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A Comparative Analysis of Strategic Factors Influencing the Usage of Thailand's Bangkok and Laem Chabang Port Logistics Systems

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ABSTRACT

This study examines the strategic factors influencing port usage in Thailand's logistics system, responding to the critical need for enhanced port competitiveness in Southeast Asia's rapidly evolving trade environment. Quantitative research was used to collect data from 378 relevant stakeholders, including shipping lines, freight forwarders, exporters, importers, and port authorities, through questionnaires. Multiple regression analyses identified and evaluated the key strategic factors influencing port usage. The research reveals significant differences in the strategic positioning of Bangkok Port (BP) and Laem Chabang Port (LCP), highlighting the unique roles each plays in Thailand's logistics network. Findings indicate that location, capacity, efficiency, and connectivity are primary factors affecting port choice among logistics operators. While these findings are specific to Thailand's port system, they offer valuable insights for other developing economies with similar dual-port systems, particularly those balancing established river ports with newer deep-sea facilities. This study contributes to the understanding of port competitiveness in Thailand and offers insights for policymakers and port authorities to enhance the strategic value of these critical logistics hubs. The research underscores the need for targeted investments and policy interventions to optimize the complementary roles of Bangkok Port and Laem Chabang Port in supporting Thailand's economic growth and trade competitiveness.

Keywords: *Bangkok Port, Laem Chabang Port, logistics, strategic factors, supply chains, Thailand*

1. INTRODUCTION

The maritime sector is essential in the global supply chain, with ports as vital logistics network nodes (Verschuur *et al*., 2022). In Thailand, a country with a strategic geographic location in Southeast Asia, the efficient operation of its ports is paramount to economic growth and trade competitiveness (Nguyen & Woo, 2022). Among Thailand's numerous ports, Bangkok Port (BP) and Laem Chabang Port (LCP) stand out as key players in the country's logistics system, each with unique characteristics and importance.

Bangkok Port, located 26 kilometers upstream from the Chao Phraya River estuary, has historically been Thailand's primary port (Sujjaviriyasup, 2025), benefiting from its proximity to the capital city and industrial areas, with the port covering an area of approximately 1,000 acres. However, since BP is a river port, it has several limitations, such as being only able to support vessels that are not bigger than 12,000 deadweight tons, with a length of not more than 172 meters, and a depth of not more than 8.2 meters (Bamrungbutr, 2020).

Therefore, as container shipping expanded and larger vessels required deeper waters, the Laem Chabang Port (LCP) was developed and used in 1991. It served as a modern deep-sea port designed to complement—and in some respects, surpass—the capabilities of Bangkok Port (Bamrungbutr, 2020; Chuchottaworn & Raothanachonkun, 2024). This shift in port dynamics has led to a complex interplay between these two major logistics hubs, influencing shipping patterns, trade flows, and Thailand's economy.

The evolving roles of BP and LCP within Thailand's logistics system are intriguing, particularly in understanding the strategic factors influencing their usage. Parola *et al.* (2017) noted that port choice is critical for shipping lines and shippers, impacting overall supply chain efficiency and costs. Factors such as location, infrastructure, service quality (Sirajuddin, 2023), and connectivity play significant roles in determining port competitiveness (Sujjaviriyasup, 2025), with competition and cooperation noted as essential factors in improving port competitiveness (Luo *et al*., 2022).

A critical assessment of the existing literature reveals several limitations in understanding Thailand's port dynamics. While numerous studies have explored port competitiveness generally, a significant gap in comparative analyses addresses explicitly the unique complementary relationship between established river ports and newer deep-sea facilities within the same national logistics system. This research gap is particularly evident in the context of developing economies in Southeast Asia, where such dual-port systems are standard yet understudied.

Several studies have examined various aspects of port operations and logistics in Thailand. For instance, Sankla and Muangpan (2022) investigated the role of innovative and sustainable ports and how they affected port performance. Ngampramuan (2021) discussed how infrastructure investments affected economic growth, specifically within the context of the Greater Mekong Sub-region (GMS) process and China's Belt and Road Initiative (BRI). However, Punyaratabandhu and Swaspitchayaskun (2021) questioned China's BRI benefits to port development and overall economic security in Thailand. Despite these ongoing discourses, there still is a significant literature gap regarding a comprehensive comparative analysis of the strategic factors influencing the usage of BP and LCP within Thailand's broader logistics system.

The motivation for this research stems from the need to address these knowledge gaps and provide a comprehensive understanding of the strategic factors that influence port usage in Thailand. By comparing BP and LCP, the authors hope to offer valuable insights into the complementary roles of river ports and deep-sea ports within national logistics systems. Additionally, the research seeks to inform policy decisions and strategic planning for Thailand's port sector, particularly in the context of increasing regional competition and the country's ambitions to serve as a logistics hub for Southeast Asia.

Therefore, this research aims to address this gap by conducting a quantitative research approach utilizing in-depth interviews and regression analysis of the strategic factors affecting the usage of BP, with LCP serving as a comparative benchmark. As such, the study seeks to identify and evaluate the key determinants influencing port choice among logistics stakeholders in Thailand. The research questions (RQs) for the study are:

- **RQ1**: What are the main strategic factors influencing the usage of BP in Thailand's logistics system?
- **RQ2**: How do these factors compare to those affecting the usage of LCP?
- **RQ3**: What are the implications of these strategic factors for the development and competitiveness of both ports?

The authors hypothesized that while both ports play essential roles in Thailand's logistics network, the strategic factors influencing their usage differ significantly due to their distinct characteristics and target markets. Specifically, (H1) the researchers expect that BP's usage is more heavily influenced by its proximity to urban centers and industrial zones. In contrast (H2), LCP's usage is driven by its superior deep-sea capabilities and modern infrastructure.

The importance of this study is that its outcomes could serve as a foundation for policy making and strategic management in Thailand's port sector. Policy makers, port authorities and other members of the logistics network will be more aware about what are the determinants of port usage and port competitiveness. Therefore, better decisions regarding infrastructure development, service enhancing and strategy positioning could be made. Furthermore, this study broadens the discourses on port competitiveness and logistics networks in developing countries.

In pursuing Thailand's goal at becoming one of the major logistics hubs within the Southeast Asian region (Phinijphara & Lakkhongkha, 2024), these insights can help with strategies that enhance the complementary roles of BP and LCP, thereby creating a more efficient and competitive logistics system that supports Thailand's economic growth and trade ambitions in a more interconnected global economy.

The next sections detail a comprehensive literature review, outlining the theoretical foundations and recent studies in connection to our research, followed by our methodology, our results and discussion of our findings within practice and theory. The authors then conclude with a summary and suggestions of key insights garnered for future research direction.

2. LITERATURE REVIEW

The strategic role of ports in global and national logistics systems has been widely studied in maritime economics and supply chain management (Heikkilä *et al*., 2022; Lee *et al*., 2022; Tang, 2024; Verschuur *et al*., 2022). This section reviews key literature on port competitiveness, port choice factors, economic impact, sustainability, and digital transformation, providing a foundation for analyzing BP and LCP in Thailand's logistics system.

2.1 Port Competitiveness and Strategic Factors

Port competitiveness is a multidimensional construct shaped by an interplay of factors such as infrastructure quality (Baştuğ *et al*., 2022), geographical location (Mdanat *et al*., 2024; Palyvoda *et al*., 2020), intermodal connectivity (Dini *et al*., 2024; Nguyen *et al*., 2024; Yin *et al*., 2023), operational performance (Chen & Hasan, 2023), governance, and strategic partnerships (Luo *et al*., 2022; Yu *et al*., 2023). While traditional metrics such as throughput and turnaround time remain important (Sirajuddin, 2023), emerging literature increasingly emphasizes broader strategic determinants such as the digitalization of 'smart ports' (Molavi, 2020; Sankla & Muangpan, 2022; Tang, 2024; Wang *et al*., 2024; Yau *et al*., 2020), environmental compliance (Muangpan & Suthiwartnarueput, 2019; Saengsupavanich *et al*., 2024; Satta *et al*., 2024), and regional logistics integration.

Moreover, infrastructure has been stated to be key to competitiveness (Pietrzak *et al*., 2020). Specifically, ports with modern cargo handling systems, deep berths, hinterland connectivity—particularly rail (Pietrzak *et al*., 2020) and inland waterway links—are more attractive to shippers and carriers. Also, other studies have determined that investments in smart infrastructure significantly impact port attractiveness (Othman *et al*., 2022; Tang, 2024; Yau *et al*., 2020), especially in emerging economies where logistics systems are evolving (Molavi, 2020).

Geographical location and maritime accessibility are classic variables (Dini *et al*., 2024), but their importance persists in empirical modeling of port competitiveness (Mdanat *et al*., 2024). Coastal proximity to industrial clusters and major sea lanes correlates strongly with transshipment activity and port hierarchy in regional networks (Sankla & Muangpan, 2022).

Service efficiency has been redefined in recent studies to include not only dwell times and cargo handling but also the availability of digital port services such as e-documentation, cargo tracking, and vessel scheduling (Chen & Hasan, 2023; Tohir *et al*., 2024). This is consistent with Sirajuddin (2023), who has similarly reported for Indonesian ports that, to decrease dwelling time, there needs to be deregulation, infrastructure and port availability, ICT and digital integration, and service quality. Operational excellence now blends physical throughput efficiency with information flow optimization (Alzate *et al*., 2024).

In Southeast Asia, the increasing integration of regional supply chains has shifted port roles from isolated entities to nodes in a cooperative competitive (co-opetitive) landscape (Lyu *et al*., 2023; Sankla & Muangpan, 2022). Various authors have underscored this dynamic by exploring how adjacent ports often coordinate on infrastructure and hinterland access to avoid redundant investments while maintaining healthy competition in service delivery (Wang *et al*., 2022). This is especially relevant for the case of BP and LCP in Thailand, whose strategic development plans benefit from a co-opetitive rather than a rivalry relationship.

Recent research from Northern Vietnam affirms that economic criteria such as transport cost and port fees continue to outweigh environmental or intermodal accessibility concerns in port choice decisions (Nguyen *et al*., 2024; Saengsupavanich *et al*., 2024). This suggests that economic priorities still dominate port choice decisions in the region (Zheng *et al*., 2022). Similar trends are noted in Thailand and Indonesia, where port selection behavior among freight forwarders still leans heavily on direct logistics cost rather than broader sustainability or digital readiness considerations.

Additionally, governance and stakeholder engagement have emerged as pivotal components of port competitiveness (de Oliveira *et al*., 2021; Satta *et al*., 2024), with various researchers noting that transparent governance models and participatory planning processes increase port resilience and responsiveness to market dynamics (Argyriou & Tsoutsos, 2023; Brooks *et al*., 2022). This insight is valuable for policy-makers designing port development strategies with public-private partnerships (PPPs) (Wiegmans *et al*., 2022).

Finally, the role of green and smart port initiatives cannot be overlooked (Safuan, 2024). Ports that adopt digitalization strategies, emissions monitoring, and automation gain long-term advantages in regulatory compliance and operational adaptability (Mahmud *et al*., 2024). For instance, the Port of Singapore's Smart Port strategy is widely studied as a benchmark for innovation-led competitiveness (Heikkilä *et al*., 2022; Tang, 2024).

2.2 Port Choice and Economic Impact

Port choice is a critical decision-making process that encompasses a combination of cost-efficiency, infrastructure readiness (Zhu *et al*., 2021), hinterland connectivity (Yeo, 2024), and strategic alignment with shippers' operational goals. For logistics service providers and freight forwarders in Thailand and neighboring regions, this decision is increasingly influenced by the comparative performance of major ports such as Thailand's BP and LCP. This is consistent with Dini *et al*., (2024) and Yin *et al*., (2023), who reported that multimodality is also key for logistics carriers in reducing costs and environmental impacts.

2.2.1 Cost Efficiency and Infrastructure Access

Multiple studies underscore the primacy of transport costs, port fees, and accessibility as primary determinants of port selection (Dini *et al*., 2024). In a study conducted in Northern Vietnam, Nguyen *et al*., (2024) found that logistics providers prioritize low transport costs and reduced port charges over environmental sustainability or advanced intermodal systems. This finding is highly relevant to the Thai context, where BP and LCP present different trade-offs between cost, location, and scale of operations.

Pietrzak *et al*., (2020) further emphasize the importance of hinterland rail connectivity, identifying it as a key enabler of port competitiveness. As Thailand's infrastructure development plans increasingly prioritize rail and multimodal logistics (Buthphorm *et al*., 2024; Peetawan & Suthiwartnarueput, 2018), LCP's rail-linked advantages could offer it a strategic edge, especially in capturing inland cargo from the Eastern Economic Corridor (EEC).

2.2.2 Operational Performance and Smart Capabilities

The operational efficiency of a port plays a pivotal role in port selection. Sirajuddin (2023) highlights how Indonesian ports that adopted ICT tools and streamlined customs processes experienced reduced port dwelling times, directly boosting their attractiveness to logistics operators. In Thailand, similar modernization efforts—especially at LCP—support faster cargo handling and improved scheduling reliability (Makkawan & Muangpan, 2021; Nakchatree & Prabnasak, 2023).

Alzate *et al*., (2024) and Molavi (2020) link port operational performance with broader economic impact, arguing that smart port implementations, such as automation, digital documentation, and predictive analytics, not only increase throughput capacity but also stimulate regional development by attracting high-value and time-sensitive cargo. While BP remains constrained by urban congestion and space limitations, its smaller scale may allow for quicker adaptation to smart port upgrades, which could serve as a differentiating factor.

2.2.3 Hinterland Connectivity & Regional Economic Spillovers

Port choice cascades regional logistics costs, trade flows, and economic distribution. Wang *et al*., (2022) underscore the importance of coordinated port-hinterland integration, noting that synchronized development between ports and inland logistics zones enhances economic resilience and distribution efficiency.

Thailand's push for EEC integration — especially with LCP as the key maritime gateway—aligns with this principle, positioning it as a hub for export-import activities and industrial clustering and value-added services (Jaiprasert & Maluleem, 2023). This port-centric model fosters long-term regional economic impact by lowering logistics bottlenecks and attracting FDI into manufacturing and processing (Kolcubaşı &Yıldırım, 2024; Liu & Wang, 2023).

2.2.4 Evolving Expectations: Green & Smart Governance

Though traditionally dominated by cost considerations, port choice behavior is beginning to reflect a shift toward digital and environmental performance. In Indonesia, Safuan (2024) and Satta *et al*., (2024) identify emerging stakeholder preferences for green and smart port features, driven by regulatory compliance and long-term efficiency gains.

While such considerations may still be secondary for freight forwarders in Thailand (as observed by Nguyen *et al*. 2024), their relevance is expected to grow, particularly as global supply chains face increased ESG scrutiny and decarbonization mandates. Thus, ports that preemptively adopt green strategies and digital transparency may secure future user loyalty and investment.

2.3 Supply Chain Integration and Logistics Performance

Ports are vital to achieving supply chain efficiency and resilience (Verschuur *et al*., 2022). As pointed out by Kolcubaşı & Yıldırım (2024), ports are crucial nodes for determining overall logistics efficiency and effectiveness. Overall transportation costs, inventory availability and reliability, and delivery time are all related to the movement of goods through port nodes, making ports not only trade gateways, but also key determinants in logistics performance. The port-centric logistics concept centers supply chain activities around an integrated port system to improve regional logistics performance and it emerged as a potentially effective approach to enhance regional trade (Kolcubaşı &Yıldırım, 2024; Liu & Wang, 2023).

In Thailand, BP and LCP are complementary, although strategically distinct, as BP supports domestic and short-sea routes. However, it faces congestion within an urban environment with minimal room for growth. On the other hand, LCP is Thailand's deep-sea main gateway capable of expanding with significant intermodal integration potential.

2.3.1 Port Quality and Trade Competitiveness

Munim and Schramm (2018) asserted that port quality and logistics efficiency are crucial to trade competitiveness, particularly in developing economies. Their findings echo Thailand's role in the Thailand-Malaysia-Singapore (TMS) logistics corridor (Jeevan *et al*., 2021). As trade volumes grow and regional production networks deepen, the performance of Thai ports becomes increasingly linked to the ability to support predictable and cost-effective logistics.

Jeevan *et al*., (2021) highlight that infrastructure bottlenecks, fragmented customs procedures, and a lack of digital coordination hinder logistics performance in the TMS corridor. These issues are especially pertinent at BP, where limited land-side access and aging facilities can create delays, increasing dwell times and reducing throughput efficiency. Addressing these constraints is essential if Thai ports are to support just-in-time supply chains and remain regionally competitive.

2.3.2 Hinterland and Intermodal Connectivity

The integration of ports with their hinterlands, through rail, road, and inland dry ports, directly influences supply chain fluidity, subsequently affecting the supply chain. This is consistent with Pietrzak *et al*., (2020), who reported that rail and intermodal access are fundamental to modern port competitiveness. Given these factors, LCP has made tremendous strides in enhancing intermodal rail services and connections with its inland container depots (Chuchottaworn & Raothanachonkun, 2024). These investments have ensured higher cargo throughput, reduced urban congestion, and sped up the supply chain delivery process.

Additionally Wang *et al*., (2022) highlight that the integration of supply chain via the hinterland logistics zone can enhance the port impact by attracting manufacturing and distribution activities. In the case of Thailand, the port development also has to fit with the plan of EEC, which can result in the synergy of logistics ecosystem where the port plays the role of both geographic node for leg exchange and industrial and logistical value-added activity.

2.3.3 Digitalization and Logistics Visibility

A modern supply chain relies heavily on real-time data, predictive analytics, and digital interfaces between stakeholders. Sirajuddin (2023) found that digitized port processes, such as electronic customs, digital booking, and port community systems, significantly improve logistics visibility and reduce delays. Thailand's ports are moving in this direction, but gaps remain, especially at BP, where legacy systems limit real-time coordination.

Safuan (2024) and Satta *et al*. (2024) further emphasize the increasing demand from stakeholders for integrated digital systems, particularly in contexts where logistics chains span multiple jurisdictions and transport modes. Implementing such systems at BP and expanding them at LCP would enhance logistics performance, particularly in handling high-frequency trade flows within ASEAN.

2.4 Sustainability and Green Port Initiatives

Environmental sustainability is emerging as a defining concern in port development and operations. The traditional focus on throughput and infrastructure expansion is now increasingly balanced by efforts to reduce the environmental footprint of port activities. As Mahmud *et al*., (2024) highlight, Asian ports have begun adopting green strategies, including Cold Ironing (CI), shore-to-ship power supply, renewable energy deployment, and emissions mitigation technologies. While progress varies across the region, many ports are aligning their development with the United Nations Sustainable Development Goals (SDGs) and the IMO 2030 and 2050 decarbonization targets.

In their comprehensive review of 478 publications, Xiao *et al*., (2024) emphasize that multi-stakeholder engagement—involving port authorities, terminal operators, shipping lines, and local governments—is fundamental to successfully implementing green port strategies. Sustainable port development requires infrastructure investment and governance structures that promote environmental compliance and innovation.

2.4.1 Regional Trends and Regulatory Pressures

Historically, Southeast Asian ports have lagged behind their European and East Asian counterparts in implementing green port practices. However, external pressures from international shipping alliances, trade partners, and environmental standards catalyze a shift. Safuan (2024) notes that Southeast Asian ports are more aware of their cost efficiency, carbon footprint, and environmental governance.

For Thailand, both Bangkok Port (BP) and Laem Chabang Port (LCP) are under growing scrutiny to improve their environmental performance. Constrained by its urban location and limited expansion potential, BP faces particular challenges in implementing large-scale environmental infrastructure. However, its urban proximity also presents opportunities for short-haul electrified logistics, eco-friendly last-mile solutions, and integration with city-wide sustainability goals.

2.4.2 Green Port Practices in Thailand

At the national level, the Port Authority of Thailand (PAT) has begun integrating green initiatives into strategic plans, especially at LCP, which offers more scalability. Current efforts include:

- pilot projects for shore power infrastructure to reduce emissions from berthed vessels,
- trials of alternative fuel sources, including LNG and biofuels,
- installation of solar panel systems for administrative and logistics facilities, and

- wastewater and stormwater management improvements to protect coastal ecosystems.

These actions reflect growing awareness of the need to transition toward eco-efficient port operations, especially at LCP, which is envisioned as a regional transshipment hub within the Eastern Economic Corridor (EEC). LCP is also poised to benefit from foreign investment and public-private partnerships to align ports with green logistics standards.

2.4.3 Digitalization as a Sustainability Enabler

Digital transformation plays a dual role in enhancing efficiency and environmental sustainability. Sirajuddin (2023) and Satta *et al*., (2024) argue that digital platforms, such as Port Community Systems (PCS) and Smart Gateways, not only improve cargo flow but also reduce idling time, streamline clearance processes, and thus lower emissions. Thailand's ports, especially LCP, are increasingly integrating such systems to optimize vessel scheduling and cargo handling in environmentally responsible ways.

2.5 Technological Advancements and Port Digitalization

The global maritime sector is transforming significantly by adopting smart port technologies to increase operational efficiency, ensure safety, and improve sustainability outcomes. These technologies—from Artificial Intelligence (AI) and blockchain to the Internet of Things (IoT) and digital twins—are driving ports toward a Fourth Industrial Revolution in logistics.

2.5.1 Smart Port Framework and Indicators

Molavi *et al*., (2022) provide a global perspective on integrating technologies into port logistics, emphasizing how AI algorithms optimize berth scheduling, blockchain ensures secure documentation, and IoT sensors enhance cargo tracking and predictive maintenance. These technologies improve efficiency and reduce environmental impacts through better resource use and emissions monitoring.

Locally, Makkawan and Muangpan (2021) developed the Smart Port Indicator (SPI) framework for Thailand, encompassing key dimensions such as operational efficiency, environmental performance, cybersecurity readiness, and intermodal connectivity. This framework serves as a blueprint for ports like BP and LCP, highlighting the necessity of performance benchmarks that guide smart port development and monitoring.

2.5.2 National Systems and Regional Connectivity

At the macro level, Tijan *et al*., (2019) argue the importance of Maritime National Single Window (NSW) systems to support interagency collaboration, reduce redundancies, and streamline customs clearance. Thailand's current NSW platform is still evolving, and its full integration with regional partners—especially Malaysia and Singapore—is essential for seamless trade in the Thailand-Malaysia-Singapore corridor (Jeevan *et al*., 2021).

Jeevan *et al*., (2021) underscore the need for digital harmonization to support just-in-time shipping, cargo transparency, and real-time documentation sharing. For BP and LCP, this means adopting cross-border data-sharing protocols and investing in digital infrastructure that aligns with ASEAN logistics digitalization strategies (Molavi, 2020; Sankla & Muangpan, 2022; Tang, 2024; Wang *et al*., 2024; Yau *et al*., 2020).

2.5.3 Emerging Technologies and Data Governance

While the benefits of digitalization are clear, future advancements come with complex demands. Xiao *et al*., (2024) highlight that intelligent shipping technologies—including automated terminals and smart vessel-port communication—will rely heavily on secure data architectures, real-time interoperability, and multi-source data analytics. Thailand's ports must therefore strengthen cybersecurity policies, enhance data integration platforms, and support intermodal smart systems (e.g., linking rail, road, and sea through unified tracking and scheduling).

In this context, LCP is better positioned than BP to serve as a digital logistics hub, due to its larger physical footprint, integration within the Eastern Economic Corridor (EEC) (Sumrit & Jaidee, 2024), and higher volume of international container traffic (Chuchottaworn & Raothanachonkun, 2024). LCP has initiated smart upgrades (Makkawan & Muangpan, 2021), such as automated gate systems, digital twin simulations, and IoT-based yard management—steps that could serve as a roadmap for BP, albeit at a smaller scale.

2.6 Research Gap and Theoretical Framework

Although the literature on port development, competitiveness, and sustainability has grown considerably in recent years, there remains a critical research gap in comparative analyses of individual port performance within the same national context. While numerous studies examine major ports in isolation—such as LCP as Thailand's flagship deep-sea hub or BP as a legacy inner-city terminal—few explore the strategic interdependence and contrasting development trajectories of these two critical nodes in Thailand's logistics network.

Most academic contributions, including those by Munim and Schramm (2018) and Jeevan *et al*., (2021), either take a macroeconomic perspective on port logistics performance or focus on regional integration across Southeast Asia. These works, while valuable, tend to generalize national port systems, overlooking the distinct operational, infrastructural, and policy-related challenges faced by different ports within the same country. As a result, the strategic roles and spatial complementarities between LCP and BP remain under-theorized.

2.6.1 Theoretical Integration

To address this research void, the present study adopts a multi-theoretical framework drawing from three key conceptual models:

1. Port Competitiveness Theory: Yeo *et al*., (2014) and Sirajuddin (2023) define port competitiveness as a function of infrastructure quality, hinterland connectivity, service efficiency, and stakeholder collaboration. This theory is instrumental in evaluating BP and LCP's competitive positioning in both domestic and international logistics chains. It also enables a benchmarking approach to analyze how each port aligns with global performance standards.
2. Supply Chain Performance Models: Kolcubaşı and Yıldırım (2024) provide a framework for analyzing logistics performance through supply chain integration, information-sharing, and resilience. Using this model, they assess how each port contributes to Thailand's overall supply chain efficiency, especially within the Thailand-Malaysia-Singapore trade corridor (Jeevan *et*

al., 2021). The model helps explain why infrastructure alone is insufficient without effective intermodal and digital integration (Sarkar & Shankar, 2021).

3. Sustainable Port Development Frameworks: Mahmud *et al*. (2024) propose a sustainability-oriented framework focusing on green technologies, emissions reduction, and stakeholder governance. This is particularly relevant given the emerging regulatory and environmental pressures facing both BP and LCP. The framework offers a lens to evaluate how environmental policies and green initiatives are being (or not being) embedded in Thai port operations.

2.6.2 Contributions of This Study

By synthesizing these three perspectives, this research:

- Provides a side-by-side comparative analysis of BP and LCP, addressing the lack of port-specific comparative studies in the Thai context.
- Offers a holistic interpretation of port roles, not just as transport nodes but as integrated agents within supply chain ecosystems and sustainability agendas.
- Bridges the gap between theoretical models and practical port management, offering actionable insights for policymakers, port authorities, and regional planners.

In doing so, this study makes a unique contribution to the literature on Southeast Asian port development by highlighting how two ports within the same national system can evolve along divergent strategic pathways, yet remain interlinked in terms of trade facilitation, infrastructure investment, and logistics modernization.

3. METHODOLOGY

This study employs a quantitative research design to analyze the strategic factors influencing the usage of BP in comparison with LCP within Thailand's logistics system. The methodology is designed to address the research questions and test the hypotheses outlined in the introduction, ensuring a rigorous and systematic approach to data collection and analysis.

3.1 Research Design

The research design follows a structured approach as illustrated in Figure 1. The design begins with problem identification and literature review, followed by formulating a research question and a hypothesis. The quantitative approach involves questionnaire design, sampling, data collection, and statistical analysis. This research design effectively identifies and analyzes the key strategic factors currently shaping port utilization, while enabling a direct comparative analysis of the BP and LCP ports. Finally, the results are interpreted, and conclusions are drawn to address the research questions.

The research design is based on a cross-sectional survey approach, allowing for data collection from a large sample of participants simultaneously. This framework is appropriate for identifying and analyzing the current factors affecting port usage and comparing BP and LCP.

3.2 Participant Selection and Characteristics

The target population for this study consists of stakeholders involved in Thailand's logistics and maritime

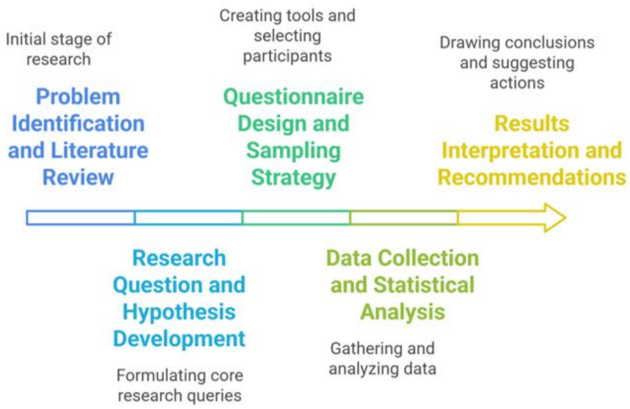

Figure 1 Research design framework.

sectors. Following Krejcie and Morgan's (1970) sample size determination table, a sample size of 384 was determined to be appropriate for a population exceeding 100,000 with a 95% confidence level and ±5% margin of error. We targeted 400 participants to account for potential non-responses or invalid data.

The five strategic factors examined in this study—Port Infrastructure and Capacity (PIAC), Location and Connectivity (LAC), Operational Efficiency (OE), Cost and Pricing (CAP), and Environmental and Social Responsibility (EASR)—were selected based on a comprehensive review of the literature on port competitiveness. These factors have been consistently identified in previous studies as key determinants of port choice and performance (Jeevan *et al*., 2021; Luo *et al*., 2022; Parola *et al*., 2017). The selection was further validated through pilot testing with experts to ensure relevance to the specific context of Thailand's port system.

Participants were selected using a stratified random sampling technique to ensure representation across different stakeholder groups. The stratification was based on the following categories:

1. Shipping lines and agents (25%)
2. Freight forwarders and logistics service providers (25%)
3. Exporters and importers (30%)
4. Port authorities and terminal operators (10%)
5. Other relevant stakeholders (e.g., customs brokers, transportation companies) (10%).

To be eligible for participation, individuals were required to have at least two years of experience in their respective roles and direct involvement in decision-making processes related to port usage or logistics operations in Thailand.

3.3 Data Collection Methods

Data collection was conducted over a three-month period from July to September 2023 through a structured questionnaire designed to capture information on the strategic factors influencing port usage (Appendix A). The questionnaire was developed based on the literature review and adapted to the specific context of Thailand's port system. It consisted of multiple sections. These include demographic information and professional background, Likert-scale questions assessing the importance of various strategic factors in port choice decisions, comparative questions evaluating BP and LCP on key performance indicators, and open-ended questions allow participants to provide additional insights or comments

The questionnaire was initially developed in English and then translated into Thai using a back-translation method to ensure accuracy and cultural appropriateness. It was pilot-tested with a small group of 20 industry experts to refine the questions and ensure clarity (Bamrungbutr, 2020).

Data collection was conducted over three months, using a combination of online surveys and in-person interviews to maximize response rates and ensure data quality. Online surveys were distributed via email and professional networking platforms, while in-person interviews were conducted at major logistics hubs and industry events in Thailand. Statistical analysis was performed using IBM SPSS Statistics version 26.

3.4 Data Analysis Procedures

The collected data underwent several preprocessing steps before analysis, including handling missing values, detecting outliers using Mahalanobis distance, and checking for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics were calculated to summarize participant characteristics and response patterns. The primary analytical method employed was multiple regression analysis, which allowed for identifying key strategic factors influencing port usage and comparing these factors between BP and LCP.

The data analysis process included the following steps:

1. Descriptive statistical analysis to summarize participant characteristics and overall response patterns.
2. Exploratory Factor Analysis (EFA) to identify underlying constructs and reduce the dimensionality of the strategic factors. Principal Component Analysis (PCA) with varimax rotation was selected due to its effectiveness in condensing a large set of variables into a smaller set of uncorrelated components while maintaining maximum variance. Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity were performed to assess the suitability of data for factor analysis.
3. Reliability analysis using Cronbach's alpha to assess the internal consistency of the measurement scales, with values above 0.7 considered acceptable (Nunnally & Bernstein, 1994).
4. Correlation analysis using Pearson's correlation coefficient to examine relationships between variables and check for multicollinearity.
5. Multiple regression analysis to determine the relative importance of different strategic factors in influencing port usage. Variance Inflation Factor (VIF) values were calculated to assess multicollinearity among predictors, with values below 5 considered acceptable (Hair *et al*., 2019). Regression models were validated with standard tests, including residual analysis, heteroscedasticity testing (Breusch-Pagan test), and normality testing of residuals (Kolmogorov-Smirnov test).
6. Comparative analysis using independent samples t-tests to identify significant differences in factor importance between BP and LCP

4. RESULTS

The results of our study provide comprehensive insights into the strategic factors influencing the usage of BP and LCP within Thailand's logistics system. This section presents the findings from our statistical analyses, organized to address the research questions and hypotheses.

4.1 Descriptive Statistics

Of the 400 questionnaires distributed, 378 valid responses were received, representing a response rate of 94.5% (Table 1). The average years of experience among respondents was 8.7 years (SD = 4.3), indicating a high level of industry expertise in the study's sample. The demographic breakdown of respondents is shown in Table 1.

Table 1 Respondent demographics (n=378)

Stakeholder Group	Number	%
Shipping lines and agents	95	25.1%
Freight forwarders and logistics service providers	94	24.9%
Exporters and importers	113	29.9%
Port authorities and terminal operators	38	10.1%
Other relevant stakeholders	38	10.1%

4.2 Exploratory Factor Analysis (EFA)

An EFA was conducted to identify the underlying constructs influencing port usage. The primary objective of employing EFA was to reduce the dimensionality of the data while retaining as much of the original variance as possible. Principal Component Analysis (PCA) with varimax rotation was selected as it produces orthogonal factors that are easier to interpret, making it particularly suitable for identifying distinct strategic factors influencing port usage.

Additionally, the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.891, indicating that the data were suitable for factor analysis. Bartlett's test of sphericity was significant ($\chi 2$ (120) = 3245.67, $p < .001$), further confirming the appropriateness of factor analysis. Principal component analysis with varimax rotation yielded five distinct factors explaining 72.3% of the total variance. Table 2 presents the factor loadings and reliability coefficients for each construct. All factors demonstrated good internal consistency with Cronbach's alpha values above 0.80.

Table 2 Factor analysis results.

Factor	Items	Factor Loadings	Cronbach's α
Port Infrastructure and Capacity (PIAC)	5	0.72 - 0.85	0.88
Location and Connectivity (LAC)	4	0.69 - 0.81	0.84
Operational Efficiency (OE)	4	0.75 - 0.88	0.89
Cost and Pricing (CAP)	3	0.78 - 0.86	0.85
Environmental and Social Responsibility (EASR)	3	0.71 - 0.83	0.82

4.3 Multiple Regression and Bangkok Port & Laem Chabang Port Comparative Analysis

This study employed multiple regression analyses to examine the factors influencing port usage at Bangkok Port (BP) and Laem Chabang Port (LCP), two major nodes in Thailand's logistics infrastructure (Table 3). The dependent variable—frequency of port usage—was assessed on a 5-point Likert scale.

For Bangkok Port, the regression model was statistically significant, explaining 53.4% of the variance in port usage ($R^2 = 0.534$, $p < .001$). Among the five strategic factors analyzed, Location and Connectivity (LAC) had the strongest influence ($\beta = 0.389$, $p < .001$), emphasizing BP's geographical advantage and efficient transport links. Port Infrastructure and Capacity (PIAC) also played a meaningful role ($\beta = 0.261$, $p < .001$), albeit to a lesser extent. Other factors—Operational Efficiency (OE), Cost and Pricing (CAP), and Environmental and Social Responsibility (EASR)—had more modest but still significant contributions, with EASR narrowly missing the conventional significance threshold ($p = .059$).

In comparison, the regression model for Laem Chabang Port accounted for a higher proportion of variance (61.2%) in port usage ($p < .001$), indicating stronger predictive power overall. The most influential factor for LCP was Port Infrastructure and Capacity (PIAC) ($\beta = 0.398$, $p < .001$), consistent with its reputation as a modern, high-capacity international gateway. This was followed by Operational Efficiency (OE) ($\beta = 0.276$, $p < .001$), reflecting LCP's emphasis on technology-driven operations. Interestingly, Location and Connectivity (LAC) was less influential for LCP ($\beta = 0.183$, $p < .001$) than for BP, suggesting that LCP's appeal lies more in its facilities and operations than geographic positioning.

Figure 2 visually compares the standardized beta coefficients, clearly depicting the divergent impact of strategic factors across the two ports. Notably, while LCP leads in infrastructure and operational metrics, BP maintains a distinct edge in locational attributes.

Table 3 Multiple regression results for Bangkok Port (BP) and Laem Chabang Port (LCP).

Factor	B BP	B LCP	SE B BP	SE B LCP	β BP	β LCP	t BP	t LCP	*p* BP	*p* LCP
Port Infrastructure and Capacity (PIAC)	0.287	0.425	0.052	0.049	0.261	0.398	5.519	8.673	<.001	<.001
Location and Connectivity (LAC)	0.412	0.201	0.048	0.051	0.389	0.183	8.583	3.941	<.001	<.001
Operational Efficiency (OE)	0.198	0.312	0.055	0.053	0.172	0.276	3.600	5.887	<.001	<.001
Cost and Pricing (CAP)	0.156	0.178	0.050	0.048	0.143	0.165	3.120	3.708	.002	<.001
Environmental and Social Responsibility (EASR)	0.089	0.112	0.047	0.045	0.082	0.104	1.894	2.489	.059	.013

Model Summary:
BP: $R^2 = 0.534$, Adjusted $R^2 = 0.527$, $F(5, 372) = 85.231$, $p < .001$
LCP: $R^2 = 0.612$, Adjusted $R^2 = 0.606$, $F(5, 372) = 117.345$, $p < .001$

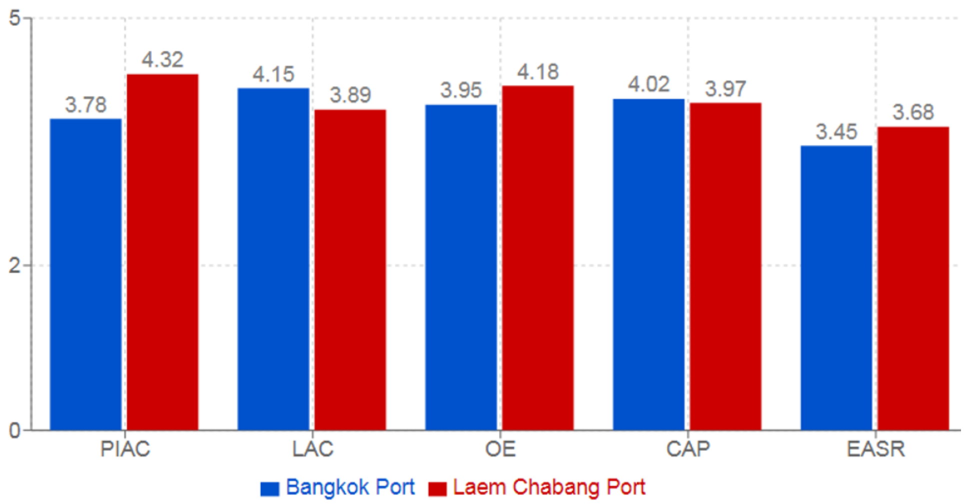

Figure 2 Comparative importance of strategic factors (Standardized Beta Coefficients) Port Infrastructure and Capacity (PIAC), Location and Connectivity (LAC), Operational Efficiency (OE), Cost and Pricing (CAP), and Environmental and Social Responsibility (EASR). Note: Statistical significance at p <0.001 for all factors except Cost and Pricing (CAP) (p=0.383).

The multicollinearity diagnostics revealed acceptable Variance Inflation Factor (VIF) values for all predictors in both models, ranging from 1.32 to 1.81, well below the commonly accepted threshold of 5 (Hair *et al*., 2019). This indicates that multicollinearity was not a concern.

A comparative analysis further illuminated the differential emphasis users place on strategic factors across the two ports. As shown in Table 4, LCP received significantly higher ratings for PIAC, OE, and EASR, supporting its position as the country's premier international port, known for its advanced infrastructure and sustainability measures. On the other hand, BP was rated significantly higher in LAC, aligning with its strength in regional and urban connectivity. No significant difference was observed for Cost and Pricing (CAP), suggesting that pricing strategies are comparably important at both facilities.

Table 4 Comparative analysis of strategic factors (Mean ± SD)

Factor	BP Mean (SD)	LCP Mean (SD)	t	*p*	Cohen's d
Port Infrastructure and Capacity (PIAC)	3.78 (0.89)	4.32 (0.76)	-9.874	<.001	0.65
Location and Connectivity (LAC)	4.15 (0.82)	3.89 (0.91)	4.623	<.001	0.30
Operational Efficiency (OE)	3.95 (0.88)	4.18 (0.79)	-4.132	<.001	0.27
Cost and Pricing (Cap)	4.02 (0.86)	3.97 (0.90)	0.874	.383	0.06
Environmental and Social Responsibility (EASR)	3.45 (1.02)	3.68 (0.95)	-3.541	<.001	0.23

4.4 Additional Insights and Implications

Beyond the quantitative findings, the study uncovered several noteworthy trends. Respondents rated LCP higher on key performance indicators such as container handling efficiency ($t = -7.234$, $p < .001$) and vessel turnaround time ($t = -6.542$, $p < .001$), further cementing its status as a leading international port. When asked about future development priorities, stakeholders highlighted the need for enhanced hinterland connectivity for BP (72% of respondents) and increased automation and digitalization for LCP (68% of respondents). These priorities reflect the distinct roles of the two ports: BP as a hub for domestic and regional trade, and LCP as a global logistics gateway.

Environmental and Social Responsibility (EASR) emerged as the least important factor in the regression models for both ports. However, qualitative responses suggested a shifting landscape, with 63% of respondents anticipating that EASR's importance will grow over the next five years, particularly for LCP. This trend aligns with global movements toward sustainability and corporate social responsibility in the maritime industry.

Stakeholders also emphasized the complementary roles of BP and LCP within Thailand's logistics system. While BP leverages its location and connectivity to serve domestic and regional markets, LCP focuses on international container traffic, supported by its superior infrastructure and operational efficiency. This complementary relationship underscores the need for coordinated policy and investment strategies to optimize the strengths of both ports.

Multiple regression analyses were conducted to determine the relative importance of the identified factors in influencing port usage for BP and LCP separately. The dependent variable was the frequency of port usage, measured on a 5-point Likert scale. The regression model for BP was statistically significant, explaining 53.4% of the variance in port usage. Location and Connectivity emerged as the strongest predictor ($\beta = 0.389$, $p < .001$), followed by Port Infrastructure and Capacity ($\beta = 0.261$, $p < .001$). The regression model for LCP was also statistically significant, explaining 61.2% of the variance in port usage. Port Infrastructure and Capacity was the strongest predictor ($\beta = 0.398$, $p < .001$), followed by Operational Efficiency ($\beta = 0.276$, $p < .001$).

5. DISCUSSION

The findings of this study provide critical insights into the strategic factors influencing the usage of BP and LCP within Thailand's logistics system. By addressing the research questions in the introduction, this discussion interprets the results, compares them with existing literature, and explores their implications for theory and practice.

5.1 Interpretation of Key Findings

The analysis identified five key factors influencing port usage: Port Infrastructure and Capacity (PIAC), Location and Connectivity (LAC), Operational Efficiency (OE), Cost and Pricing (Cap), and Environmental and Social Responsibility (EASR). The relative importance between BP and LCP varied significantly, reflecting their distinct characteristics within Thailand's logistics network.

For BP, Location and Connectivity emerged as the most critical factors, followed by Port Infrastructure and Capacity. This aligns with the port's historical role as a gateway to Thailand's capital and its proximity to major industrial zones. The emphasis on location is consistent with prior studies, which underscore the importance of geographic proximity in port choice decisions (Mdanat *et al*., 2024; Palyvoda *et al*., 2020; Tongzon & Sawant, 2007). However, the lower ratings for Port Infrastructure and Capacity compared to LCP suggest areas for improvement, echoing Yeo *et al*. (2014), who highlighted infrastructure quality as a key component of port competitiveness.

In contrast, LCP's usage was most strongly influenced by Port Infrastructure and Capacity, followed by Operational Efficiency. This reflects its role as Thailand's primary deep-sea port, designed to handle larger vessels and higher international trade volumes. The importance of operational efficiency aligns with the findings of Parola *et al*. (2017), who emphasized performance metrics as determinants of port competitiveness. Additionally, while Environmental and Social Responsibility was the least important factor overall, its higher rating at LCP suggests an emerging awareness of sustainability issues, consistent with global trends toward green port strategies.

5.2 Comparative Analysis and Implications

The comparative analysis reveals a nuanced picture of the complementary roles played by Bangkok Port and Laem

Chabang Port within Thailand's logistics system. The significant differences in the importance of strategic factors highlight how these ports cater to different market segments and trade flows.

5.2.1 Port Infrastructure and Capacity

The higher importance of this factor for LCP underscores its role as Thailand's premier container port for international trade. This aligns with Bottasso *et al.*, (2021), who emphasized the economic impact of port infrastructure investments. In contrast, BP's lower rating in this area suggests a need for targeted infrastructure upgrades to remain competitive.

5.2.2 Location and Connectivity

Bangkok Port's advantage in this area highlights its strategic position near urban centers and industrial zones, particularly for domestic and regional trade. This supports the port-centric logistics concepts by Kolcubaşı and Yıldırım (2024). For LCP, while location remains important, it is less critical than infrastructure and operational efficiency, reflecting its focus on international trade.

5.2.3 Operational Efficiency

Laem Chabang Port's higher rating in this area suggests that stakeholders expect greater efficiency from larger, more modernized ports. This aligns with Munim and Schramm (2018), who emphasized operational performance as a key driver of port competitiveness. While performing adequately, BP may need to invest further in streamlining operations to meet evolving stakeholder expectations.

5.2.4 Cost and Pricing

The lack of significant difference between the two ports in this factor indicates that pricing strategies may have reached a competitive equilibrium. This finding contrasts with earlier studies, such as Tongzon and Sawant (2007), which identified port charges as a significant differentiator in port choice. The convergence in pricing importance suggests that other factors, such as infrastructure and efficiency, are now more critical in port usage decisions.

5.3 Theoretical Implications

This study contributes to the literature on port competitiveness and strategic management in several significant ways.

First, it advances theoretical understanding by empirically validating a multi-dimensional model of port competitiveness in the context of Thailand's logistics system. By identifying five distinct factors that influence port usage and quantifying their relative importance, this research extends the work of Kolcubaşı and Yıldırım (2024) and provides a more nuanced framework for analyzing port choice decisions.

Second, the varying importance of strategic factors between BP and LCP challenges the notion of universal determinants of port competitiveness and underscores the need for context-specific models. This finding contributes to the theoretical discourse by highlighting how port characteristics, market positioning, and historical trajectories shape the factors that drive port usage.

Third, the results provide empirical support for the concept of port co-opetition proposed by Parola *et al.*, (2017), demonstrating how ports within the same national system can develop complementary specializations rather than engaging in direct competition. This advances our understanding of port dynamics in integrated logistics networks and suggests that theoretical models should account for these complementary relationships.

Fourth, the emerging importance of Environmental and Social Responsibility indicates a shift in the theoretical framework of port competitiveness. While traditional models have focused primarily on operational and economic factors, this study suggests that sustainability is becoming an increasingly relevant dimension, particularly for modern, internationally-oriented ports like LCP.

Finally, this research contributes to the theoretical understanding of port development in developing economies by illustrating how traditional river ports and newer deep-sea facilities can coexist and evolve within the same national logistics system. This has implications for port development theories and suggests the need for integrated models for the distinct but complementary roles of different port types.

5.4 Practical Implications

The findings of this study offer several actionable insights for port authorities, policymakers, and logistics stakeholders in Thailand and potentially other countries with similar port systems:

5.4.1 Targeted Development Strategies

Bangkok Port should prioritize enhancing hinterland connectivity and upgrading its infrastructure to maintain and strengthen its competitive position in domestic and regional trade. Specific recommendations include: 1) Investing in improved road and rail connections to key industrial zones; 2) Modernizing handling equipment to improve operational efficiency while developing specialized facilities for high-value regional cargo; and 3) Enhancing digital connectivity with other transport modes and logistics partners

Laem Chabang Port should focus on further improving its operational efficiency and expanding its capacity to meet growing international trade volumes. Specific actions could include: 1) Continued investment in automation and digitalization; 2) Expansion of deep-water berths to accommodate larger vessels; 3) Development of value-added services to enhance competitiveness; and 4) Implementation of traffic management systems to reduce congestion.

While these findings are specific to Thailand, they offer valuable insights for other developing economies with similar dual-port systems, particularly those balancing established river ports with newer deep-sea facilities.

5.4.2 Complementary Specialization

Rather than competing directly, the two ports should leverage their unique strengths through a coordinated national port strategy that positions: 1) Bangkok Port as the primary hub for domestic and regional trade, particularly for smaller vessels and time-sensitive cargo; 2) Laem Chabang Port as Thailand's international gateway, focusing on large-scale container operations and transhipment services; and 3) Integrated logistics corridors connecting the two ports to optimize cargo flows based on shipment characteristics, origin, and destination.

5.4.3 Sustainability Initiatives

Both ports should incorporate sustainability into their long-term development plans, with particular emphasis on: 1) Reducing carbon emissions through shore power facilities and alternative fuels - Implementing more stringent environmental monitoring and reporting; 2) Engaging with local communities to address social and environmental concerns; 3) Developing green incentive schemes for environmentally responsible port users; and 4) Establishing sustainability targets aligned with international standards.

5.4.4 Technology and Digitalization

Investments in automation and digitalization are crucial for enhancing operational efficiency, with priority areas including: 1) Implementation of port community systems to facilitate information sharing among stakeholders; 2) Deployment of smart port technologies for real-time monitoring and optimization; 3) Development of digital platforms for streamlined documentation and customs procedures; 4) Application of predictive analytics for better resource allocation and congestion management; and 5) Integration with national single window systems to reduce administrative burden.

5.4.5 Stakeholder Engagement

Ongoing engagement with logistics stakeholders is essential for understanding evolving needs and expectations. This should involve: 1) Regular consultation forums with key user groups - Periodic satisfaction surveys to identify areas for improvement; 2) Collaborative planning processes for major infrastructure investments; 3) Joint working groups on sustainability and digitalization issues; and 4) Transparent reporting and international benchmarking.

5.5 Practical Implications

The findings offer insights for port authorities, policymakers, and logistics stakeholders in Thailand:

5.5.1 Targeted Development Strategies

Bangkok Port should prioritize enhancing hinterland connectivity and upgrading its infrastructure to remain competitive in domestic and regional trade. On the other hand, Laem Chabang Port should focus on further improving its operational efficiency and expanding its capacity to handle growing international trade volumes.

Currently, LCP is doing this in its ongoing Phase 3 expansion—a 114-billion-baht ($3.3 billion USD) upgrade. As of October 2024, this upgrade has been described as the key in transforming LCP into a major regional logistics hub. The expansion aims to increase the port's annual container-handling capacity from 11 million Twenty-foot Equivalent Units (TEUs) to 18 million TEUs ("Laem Chabang Port Expansion," 2024). The new U-shaped port, 920 meters wide, 2,275 meters long and equipped with seven quays, will be able to accommodate a Super-Post Panamax (100,000 DWT with the capacity to carry more than 10,000 TEUs) (Figure 3). When the third phase completed, Thailand will rank among the top 10 countries in terms of port traffic.

This transformation is also expected to play a crucial role in reducing Thailand's logistics costs and strengthening its position as a key logistics gateway linking southern China to its ASEAN neighbors: Cambodia, Laos, Myanmar, and Vietnam.

Once completed, the project will increase the share of rail transport from 7% to 30% and raise the port's annual vehicle handling capacity from 2 million to 3 million units. These improvements are projected to lower transportation costs from 14% of GDP to 12%, resulting in estimated savings of approximately 250 billion baht.

Figure 3 Laem Chabang Port construction – Phase 3.

Once completed, the project will increase the share of rail transport from 7% to 30% and raise the port's annual vehicle handling capacity from 2 million to 3 million units. These improvements are projected to lower transportation costs from 14% of GDP to 12%, resulting in estimated savings of approximately 250 billion baht.

5.5.2 Complementary Specialization

The two ports should leverage their unique strengths rather than competing directly (Yu *et al*., 2023). Bangkok Port can focus on serving domestic and regional markets, while LCP focuses on its development as an international trade hub. This complementary approach can optimize Thailand's overall logistics system.

5.5.3 Sustainability Initiatives

Both ports, particularly LCP, should incorporate sustainability into their long-term development plans (Idris, 2022). This includes adopting green technologies, reducing emissions, and engaging with local communities to address environmental and social concerns (ESCAP, 2020).

5.5.4 Technology and Digitalization

Investments in automation and digitalization are crucial for enhancing operational efficiency, particularly at LCP (Jeevan *et al*., 2021). These technologies can help streamline processes, reduce turnaround times, and improve overall port performance (Pavlić Skender *et al*., 2020). These ideas are consistent with Kurniawan *et al*. (2022) who identified operation times, container handling times, and quay crane productivity as the most important components influencing container terminal performance.

5.5.5 Stakeholder Engagement

Ongoing engagement with logistics stakeholders is essential for understanding evolving needs and expectations. Regular feedback mechanisms can help port authorities align their strategies with stakeholder priorities.

5.6 Limitations and Future Research Directions

While this study provides valuable insights, it has certain limitations. The focus on two major Thai ports limits the generalizability of the findings to other contexts. Additionally, the study's cross-sectional nature does not capture changes in strategic factors over time. Future research could address these limitations by expanding the geographic scope to include other Southeast Asian ports and conducting longitudinal studies to track evolving trends.

Other potential research directions include investigating the impact of emerging technologies on port competitiveness, exploring the role of ports in supporting sustainable supply chains and analyzing the effects of regional trade agreements on port usage patterns. These studies could provide deeper insights into the dynamics of port competitiveness and inform strategies for optimizing Thailand's logistics system.

6. CONCLUSION

This study has made significant contributions to understanding the strategic factors that influence port usage in Thailand's logistics system, with important implications for both theory and practice. Through rigorous empirical analysis, we have identified and evaluated five key factors—Port Infrastructure and Capacity, Location and Connectivity, Operational Efficiency, Cost and Pricing, and Environmental and Social Responsibility—that shape the usage patterns of Bangkok Port and Laem Chabang Port.

Our findings reveal distinct patterns of influence across these factors for each port, highlighting their complementary roles within Thailand's logistics network. Bangkok Port's strength lies primarily in its strategic location and connectivity to urban centers and industrial zones, making it particularly valuable for domestic and regional trade. In contrast, Laem Chabang Port excels in infrastructure, capacity, and operational efficiency, establishing it as Thailand's premier gateway for international trade.

These differences underscore the need for tailored development strategies that leverage the unique strengths of each port while addressing their specific challenges. For Bangkok Port, enhancing infrastructure and operational efficiency should be prioritized, while maintaining its locational advantage. For Laem Chabang Port, continued investment in capacity expansion and technological advancement will be crucial to sustaining its competitive edge in international shipping.

The research also points to emerging trends that will shape future port development, particularly the growing importance of environmental and social responsibility. While currently less influential than other factors, sustainability considerations are likely to become increasingly significant drivers of port choice decisions, reflecting broader shifts in global supply chain management.

From a broader perspective, this study offers insights that extend beyond Thailand to other developing economies with similar port systems. The complementary relationship between established river ports and newer deep-sea facilities observed in Thailand may provide a model for optimizing national logistics networks elsewhere, particularly in Southeast Asia and other regions experiencing rapid maritime trade growth.

Looking ahead, the continued success of Thailand's port system will depend on coordinated planning, targeted investments, and strategic positioning within the evolving regional and global trade landscape. By understanding and responding to the factors that drive port usage, policymakers, port authorities, and logistics stakeholders can work together to enhance the competitiveness of both ports, ultimately strengthening Thailand's position as a key logistics hub in Southeast Asia.

Further research in this area could build on our findings by exploring how these strategic factors evolve over time, investigating the impact of emerging technologies and sustainability initiatives on port competitiveness, and examining how changing trade patterns might reshape the roles of different ports within national and regional logistics systems.

In conclusion, this study provides a foundation for informed decision-making and strategic planning in Thailand's port sector, with the goal of creating a more efficient, competitive, and sustainable logistics system that can effectively support the country's economic growth and integration into the global economy.

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DATA AVAILABILITY STATEMENT

Data available upon request to the authors.

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APPENDIX A: QUESTIONNAIRE

Strategic Comparative Logistics Questionnaire: Bangkok Port and Laem Chabang Port

Introduction

Dear Respondent,

Thank you for participating in this research study on the strategic factors influencing port usage in Thailand's logistics system. This questionnaire aims to analyze the comparative advantages and strategic roles of Bangkok Port and Laem Chabang Port. Your expertise and insights are invaluable to this research. The questionnaire should take approximately 15-20 minutes to complete. All responses will be kept confidential and used solely for research purposes. The findings will contribute to enhancing Thailand's logistics infrastructure and port development strategies.

Section 1: Respondent Profile

1. Please indicate your role in the logistics/shipping industry:
   - ☐ Shipping line/agent
   - ☐ Freight forwarder/logistics service provider
   - ☐ Exporter/importer
   - ☐ Port authority/terminal operator
   - ☐ Customs broker
   - ☐ Transportation company
   - ☐ Other (please specify): _______________
2. Years of experience in the logistics/shipping industry:
   - ☐ Less than 2 years
   - ☐ 2-5 years
   - ☐ 6-10 years
   - ☐ 11-15 years
   - ☐ More than 15 years
3. Company size (number of employees):
   - ☐ Small (1-50)
   - ☐ Medium (51-200)
   - ☐ Large (more than 200)
4. Frequency of port usage (Bangkok Port):
   - ☐ Daily
   - ☐ Weekly
   - ☐ Monthly
   - ☐ Quarterly
   - ☐ Rarely or never
5. Frequency of port usage (Laem Chabang Port):
   - ☐ Daily
   - ☐ Weekly
   - ☐ Monthly
   - ☐ Quarterly
   - ☐ Rarely or never
6. Primary type of cargo handled by your organization:
   - ☐ Container
   - ☐ Bulk
   - ☐ Break bulk
   - ☐ Roll-on/Roll-off
   - ☐ Liquid bulk
   - ☐ Other (please specify): _______________
7. Primary trade routes used by your organization:
   - ☐ Domestic (within Thailand)
   - ☐ Regional (Southeast Asia)
   - ☐ Asia-Pacific
   - ☐ Europe
   - ☐ Americas
   - ☐ Middle East/Africa

☐ Other (please specify): _______________

Section 2: Port Infrastructure and Capacity (PIAC)
Please rate the importance of the following factors in your decision to use a port, and then rate how Bangkok Port and Laem Chabang Port perform on each factor.
Rating Scale: 1 = Not important at all, 2 = Slightly important, 3 = Moderately important, 4 = Very important, 5 = Extremely important

No.	Factor	Importance	Bangkok Port Performance	Laem Chabang Port Performance
8.	Vessel handling capacity (maximum vessel size accommodation)	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
9.	Container handling capacity (TEUs per year)	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
10.	Quality and availability of handling equipment (cranes, vehicles, etc.)	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
11.	Storage capacity and warehouse facilities	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
12.	Specialized facilities for different cargo types	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

Section 3: Location and Connectivity (LAC)
Rating Scale: 1 = Not important at all, 2 = Slightly important, 3 = Moderately important, 4 = Very important, 5 = Extremely important

No.	Factor	Importance	Bangkok Port Performance	Laem Chabang Port Performance
13.	Proximity to your main production or distribution centers	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
14.	Road network connectivity and quality	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
15.	Rail connectivity and service frequency	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
16.	Connectivity to other transportation modes (intermodal connections)	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

Section 4: Operational Efficiency (OE)
Rating Scale: 1 = Not important at all, 2 = Slightly important, 3 = Moderately important, 4 = Very important, 5 = Extremely important

No.	Factor	Importance	Bangkok Port Performance	Laem Chabang Port Performance
17.	Vessel turnaround time	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
18.	Cargo handling speed and efficiency	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
19.	Documentation and customs clearance efficiency	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
20.	Information systems and digital technology implementation	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

Section 5: Cost and Pricing (CAP)
Rating Scale: 1 = Not important at all, 2 = Slightly important, 3 = Moderately important, 4 = Very important, 5 = Extremely important

No.	Factor	Importance	Bangkok Port Performance	Laem Chabang Port Performance
21.	Port charges and fees	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
22.	Total logistics cost (including inland transportation)	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
23.	Cost predictability and transparency	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

Section 6: Environmental and Social Responsibility (EASR)
Rating Scale: 1 = Not important at all, 2 = Slightly important, 3 = Moderately important, 4 = Very important, 5 = Extremely important

No.	Factor	Importance	Bangkok Port Performance	Laem Chabang Port Performance
24.	Environmental management and green initiatives	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
25.	Community engagement and social responsibility programs	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]
26.	Safety record and protocols	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]	1[ ] 2[ ] 3[ ] 4[ ] 5[ ]

Section 7: Port Development and Future Perspectives

27. How important do you think each of these factors will be for Thailand's port competitiveness in the next 5 years? (1 = Not important at all, 5 = Extremely important)
- Enhanced hinterland connectivity: 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ]
- Increased automation and digitalization: 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ]
- Green port initiatives: 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ]
- Port capacity expansion: 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ]
- Integration with special economic zones: 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ]

28. Which areas should Bangkok Port prioritize for development? (Select top 3)

☐ Infrastructure modernization
☐ Improved road/rail connectivity
☐ Expanded capacity
☐ Automation and digitalization
☐ Environmental sustainability
☐ Operational efficiency
☐ Cost competitiveness
☐ Value-added services
☐ Other (please specify): ________________

29. Which areas should Laem Chabang Port prioritize for development? (Select top 3)

☐ Infrastructure modernization
☐ Improved road/rail connectivity
☐ Expanded capacity
☐ Automation and digitalization
☐ Environmental sustainability
☐ Operational efficiency
☐ Cost competitiveness
☐ Value-added services
☐ Other (please specify): ________________

30. In your opinion, how complementary are the roles of Bangkok Port and Laem Chabang Port within Thailand's logistics system?

☐ Not complementary at all (direct competitors)
☐ Slightly complementary
☐ Moderately complementary
☐ Very complementary
☐ Perfectly complementary (completely different roles)

31. How do you think the balance of usage between Bangkok Port and Laem Chabang Port will change over the next decade?

☐ Bangkok Port usage will significantly increase compared to Laem Chabang Port
☐ Bangkok Port usage will slightly increase compared to Laem Chabang Port
☐ The balance will remain roughly the same
☐ Laem Chabang Port usage will slightly increase compared to Bangkok Port
☐ Laem Chabang Port usage will significantly increase compared to Bangkok Port

Section 8: Additional Comments

32. What do you see as the main strategic advantage of Bangkok Port over Laem Chabang Port?

……

33. What do you see as the main strategic advantage of Laem Chabang Port over Bangkok Port?

………

34. Please provide any additional comments or suggestions regarding the strategic roles of Bangkok Port and Laem Chabang Port within Thailand's logistics system.

……

Thank You

Thank you for completing this questionnaire. Your insights will contribute to understanding the strategic factors influencing port usage in Thailand and help inform future port development policies and strategies.

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