businesses. These results align with Yanu and Juasrikul (2020), who found that overall customer-centric market orientation impacts growth rates, fundraising, profitability, efficiency, and productivity of organizations. Suwannakul & Vongsaroj (2020) state that customer orientation, an element of market orientation, promotes employee loyalty to the organization, increases competitiveness, facilitates cost control, and ensures sustainable business operations.

3.4. Green Network

Wong et al. (2021) studied the operational cycle of stakeholders in the supply chain by evaluating awareness, monitoring, and social and environmental impacts. Their findings highlighted the organizational responsibilities towards the supply chain, which allows organizations adhering to the same standards to collaborate efficiently. Raksasi et al. (2019) identified that business alliances between organizations directly influence performance aspects such as products, marketing, technology, research and development, and strategic resources. Interstingly, Sukhawatthankun & Supapon (2024) mentioned that agile marketing competency and innovation capability play a high role in new product management for green industrial business development. Careful selection of partners is crucial for forming strategic alliances that lead to tremendous organizational success. Banomyong et al. (2020) studied supply chain management closure, revealing that developing a reverse logistics system in Thailand must begin with raising awareness and understanding across all sectors about the importance of reverse logistics and all activities throughout the supply chain. This loop supports creating a circular economy and reduces environmental impacts affecting society and the economy on a broader scale while also requiring an appropriate infrastructure system. Numsiri & Suthiwartnarueput (2021) stated that effective management systems and cooperation within and outside the organization directly influence business waste management. Additionally, the research by Golmohammadi et al. (2018) confirmed that cooperation between sellers and buyers in improving supplier supply chain efficiency helps enhance product quality, reduce costs, and increase profitability for supply chain members who collaborate and share the same vision effectively.

4. Hypotheses Development

4.1 Logistics Process element directly influences the Organization Management element

Banomyong et al. (2020) proposed developing logistics processes from a policy perspective as an initial guideline for developing the country's economic system. They indicated that the development of logistics systems is a fundamental aspect that positively impacts various dimensions of national development, such as policy formulation, strategies, strategic planning, and operational planning both within and outside organizations, as well as the positive impacts on the industrial sector. Rattanawong (2018), in his book "Logistics Operations to Stop Disruption in SMEs," stated that the current business environment is increasingly competitive. Businesses and organizations must adapt and manage their internal operations to keep pace with changing conditions. They need to find new tools and strategies or adjust logistics and supply chain strategies, which are crucial for developing operational plans to align with changes. These practices directly impact businesses, such as creating new technologies and innovations, access to technology, and acquiring new knowledge to improve operational efficiency for business survival, all of which play a significant role in the national economic system. Theppitak et al. (2021) researched enhancing the competitiveness of community enterprise products using logistics and supply chain management; research results state that analyzing upstream, midstream, and downstream activities is crucial in influencing planning and strategy formulation, improving competitiveness, and creating business advantages.

H_1: *Latent variables, the 'Logistics Process' element directly influences the 'Organization Management' element.*

4.2 Logistics Process element directly influences the Customer Orientation element.

Lazar et al. (2021) studied "Sustainability orientation and focus in logistics and supply chains (LSC)" and found that sustainable development in logistics and supply chains involves responsible consumption and production, creating industries

focused on sustainability, innovation, and appropriate infrastructure using affordable, clean energy. However, sustainable development in LSC drives consumers to prioritize and foster mutual sustainability. Huma and Ahmed (2019), in their research "The Effect of Logistics Service Quality on Customer Loyalty: Case of Logistics Service Industry," collected data from 250 customers. The findings revealed that the quality of logistics services in operations and logistics service quality impacts customer loyalty. Additionally, fostering customer loyalty emphasizes quality as a crucial factor. Benchanakatkun and Paopun (2020), in their research on "Causal Factors Influencing Lean Management of Freight Forwarding Companies in Thailand," stated that market and customer focus are influenced by logistics efficiency but directly impact internal quality operations. They also found that lean management within organizations directly influences logistics efficiency. Supporting the study of Sukhawatthankun and Supapon (2024), industrial firms must design efficient logistics systems management to deliver new products to target customers on time during the launch period.

H_2: *Latent variables, the 'Logistics Process' element directly influences the 'Customer Orientation' element.*

4.3 Logistics Process element directly influences the Green Network element.

Feng et al. (2020) studied "The Dual Process Between Green Supplier Collaboration and Firm Performance: A behavioral perspective," summarizing solutions for problems related to green supplier collaboration (GSC). Based on survey data from 206 manufacturing companies in China, GSC positively influences financial and environmental performance through increased information sharing. However, the direct impact of GSC on such behavior is a result of supply chain operation management. Banomyong et al. (2019) studied supply chain management closure and the use of reverse logistics to support economic and environmental development. They found that raising awareness, environmental collaboration, and recognition across all sectors can effectively develop and support a circular economy and ecological system. All sectors must have a suitable and well-developed infrastructure, including logistics systems, which are crucial for driving such collaboration. However, key challenges and obstacles in developing environmental logistics systems include a lack of understanding of logistics and supply chain management, technology, communication for awareness, and collaboration between units to drive and establish environmental logistics systems effectively. Lim et al. (2017) researched "Knowledge Management in Sustainable Supply Chain Management: Enhancing Efficiency with Structural Modeling Approaches." They found that supply chain and logistics management significantly impact knowledge management, information sharing, knowledge creation, and collaboration within and outside organizations. These elements are highly effective mechanisms for organizations. Knowledge sharing and cooperation in equipment, facilities, and environmental aspects among organizations with aligned interests lead to technological and innovation development, meeting customer needs, and enhancing operational efficiency within organizations and sustainable supply chain management.

H_3: *Latent variables, the 'Logistics Process' element directly influences the 'Green Network' element.*

4.4 Customer Orientation element directly influences the Organization Management element.

Issarabaibool (2019) studied "The relationship between factors affecting the operational capability strategies of logistics businesses in Thailand." The research aimed to examine the impact and relationship of organizational operational structures. The findings indicated that the competitive direction, understanding, and responding to consumer needs significantly impact operational management capabilities. There is a positive relationship between planning and strategic logistics management, which promotes operational processes and enables organizations to achieve their goals efficiently. Patthanakitthanachot and Wanarat (2022) stated in their research that enhancing internal organizational efficiency relies heavily on promoting and supporting the relationship between customer and market needs. Emphasizing customer satisfaction and trust is crucial for building loyalty, leading to improvements and changes in organizational management. Yanu and Juasrikul (2020) found that a market and customer focus significantly impacts business operations, growth rates, and investment. It also influences profitability, efficiency, and organizational effectiveness. Additionally, research by Suwannakul and Vongsaroj (2020) highlighted that a customer focus, an element of market orientation, promotes employee loyalty to the organization and enhances competitive advantage, cost control, operational standards, and business sustainability, affecting organizational management efficiency.

H_4: *Latent variables, the 'Customer Orientation' element directly influences the 'Organization Management' element.*

4.5 Customer Orientation element directly influences the Green Network element.

Teimtes et al. (2021) examined the influence of marketing orientation and customer orientation. The study found that effective marketing strategies must begin with understanding marketing concepts, customer insights, and competitor awareness. Such operations enhance organizational effectiveness and promote internal collaboration, leading to the achievement of defined goals. This process fosters an organizational culture by integrating operations across various internal and external departments. These three aspects contribute to beneficial collaboration for developing new product innovations. Sajjaviriya et al. (2020) researched the relationship between marketing and customer orientation. Their findings indicated that marketing orientation, focusing on customer orientation, fosters an organizational culture prioritizing collaborative value creation. Then, it is the

crucial metric for assessing organizational potential to meet target customer needs. Establishing such a culture impacts cooperation integration, including resource sharing, data exchange, and communication. Dechanubeksa et al. (2020) studied the effects of green system management on marketing performance. The results revealed that green management systems positively influence marketing outcomes and green market orientation. This green market focus affects the design of environmentally friendly products and collaboration among organizations with shared goals, leading to comprehensive management of green operations for competitive advantage. Similarly, Wong et al. (2020) explored the effects of green supply chain integration and conducted surveys with manufacturers in China and the United Kingdom. They found that collaboration, from senior management to operational levels, is heavily influenced by customer demands, yielding social, environmental, cost, and competitive benefits, directly enhancing supply chain management that responds effectively to executive and customer needs.

H_5: *Latent variables, the 'Customer Orientation' element directly influences the 'Green Network' element.*

4.6 Logistic System and Supply Chain Management for Environment in Industrial Business, categorized by the size of the industrial business, the research results were not different.

Techakana (2019) conducted a study on successful high-level business models characterized by innovation, interviewing 47 small and medium-sized enterprises awarded the Bai Po Business Awards. The findings revealed that crucial success factors share commonalities regardless of the business type. These include managing resources, operations, and marketing and creating value for products and services to meet consumer needs, all demonstrating similar operational characteristics.

H_6: *The importance level of the logistics system and supply chain management for the environment in industrial business, Categorized by industry business size not different.*

5. Methodology

This research is creating inductive research using mixed methodology. The research method is presented in steps, including population and sample, data collection, and statistics used in data analysis. This inductive research creates new knowledge by employing a mixed methodology research consisting of 3 components: 1) qualitative research using in-depth interviews, 2) quantitative research through survey data collection and 3) qualitative research using focus groups to validate and confirm the model. The research procedure is presented sequentially.

Population and Sample: Qualitative Research using in-depth interviews: The research population comprises nine experts, selected through purposive sampling, including three business entrepreneurs or managers, three government officials and relevant agency representatives, and three academics.

(1) Quantitative research: using a questionnaire, the research population comprises industries committed to environmentally friendly entrepreneurship, focusing on continuous development and improvement in production processes and environmental management. These industries are certified as Green Industry (GI) by the Ministry of Industry of Thailand at levels 3-5, with certification numbers from 2020 to 2022. The sample size is determined to be 500 (Comey & Lee, 1992; Ministry of Industry, 2022; Theppitak, 2023) using multi-stage sampling (Silpcharu, 2020), which includes stratified sampling by dividing industrial businesses into medium and large sizes, followed by simple random sampling using a lottery method within each group.

(2) Qualitative research: using a focus group; the population for this phase consists of 11 experts in industrial business and environmental logistics, selected through purposive sampling.

Research instruments: The research instruments are categorized based on the research methods into two types: qualitative and quantitative research tools. The tools and their development approaches are as follows:

(1) Qualitative research using in-depth interviews: The instrument is a structured interview form.

(2) Quantitative research: the instrument is an environmental logistics and supply chain management questionnaire. The questionnaire uses a Rating Scale with five levels, following the Likert method, and consists of 100 items. Five experts verified the index of item objective congruence (IOC), and a try-out was conducted with a similar population of 30 cases. The results from the try-out were analyzed for discrimination using the discrimination index for checklist questions and the correlation item-total correlation for rating scale questions. The reliability of the questionnaire was determined using Cronbach's alpha (Silpcharu, 2024) with the (Statistical Package for the Social Sciences for Windows: SPSS) software. The discrimination analysis of individual checklist questions showed standard deviation values ranging from 0.51 to 1.93. The corrected item-total correlation values ranged from 0.31 to 0.77 for rating scale questions. The overall questionnaire reliability, as determined by Cronbach's alpha coefficient, was no less than 0.97.

Data analysis: Researchers analyzed the research data:

(1) Qualitative research using content analysis and frequency statistics.

(2) Quantitative research: The statistical analysis uses descriptive, reference, and multiple statistics to develop SEM using SPSS and AMOS. For the Statistical values that assessed the consistency of the structural equation model, the researcher used (Arbuckle's, 2016) criteria for model fit, consisting of 4 criteria as follows: (1) (CMIN-p) is more significant than 0.05, (2) (CMIN/DF) must be less than 2, (3) (GFI) more significant than 0.90, and (4). (RMSEA) is less than 0.08.

6. Result

The statistical analysis of the importance level of the components of guidelines for logistic system and supply chain management for the environment in industrial business, categorized by business size, is shown in Table 1.

Table 1
Comparison of the importance of the guidelines for logistic system and supply chain management for environment in industrial business

Logistics system and supply chain management for environment in industrial business	Medium enterprise			Large enterprise		
	Mean	S.D.	Sig. level	Mean	S.D.	Sig. level
Overall	4.02	0.49	High	4.00	0.48	High
Customer Orientation	4.16	0.49	High	4.08	0.51	High
Green Network	4.08	0.49	High	4.04	0.49	High
Logistics Process	3.91	0.60	High	3.95	0.57	High
Organization Management	3.92	0.60	High	3.91	0.58	High

Table 1 shows that the importance level of logistics and supply chain management for the environment in industrial business in medium-sized businesses is overall high, with an average of 4.02 and S.D. = 0.49. When considered in four dimensions, all dimensions are of high-level importance, as follows: (1) Customer Orientation with a mean of 4.16, S.D. = 0.49, (2) Green Network with a mean of 4.08, S.D. = 0.49, (3) Organization Management with a mean of 3.92, S.D. = 0.60, and (4) Logistics Process with a mean of 3.91, S.D. = 0.60. For large businesses, the overall importance level of logistics and supply chain management for the environment in Industrial Business is also high, with an average of 4.00 and S.D. = 0.48. The ranking of the four dimensions is as follows: (1) Customer Orientation with a mean of 4.08, S.D. = 0.51, (2) Green Network with a mean of 4.00, S.D. = 0.49, (3) Logistics Process with a mean of 3.95, S.D. = 0.57, and (4) Organization Management with a mean of 3.91, S.D. = 0.58.

Fig. 3 shows the SEM analysis for guidelines for logistic system and supply chain management for environment in industrial business in the standardized mode after model adjustments. Table 2 shows the model fit assessment of the SEM for logistics and supply chain management approaches for the environment in industrial business before and after model modification.

Table 2
Statistical values that assessed the consistency of the comparative structural equation model before and after modifying the model

Statistics	Standard criteria	Before modification	After modification
CMIN-p (Chi-Square Probability Level)	> 0.05	0.000	0.066
CMIN/DF (Relative Chi-Square value)	< 2.00	2.167	1.133
GFI (Goodness of Fit Index)	> 0.90	0.682	0.954
RMSEA (Root Mean Squared Error of Approximation)	< 0.08	0.048	0.016

For the Statistical value to evaluate the consistency of the SEM before improving the model, the researcher used (Arbuckle's, 2016) criteria for model fit, consisting of 4 criteria as follows: Before model adjustment, the statistical fit values showed that the model met only one criterion: (RMSEA) was 0.048, which meets the empirical data fit criterion. However, it did not meet three criteria: (CMIN-p) was 0.000, (CMIN/DF) was 2.167, and GFI was 0.682, which did not meet the empirical data fit assessment criteria. The researcher improved the model by considering the modification indices values, following Arbuckle's (2016) recommendations. This method involved evaluating the results from the software program alongside theoretical principles, removing unsuitable observed variables one by one, and reprocessing the model. This process was repeated until the model met all four statistical criteria, indicating that the SEM was complete and aligned with empirical data. After adjusting the model, (CMIN-p) was 0.066, (CMIN/DF) was 1.133, GFI was 0.954, and (RMSEA) was 0.016. Therefore, all four statistical values met the evaluation criteria, confirming that the structural equation model of Guidelines for logistic system and supply chain management for environment in industrial business was consistent with empirical data.

Table 3
Highest score for observed variable after SEM modification

Highest score for observed variable after SEM modification		Standardized regression weight
Customer Orientation		
CO20	Listen to environmental impacts from every stakeholder and related groups.	0.71
CO6	The organization's main environmental logistics strategy is to Understand customer needs and satisfy customers	0.69
CO21	Focus on the customer as the center (Customer Oriented) by using customer demand as the determining factor.	0.62
CO23	Create awareness with customers about the environment both inside and outside.	0.58
CO14	Modify processes and methods to make customers aware that the organization places importance on the environment.	0.58
CO9	Display an environmental brand that customers can easily recognize.	0.51

Table 3
Highest score for observed variable after SEM modification (Continued)

Green Network		
NG17	Create a green network by supporting partners or partners to enter into green industry mark certification.	0.63
NG10	Set criteria for selecting suppliers who value environmental management.	0.61
NG9	Create a knowledge network regarding the environment with educational agencies. research and development	0.59
NG13	Focus on green logistics activities that are friendly to the environment rather than reducing costs, which focus primarily on profits.	0.55
NG19	Choose an external service provider (outsourced) that meets environmental standards to reduce environmental impact.	0.53
NG7	Promote participation in community development to stimulate awareness and understanding of the sustainable environment.	0.50
Logistics Process		
LP9	Define each logistics process's structure, authority, and duties to be responsible for transparent environmental management.	0.68
LP14	Source the raw materials from suppliers that focus on environmental sustainability.	0.68
LP15	Reduce unnecessary movement, travel for nothing and emissions of power consumption.	0.66
LP17	Use various modes of transportation besides trucks, such as rail, water, air, etc.	0.65
LP13	Check the production process to create as little waste as possible.	0.65
LP23	Analyze the natural impacts caused by logistics operations such as production, delivery, and distribution.	0.62
LP8	Use environmentally friendly packaging. (Eco-wrapping) that can be reused.	0.61
Organization Management		
OM9	Environmental objectives are in line with the organization's environmental policy.	0.76
OM8	Stimulate the exchange of environmental knowledge within the organization through formal and informal communication.	0.72
OM10	Control safe operations at a low accident rate to meet the best practices in the same industry.	0.72
OM4	Design an environmental management system within the organization to connect effectively to a network.	0.69
OM6	Follow up on environmental impacts from the logistics system and supply chain for continuous development.	0.64
OM11	Create a corporate culture To make everyone aware of the environment.	0.64

Table 4
Results of the Analysis, direct influence and indirect influence SEM after model modification

Latent Variable	Logistics Process	Customer Orientation	Organization Management	Green Network
Customer Orientation	0.73	0.00	0.00	0.00
Organization Management	0.27	0.55	0.00	0.00
Green Network	0.82	0.52	0.00	0.00

Table 4 results of the analysis of overall influence, direct influence and indirect influence SEM of logistics and supply chain management for the environment in industrial business in the Standardized Estimate mode after model improvement found that the most substantial overall effect was on the 'Logistics Process' influenced the overall direct and indirect effect on the element of 'Green Network with a standardized regression weight of 0.82 (0.44+ 0.38).

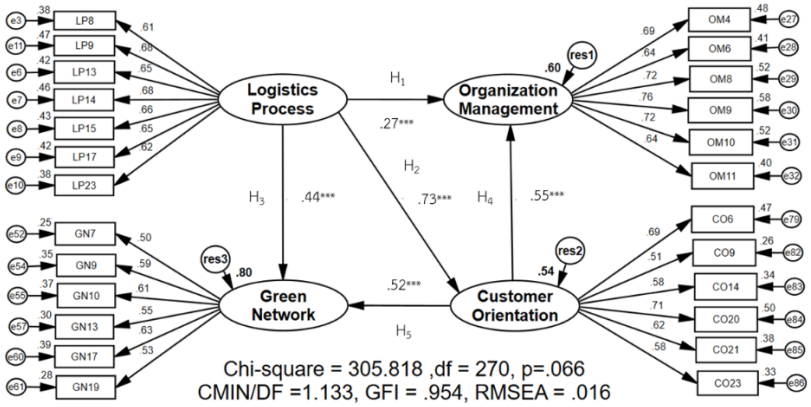

Fig. 3. The structural equation model of guidelines for logistic system and supply chain management for environment in industrial business (After modification)

6. Conclusion and Discussion

The research findings suggest that guidelines for logistic systems and supply chain management for the environment in industrial business should prioritize ensuring that all departments and sectors work towards a common goal: delivering value to customers per their requirements. Jaturapongsaton et al. (2023) and Sukhawatthankun (2023) noted that clarity in organizational goals for customer value benefits internal operations, fostering a culture that drives organizational survival and competitive advantage. Similarly, Linjee et al. (2020) found that an organization's vision and policies significantly impact business governance efficiency. A clear and robust organizational vision guides the business direction, motivates personnel, fosters cooperation, and leads the organization to achieve its goals. Thaturak (2019) concluded that long-term organizational goals focusing on customer-centricity benefit business partners, personnel, and internal operations efficiency. The comparison

of the importance levels of guidelines for logistic system and supply chain management for the environment in industrial business, categorized by business size, showed no significant statistical difference at the 0.05 level between medium-sized and large enterprises. Both sizes operate under the same Thai Green Industry standards, making their requirements and procedures similar. Both sizes emphasize the production or the use of recyclable materials, decentralization of environmental decision-making, cross-sector collaboration for environmental problem-solving, clear environmental goals, cooperation with related businesses and agencies, and modern logistics processes. Banomyong et al. (2020) emphasized that logistics is the operational infrastructure in all industrial sectors, requiring clear and appropriate operational structures to develop an efficient and sustainable logistics system. Boon-Itt (2015) stated in his book "Supply Chain Management for Excellence" that supply chain and logistics management is crucial for organizational management aiming for business excellence at all levels, requiring cooperation across the supply network to respond to business uncertainties and create competitive advantages. Wong et al. (2021) mentioned that all industries involved in logistics must be aware of partnerships, collaboration, and follow-up impacts on society and the environment, demonstrating social responsibility. The structural equation analysis, shown in Fig. 3, revealed that the logistics process directly affects customer orientation with a standardized regression weight of 0.73 highest. This result aligns with Kuo et al. (2023), who found that behavior-focused customer-centric service adjustments enhance customer perception of internal organizational efficiency. Wu & Dong (2023) studied logistics in healthcare and found that communication channels through logistics processes build customer trust. Gaudenzi et al. (2020) studied the logistics service quality and customer satisfaction and found that logistics activities lead to high customer satisfaction.

Overall, the logistics process element has the total effect on the green network, empirically demonstrating that building environmental credibility requires a robust logistics infrastructure, including personnel, machinery, and processes leading to environmental sustainability. Centobelli et al. (2020) stated that many logistics businesses start environmentally friendly initiatives under top management's vision and strategy, which is crucial for connecting like-minded business networks. Karaman et al. (2020) indicated that participating in environmentally friendly logistics creates an environmentally solid network.

7. Research implications

The researchers can suggest the Thai government as follows:

(1) The Ministry of Industry should mandate industrial businesses to undergo evaluation for Green Industry (GI) certification and aim to achieve certification levels beyond 3-5.

(2) The Ministry of Industry should consider implementing tax relief measures for businesses that operate in an environmentally friendly manner and further support ecologically friendly enterprises.

(3) The Ministry of Commerce should establish support measures for funding, access to capital, and trade for start-ups or new businesses that operate environmentally friendly practices to enhance commercial capabilities and stimulate the economy.

(4) The Ministry of Labor should develop workforce skills and promote green jobs, ensuring that the labor force is both high-quality and meets environmental needs in the labor market.

(5) The Ministry of Energy should set policies and adjust the pricing structure of all energy types to be fair and appropriate, liberalize the energy sector to foster competition and promote clean energy.

(6) The Office of the Board of Investment (BOI) and the Ministry of Agriculture should encourage investments to restructure the Thai economy towards a "green economy" in environmentally friendly businesses.

Furthermore, the researchers can suggest that future research should focus on using (1) AI plus E-System (Artificial Intelligence) to analyze and diagnose environmental problems, (2) Laws and regulations that will drive the industrial sector to address environmental issues, (3) Study small industrial businesses or service businesses (4) The combustion of fuels from product manufacturing and waste from manufacturing must change and use new technologies to create for innovation for more efficient environmental management. Therefore, the approach to reducing the carbon footprint in the production process of industrial businesses in the digital era should be studied.

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