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A NOVEL APPROACH FOR STRATEGIC PARTNER SELECTION IN THE VIETNAMESE LOGISTICS INDUSTRY USING TWO-STAGE NON-PARAMETRIC DEA MODEL OF SUPER-SBM AND RESAMPLING FORECASTING TECHNIQUE

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Due to our limited knowledge and practical experience in this field, the thesis may have shortcomings and limitations. With a spirit of eagerness to learn and continuously absorb new knowledge, we sincerely appreciate and welcome any feedback and contributions from others. This will enable us to learn from our experiences, continue to improve, and strive for excellence.

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ABSTRACT

The rapid expansion of international trade is propelling significant growth within the logistics industry. While this growth presents numerous opportunities, it also introduces competitive challenges for logistics enterprises worldwide. In this dynamic landscape, the strategic selection of alliances emerges as a crucial solution for enhancing operational efficiency and achieving sustainable success. However, despite notable instances of influential and successful strategic alliances on a global scale, the adoption of such collaborations remains limited in Vietnam. Many businesses within the Vietnamese logistics sector continue to function independently, lacking the necessary connectivity and synergy.

This research aims to evaluate the performance trajectory of 22 logistics enterprises in Vietnam across historical, current, and future periods to identify the most suitable strategic alliance. To achieve this goal, we introduce a novel methodology that combines a two-stage Data Envelopment Analysis (DEA) Model, the Super Slack-Based Measure Model (Super-SBM), and the Resampling technique. Employing the Super-SBM method, we assess the operational efficiency of these 22 logistics enterprises for ten years (2013-2022). Furthermore, through applying Resampling, we forecast performance pre-and post-implementation of strategic alliances for the subsequent five years (2023-2027). Our findings reveal that 19 out of the 22 decision-making units (DMUs) demonstrated effective operations from 2013 to 2022.

Notably, Vicem Joint Stock Company (JSC) (DMU7) emerged as the target DMU due to its consistently lower operational efficiency. By leveraging accurate and suitable estimates from the forecasting method, specifically Hybrid, DMU7 can judiciously select a partner that aligns with its strategic goals, fostering operational effectiveness over the five-year horizon. It is essential to underscore that selecting a strategic alliance necessitates a dual perspective, considering the interests and aspirations of both partners to ensure the optimal choice. This study offers an initial portrayal of the operational landscape within Vietnam's logistics industry, equipping enterprises with insights to recognize and evaluate their own performance. Moreover, it presents viable strategies for sustained development. Our research also delivers dependable forecasting outcomes, providing managers and strategists with actionable plans to enhance operational efficiencies. Investors are also poised to benefit, armed with a robust foundation for making informed investment decisions. Ultimately, this study contributes to the broader knowledge landscape, supporting the overall success of the global logistics sector, particularly within Vietnam's context.

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ABBREVIATIONS AND ACRONYMS LIST

Abbreviation	Full definition
DEA	Data Envelopment Analysis
Super-SBM	Super Slacks-Based Measure
DMU	Decision-Making Unit
JSC	Joint Stock Company
WTO	World Trade Organization
LPI	Logistics performance index
GDP	Gross domestic product
TL	Total Liabilities
TE	Total Equity
SG&A	Selling, General and Administrative Expenses
COGS	Cost of Goods Sold
IT	Inventory Turnover
DSO	Days Sales Outstanding
DPO	Days Payable Outstanding
REV	Revenue
NPM	Net Profit Margin
ROA	Return on Assets
ROE	Return on Equity
EPS	Earnings Per Share
DER	Debt–to-Equity Ratio
CR	Current Ratio
QR	Quick Ratio
MAPE	Mean Absolute Percentage Error
CLM	Council of Logistics Management
MTO	Multimodal Transport Operator
CAGR	Compound annual growth rate
SMEs	Small and Medium-sized enterprises
PPF	Production Possibility Frontier
BBC	Banker-Charners-Cooper
CCR	Charners-Cooper-Rhodes

CFI	Corporate Finance Institute
UPS	United Parcel Service
FCL	Full Container Load
LCL	Less than Container Load
UNCTAD	United Nations Conference on Trade and Development

CHAPTER 1: INTRODUCTION

1.1. Background

1.1.1. Topic Background

International trade has been gradually growing in recent years due to deepening and expanding globalization and economic interconnection, which has opened up a wide range of prospects for import-export businesses and the national economy. Particularly important to international trade are logistics services. To satisfy consumer needs, Souza et al. (2007) describe logistics as a component of the supply chain process that organizes, carries out, and manages the efficient, effective movement and storage of products, services, and associated information from the point of origin to the point of consumption. Additionally, population densities in cities are rising along with urbanization rates, making it harder and harder to sustainably provide such metropolitan regions with commodities (Nitsche, 2021). The logistics industry faces numerous challenges, such as navigating trade policies and tariffs, addressing infrastructure limitations, and managing geopolitical uncertainties. Moreover, the logistics industry is adapting to emerging trends like sustainable practices, digitalization, and integration of artificial intelligence and automation. Despite the challenges, international trade offers immense opportunities for logistics providers to expand their global reach, forge strategic partnerships, and capitalize on the growing demand for efficient and cost-effective supply chain solutions. Vietnam is one of the most sought-after rising markets because of its abundant natural resources, low cost of raw materials, and high worker productivity. On the other hand, the terrain of our nation is conducive to fostering geographic and political advantages in the development of logistical facilities, including deep-water harbors, international airports, the Trans-Asian railway system, and global transport hubs.

Vietnam's logistics market is seen as a developing one, and it is contributing more and more to the country's economic growth solutions. The potential of digital transformation is one that the logistics service sector must seize. This sector is crucial, a leader in services with high added value, the cornerstone of trade development, and it helps to make the logistics sector a more competitive economy. In 2007, Vietnam formally joined the World Trade Organization (WTO), opening the door for its nation to engage in the global market (Limbourg, Giang and Cools, 2016). **Table 1.1** shows the past logistics status quo in Vietnam over the period of 2007–2018 (Worldbank, 2018). The World Bank revealed Vietnam's position among 160 countries by employing the logistics performance index (LPI); Vietnam ranked 53rd from 2007 to 2012 and increased to 48th in 2014, but decreased to 64th in 2016, again increasing to 39th in 2018. The database of international shipments showed a continuous increase from 3.00 to 3.22 during the 2007–2014 period; however, this figure decreased to 3.12 in 2016 and again increased to 3.16 in 2018.

Table 1. 1: Vietnam's Logistics Performance Index (Worldbank, 2018)

Year	LPI Rank	LPI Score	Customs	Infrastructure	International Shipments	Logistics Quality/Competence
2018	39	3.27	2.95	3.01	3.16	3.4
2016	64	2.98	2.75	2.7	3.12	2.88
2014	48	3.15	2.81	3.11	3.22	2.88
2012	53	3	2.65	2.68	3.14	2.68
2010	53	2.96	2.68	2.56	3.04	2.89
2007	53	2.89	2.89	2.5	3	2.8

The logistics sector in Vietnam has grown at a pace of 12–14% during the past several years (Vu, 2022). Since 2010, the quantity of commodities imported and exported has increased by 3.6 times. From 157 billion USD in 2010 to 544 billion USD in 2020, the GDP has expanded by 2.4 times, with exports contributing significantly to this expansion by growing at an average rate of 4.5% each year. The COVID-19 outbreak has had a significant negative influence on the economy over the last two years, posing hitherto unheard-of challenges in every sphere of human life, including the economics, culture, and tourism, and particularly placing great strain on production capacity and the worldwide supply chain. Although still growing by double digits, is the import and export industry. A rise of 22.3% during the same time was seen in the entire import-export turnover of products, which came to USD 600 billion, with exports amounting to around USD 300 billion. As an aid in the transshipment of commodities, this outcome beneficially supports Vietnam's logistics sector. Despite the greatest difficulties, logistics companies have maintained the normal operation of Vietnam's supply chains by assisting with transporting massive amounts of import and export cargo (Dangcongsan.vn, 2021).

1.1.2. Practical Problem

Vietnamese logistics firms confront several challenges in terms of scale, capital, infrastructure, storage, equipment, application of information technology, managerial ability, and human resources despite the country's good development rate. Besides, they also have fewer strategic advantages compared to other developed countries (atmglobaltrans.com.vn, 2018). According to The Ministry of Industry and Trade's Vietnamese (2022), in terms of capital, labor, and technology, the majority of logistics enterprises in Vietnam are still small and medium-sized. Additionally, the financial potential is still constrained (80% of the enterprises that are now operating have registered capital between VND 1.5 and 2 billion). Vietnam's logistics are still inexperienced and have low competitiveness, which prevents it from having the chance to enter the market with high demand in addition to financial issues. Additionally, there are gaps in the synchronization of links between businesses and throughout the various phases of logistical activity (tbtagi.angiang.gov.vn, 2022). The High Cost in Vietnam's logistics sector, when compared to nations like Thailand, China, and Malaysia, is one of the major problems. Therefore, reducing expenses is a great method to improve performance. Small and medium-sized enterprises in Vietnam can acquire financing, reduce transportation expenses, and boost operational effectiveness thanks to the cooperation of logistics firms. Additionally, by coordinating to link transport operations, broadening the source of information, and establishing new service sectors in this billion-dollar service value chain, this partnership will help Vietnamese logistic enterprises satisfy local demand rates. Therefore, the goal of this study is to evaluate how well strategic alliances help Vietnamese logistics companies operate more effectively.

1.2. Research Objectives

With an unwavering spirit, the objectives of this study emerge as beacons of knowledge, guiding our exploration into uncharted territories as follows:

Research Objective 1: Evaluate the performance of 22 logistics enterprises in Vietnam for ten consecutive years from 2013 to 2022.

Research Objective 2: Forecast and evaluate the effectiveness before and after the implementation of the strategic alliance in the next five years, from 2023 to 2027.

Research Objective 3: Compare the effectiveness before and after the implementation of the strategic alliance to make decisions for choosing the appropriate strategic alliance.

1.3. Research Questions

In this study, three research questions have been formulated to address the overarching objectives of evaluating efficiency, analyzing forecasts, and selecting appropriate alliances. These research questions delve into specific aspects and aim to provide insights into the following:

Question 1: What is the efficiency score of the 22 logistics companies in Vietnam from 2013 to 2022?

Question 2: What will be the efficiency scores before and after the implementation of the strategic alliance in the next five years, from 2023 to 2027?

Question 3: Which strategic alliances are appropriate for selection?

1.4. Research Scope

This thesis selects the alliance strategy between companies to increase efficiency in Vietnam. This study carefully considers the 22 companies' logistics in Vietnam from 2013 to 2022

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1.5. Research Methodology and Data View

1.5.1. Research Methodology

The Super-SBM method, a noteworthy technique widely employed in various DEA models, presents a vital role in conducting comprehensive evaluations of the operational efficiency and effectiveness of DMUs. With its exceptional potential and robust analytical foundation rooted in the principles of input-output analysis, the Super-SBM method has firmly established itself as a prominent approach for evaluating performance (Parman and Featherstone, 2019). Moreover, the Resampling forecasting technique offers several advantages in performance evaluation and forecasting by leveraging the strengths of the Super-SBM method and prediction techniques. By incorporating resampling techniques like bootstrapping, it generates multiple forecast scenarios, capturing data uncertainty and comprehensively assessing future performance (Sinharay, 2009; Lamberti, 2023). Additionally, the Resampling forecasting technique is well-suited for analyzing complex and heterogeneous datasets. It is valuable in industries or sectors where traditional forecasting techniques struggle with multiple inputs and outputs (Sinharay, 2009; Lamberti, 2023).

The authors use the two-stage DEA approach to answer the questions, which combines the Super-SBM and Resampling models. As a result, the authors' purposes were achieved. Using the Super SBM model, this paper assessed the efficiency score of Vietnamese logistics companies from 2013 to 2022. On the other hand, the Resampling model the author has used to forecast the data and the effective score for the next five years from 2023 to 2027.

1.5.2. Data View

The dataset used in this study comprises financial data from 2013 to 2022. The DEA Solver software was employed as a critical processing tool to analyze the nonparametric input/output variables and assess the logistics performance of 22 companies within Vietnam. This software facilitates evaluating these companies' operational efficiency and effectiveness in logistics. The collected financial data in conjunction with the DEA Solver software and forms the basis for the comprehensive analysis conducted in this study.

1.6. Conclusion

Chapter 1 provides background information and some critical points relevant to this study. This chapter will cover the thematic background, practice problem, research objective, research question, research scope, and methodology. Furthermore, it introduces the study's fundamental concept. Technical words that were utilized in the study will be highlighted in the next chapter.

1.7. Thesis Outline

Chapter 1: Introduction

This section is an introduction to the role of logistics in the economy and the importance of improving strategic alliance Vietnam's logistics performance. This section also provides research objectives, scope, subjects, questions, methodology and data used in the research.

Chapter 2: Literature review

The second chapter contains a number of literature reviews that are pertinent to the thesis topic. Definitions and general logistics, and strategic alliance theories are indicated to support research as well. The literature review will also review studies conducted to assess the effectiveness of companies in strategic alliance logistics in Vietnam as well as the specific implementation of DEA methods.

Chapter 3: Methodology

The research methodologies are introduced in this third chapter to clarify the research topic. The research team used two techniques: The super-SBM model and Resampling

Method. Based on established theories and assumptions, the research formula and conclusions are developed.

Chapter 4: Analysis and findings

This chapter is an important chapter of the research topic. From the data analysis, the research team offers the results of research methods and discussion about their significant implications.

Chapter 5: Conclusion, Limitations, and Future Works

Chapter five outlines the research's important findings as well as the study's limitations. Furthermore, proposals for additional research will be explained here.

CHAPTER 2: LITERATURE REVIEW

2.1. Literature Review on Logistic Industry and Strategic Alliance

2.1.1. Literature Review on Logistics Industry

Logistics is part of the supply chain process that includes planning, organizing, implementing, controlling efficiency, efficient circulation, and storing goods and services (Oboloo.com, 2023). It also involves the flow of information from the source to the consumer locations in a productive and efficient manner to meet customer needs. While the term "logistics services" is not widely discussed worldwide, in Vietnam, the concept of logistics services was mentioned in the 2005 Commercial Law. Logistics services are commercial activities in which traders organize and perform one or more tasks, including receiving goods, transportation, warehousing, storage, customs procedures, other documents, customer consulting, packaging, labeling, delivery, or other related services for goods based on agreements with customers to receive remuneration (accgroup.vn, 2023). Logistics services are similar to the activities of freight forwarders, where business entities providing services, such as receiving goods, transportation, customs clearance, etc., are considered logistics service providers. Therefore, logistics services encompass various transportation elements, and logistics service providers are similar to Multimodal Transport Operators (MTOs). However, logistics services here should be understood as a comprehensive service consisting of multiple services, spanning from pre-production to the final delivery to end consumers. Accordingly, logistics services are closely associated with the stages of sourcing raw materials, providing fuel for the production process, manufacturing goods, and entering distribution channels for delivery and distribution.

In tandem with the robust evolution of the global economy towards globalization and regionalization, the significance of logistics services is steadily amplifying. Logistics costs in Vietnam account for about 16.8% of the value of goods, while the global average is only about 10.6%. It can be seen that logistics costs have been and continue to be a burden for exporters, and it is possible that this situation will be even heavier this year (Phan, 2022). Therefore, the establishment and development of logistics services will help businesses and the entire national economy reduce costs in the logistics chain, streamline the production and business process, and achieve greater efficiency. Reducing production costs and improving the efficiency of production and business activities contribute to enhancing the competitiveness of businesses in the market. Logistics services are a more extensive and complex type of service compared to pure transportation and delivery operations. Previously, transportation service providers only offered customers simple, basic, and individual services. Nowadays, due to the development of production and circulation, the components of a product can be sourced from multiple countries.

Conversely, a company's product can be consumed in various countries and markets. Therefore, the services requested by customers from transportation and delivery businesses need to be diverse and comprehensive. Modern-day transport and delivery providers have deployed various services to meet the practical demands of customers, transforming themselves into logistics service providers. Clearly, logistics services have contributed to increasing the business value of transport and delivery companies. Production is aimed at serving consumption, so in business operations, the market is always a significant concern for manufacturers and businesses. Manufacturers and businesses that seek to dominate and expand their market for their products require the support of logistics services. Logistics services act as a bridge in the efficient transportation of goods along new routes to new markets, meeting time and location requirements. The development of logistics services plays a crucial role in exploring and expanding business markets for enterprises.

Also, the study conducted by United Nations Conference on Trade and Development (UNCTAD) furnishes country-specific insights into the requisite documentation for export operations. This research underscores the trade-offs inherent in processing rate documents (UNCTAD.org, 2011). The data reveals that the expenses incurred in document preparation represent the most significant cost factor in the export process in many developing countries. For instance, Indian exporters face costs of $350 for document preparation, $150 for port and terminal handling, $120 for Customs clearance, and $200 for inland transport. On the other hand, in countries like Germany, which have highly simplified and automated processes, the costs for document preparation were reported to be $85 per shipment. This data suggests that simplifying and automating document procedures for developing countries and transition economies is a crucial approach to enhancing competitiveness with relatively low investment costs. Logistics has provided comprehensive and diverse package services that significantly reduce costs associated with paperwork and documentation in international trade. Multimodal transportation services offered by logistics service providers have eliminated many costs associated with procedural paperwork, upgraded and standardized documentation, and reduced office workloads in the flow of goods, thereby enhancing the efficiency of international trade. In addition, alongside the development of electronic logistics, it will bring about a revolution in transportation and logistics services. The costs associated with paperwork and documentation in the flow of goods will be greatly reduced to a minimum. As the quality of logistics services continues to improve, spatial and temporal barriers to the movement of raw materials and goods will be further narrowed. Countries will be brought closer together in production and circulation activities (Bui, 2022).

The context in Vietnam

Vietnam's logistics market holds the 10th position among the top 50 emerging logistics markets globally, as per the Agility 2023 ranking (Agility, 2023).

Table 2. 1: Agility Emerging Markets Logistics Index 2023

Overall Rankings | Domestic Logistics Opportunities | International Logistics Opportunities | Business Fundamentals | Digital Readiness

Ranking	Country	Domestic Opportunities	International Opportunities	Business Fundamentals	Digital Readiness	Overall
1	China	8.47	9.75	7.11	6.63	8.31
2	India	8.04	7.45	5.94	7.61	7.43
3	UAE	5.60	5.89	9.10	7.37	6.59
4	Malaysia	5.29	5.88	7.85	6.72	6.16
5	Indonesia	6.34	5.89	5.77	6.21	6.08
6	Saudi Arabia	5.38	5.74	7.86	6.30	6.07
7	Qatar	5.91	4.96	7.92	6.38	6.02
8	Thailand	5.11	5.98	5.77	6.04	5.67
9	Mexico	5.37	6.32	4.93	5.11	5.55
10	Vietnam	5.02	6.03	5.61	5.43	5.52
11	Turkey	5.14	5.70	5.80	5.50	5.49
12	Oman	4.95	4.88	7.24	5.81	5.46
13	Chile	4.83	5.18	7.01	5.55	5.43

The Vietnam logistics market is poised for steady growth in the coming years, with a projected compound annual growth rate (CAGR) of 5.5% from 2022 to 2027. This growth is in line with the remarkable economic recovery experienced after the Covid-19 pandemic, as evidenced by a surge in GDP to 8.93% in the first nine months of 2022. These positive indicators bode well for the logistics industry in Vietnam. The Vietnam Logistics Report for 2021 sheds light on the gradual improvement in Vietnam's logistics ecosystem.

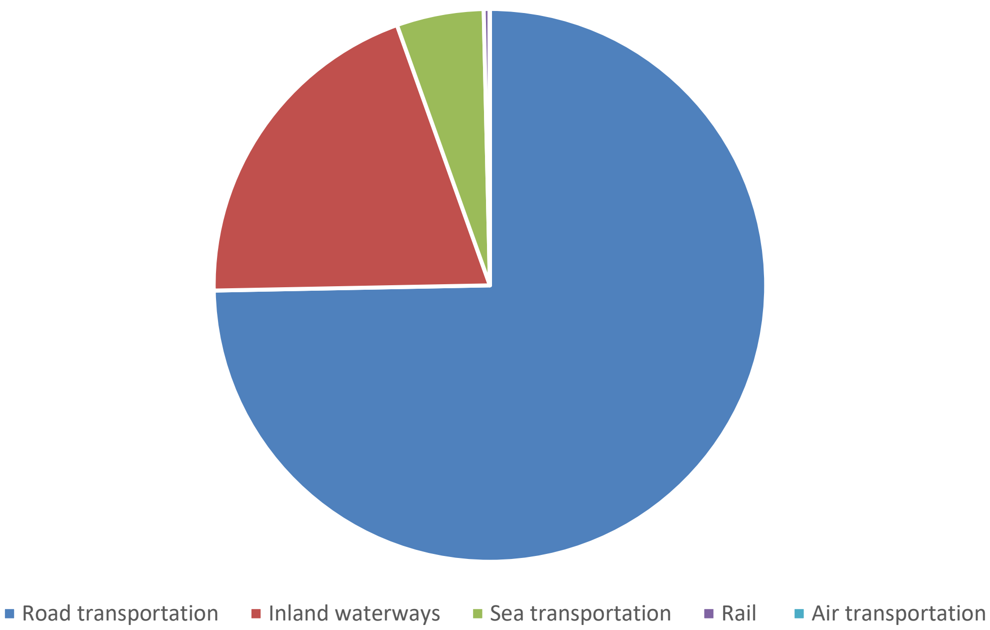


Chart 2. 1: Models of Vietnam transportation during the quarter

Among the different modes of transportation, road transportation remains the dominant player, accounting for 74.7% of the total volume of goods transported in the first nine months of 2021. This is followed by inland waterways at 19.84% and sea transportation at 5.10%. However, rail and air transportation have relatively limited volumes, comprising only 0.34% and 0.02% of the total volume of goods transported during the same period, respectively (vneconomy.vn, 2022). While rail and air transportation may have lower shares in the overall transport volume, the Vietnam Logistics Report emphasizes the significance of air transportation in the country's cargo volume, particularly in terms of contributing to the total export value. Air transportation plays a crucial role, contributing to 25% of Vietnam's total export value. This aspect holds substantial importance when formulating development plans for the logistics industry in Vietnam. As the country aims for sustained economic growth, improving the logistics infrastructure and diversifying transportation modes will be vital. Investments in road networks, inland waterways, and sea transportation will continue to be crucial to support the growing demands of the logistics industry.

Moreover, enhancing the rail and air transportation systems can unlock additional potential and enable Vietnam to handle domestic and international cargo shipments efficiently. The projected CAGR of 5.5% for the Vietnam logistics market from 2022 to 2027 reflects the positive outlook for the industry. With the country's economy rebounding strongly from the impacts of the Covid-19 pandemic, the logistics sector is expected to play a pivotal role in supporting trade and facilitating the movement of goods. As Vietnam progresses, it will be essential to prioritize the development of a well-connected and efficient logistics ecosystem to harness the full potential of its burgeoning economy.

Vietnam is currently home to a substantial number of companies involved in the logistics sector. Approximately 4.000 - 4.500 companies are directly engaged in logistics services, along with over 30.000 related companies operating in the industry (Bui, 2022). Among these businesses, it is worth noting that some are foreign-owned entities recognized as leading global players in the logistics field. Renowned companies such as Kuehne + Nagel, DSV, and DB Schenker have established their presence in Vietnam. Despite the promising prospects and growth potential of the logistics industry in Vietnam, many logistics businesses encounter various challenges. These hurdles arise due to factors such as their small scale, which limits their resources and capabilities, and their restricted access to capital, technology, and operational expertise in the international market. These constraints can impede the growth and competitiveness of local logistics companies. A significant portion of the logistics landscape in Vietnam comprises small and medium-sized enterprises (SMEs). In fact, SMEs represent the majority, accounting for approximately 90% of registered logistics businesses in the country, specifically those with capital amounts below 10 billion VND. While these SMEs may face challenges, they contribute significantly to the industry's diversity and offer a wide range of logistics services tailored to the specific needs of clients. The presence of foreign-owned companies alongside the multitude of domestic logistics providers fosters healthy competition and opportunities for collaboration. The global leaders in the logistics industry bring valuable expertise, best practices, and international standards to the Vietnamese market. This interaction and exchange of knowledge can positively impact the overall growth and development of the logistics sector in Vietnam.

To address the challenges logistics businesses face, the government and relevant stakeholders must focus on supporting the industry's growth. Initiatives that provide access to capital, promote technology adoption, and enhance operational capabilities will be essential. By fostering an enabling environment for logistics companies, Vietnam can unlock the industry's full potential and position itself as a competitive player in the global logistics arena. Furthermore, collaboration between SMEs and more prominent, established companies can create synergies and opportunities for mutual growth. This collaboration can facilitate knowledge transfer, technology adoption, and capacity building for SMEs, enabling them to expand their operations and improve their competitiveness in the international market.

In summary, despite the significant potential of Vietnam's logistics industry, it also faces challenges related to small-scale operations, limited access to resources, and technology constraints. Therefore, logistics businesses may consider exploring alliance strategies. This research paper focuses on the logistics industry in Vietnam as the scope of study for alliance strategies.

2.1.2. Literature Review on Strategic Alliance

Strategic alliances are collaborative agreements where two or more independent companies come together to work jointly on manufacturing, developing, selling products and services, or pursuing other common business objectives. Corporate Finance Institute (CFI) provides that a strategic alliance refers to a collaborative arrangement between two distinct businesses that come together to collaborate on a project that benefits both parties while maintaining their independence (CFI, 2023). Typically, these partnerships are established for the long term, allowing each business to leverage its expertise and resources to accomplish shared objectives and foster mutual growth. A strategic alliance involves a collaboration between two distinct business entities that combine their resources to accomplish a shared objective. Unlike joint ventures and certain other partnership models, strategic alliances maintain the separate identities of the participating entities and do not establish a new entity. Each participant retains their autonomy, and these alliances often focus on specific projects or initiatives rather than establishing a continuous business relationship (Globalnegotiator, 2023). There are many definitions, but the most common definition of alliance strategy is when two or more businesses collaborate to develop, produce, or sell products/services within a specific period to achieve mutual benefits for each party involved while still maintaining their independent entities, without the intention of merging, consolidating, or acquiring each other. This alliance can take place between businesses within the same country or between businesses from different countries. Therefore, the participating members of the alliance do not necessarily have to be partners in the traditional supplier-customer relationship; they can even be competitors. The essential factor is that they share common goals and collaborate in certain activities, which allows them to establish a strategic alliance. These shared goals can include market development, product enhancement, customer expansion, or profit generation. It can be affirmed that each alliance has specific objectives that are relevant and directly related to the strategic motivations of the involved parties. Each alliance has the right to access resources as well as the commitments of its partners. Additionally, alliances bring about organizational learning opportunities. A strategic alliance is an agreement that brings real benefits to all parties involved, enabling the sharing of resources, knowledge, and capabilities to enhance each party's competitive position.

The essence of a strategic alliance is simply an agreement between two or more parties to help each other achieve desired benefits. Collaboration is meant to enhance competitive advantages rather than undermine the autonomy of business operations and entities (indeed.com, 2022). In a business alliance, companies cooperate to share resources, such as manpower, production technology, or even marketing and communication, to directly impact their competitive capabilities. These agreements often focus on specific competitive abilities or target markets (everest.org.vn, 2023). Strategic alliances can be established among competitors, distributors, or suppliers. Different levels of alliances and detailed agreements are developed to lay the foundation for businesses to construct and refine their subsequent lower-level business strategies (Srishti, 2022). In a global integration trend, businesses have increasingly expanded opportunities for growth. However, accompanying these opportunities are numerous difficulties and challenges. To survive and secure their positions in the market, businesses need to formulate the most suitable and effective business strategies for themselves. Strategic alliances in business are not equivalent to calling for investment, acquisitions, or mergers between companies. Alliances entail cooperation, development, and shared resources and benefits among participating entities. In a business alliance, companies collaborate and pool their efforts to implement strategies based on agreed-upon contracts and agreements. At a certain stage, when a company desires to develop a business strategy or plan but lacks the necessary capabilities, resources, expertise, or time, while there are still existing strategies, plans, and, most importantly, long-term core values that need to be developed and preserved, a strategic alliance becomes the path pursued by business owners (indeed.com, 2022). This is particularly true when it brings practical benefits to the participating entities. By collaborating with existing partners in the market, a strategic alliance creates effective opportunities to access and explore new markets while improving the success of products and services offered by member companies. Strategic alliances enable businesses to penetrate international markets by leveraging cooperation and resource sharing (PSMJ RESOURCES, 2020). By combining their strengths, member entities can overcome market barriers when expanding internationally. A strategic alliance opens doors to new distribution channels. By collaborating with partners within their distribution networks, member companies can expand their distribution networks and reach new customers. Strategic alliances facilitate access to and utilization of new technologies. Member entities can leverage each other's knowledge and technical expertise to enhance their products, processes, and services while also seizing opportunities from new technological advancements. Strategic alliances generate economic benefits through economies of scale. By combining resources and capabilities, alliances can achieve cost efficiencies in pricing, production, and distribution, thus gaining competitive advantages and enhancing growth potential. Strategic alliances allow for reduced costs and risks associated with new strategies or products. By sharing resources and experiences, member entities can minimize individual costs and risks while strengthening the likelihood of success for joint projects. Strategic alliances foster trust and long-term partnerships among member entities. Through collaboration and shared benefits, the alliances create a trustworthy and reliable environment, reinforcing relationships and generating sustainable value.

The business alliance strategy is currently a trend that many businesses choose with the aim of effectively enhancing growth. Around the world, numerous businesses have joined forces in their operations to drive visible growth and business development. Starbucks and Nestlé joined forces to create a "global coffee alliance" through a cross-licensing agreement worth $7.15 billion, which was announced by Starbucks (Thanh, 2023). Under this agreement, Starbucks granted Nestlé, the renowned Swiss food and beverage brand, an exclusive license to use their products and link them to the Nestlé brand. Through this alliance, Starbucks gained access to the global market through Nestlé's extensive distribution network. This enabled Starbucks to reach new customers and expand its presence in countries and regions where it had not been previously established. Nestlé is one of the leading companies in producing and packaging consumer goods. Starbucks leveraged Nestlé's expertise and capabilities in manufacturing, packaging, and distributing its instant coffee and packaged Starbucks coffee products. This helped Starbucks enhance its product supply and achieve cost savings. Starbucks and Nestlé shared knowledge and techniques in coffee brewing and processing, which could lead to improvements and the development of both companies' coffee products. This alliance resulted in revenue growth for both Starbucks and Nestlé. Starbucks gained access to new markets and strengthened its global presence, while Nestlé expanded its product portfolio and leveraged Starbucks' strong brand to attract customers. After a period of ownership, Nestlé boosted the revenue of Starbucks products to $2.9 billion in 2020, nearly a 4.5-fold increase since the deal was signed. As of 2021, Starbucks had over 33.000 stores worldwide, with significant contributions from the revenue generated in 2018 and the global presence of Starbucks products through Nestlé's distribution network. The total global revenue of Starbucks products distributed by Nestlé reached $3.1 billion in 2021. Michael Conway, Starbucks' Channel Development Director, stated, "Our partnership has been highly successful for both companies, meeting the increasing demands of customers." In 2022, building on its success, Starbucks continued to sell its Seattle's Best Coffee brand to Nestlé for an undisclosed amount. In other instances, the partnership between Samsung and Microsoft has brought forth numerous favorable outcomes (News.samsung, 2019). These include the bolstering of the mobile ecosystem, the seamless integration of services and applications, the progression of technology through collaborative research, as well as the expansion of the market, and the generation of revenue growth for both corporations. Samsung and Microsoft collaborated to develop mobile products running the Windows operating system, such as Samsung Galaxy smartphones and tablets. This helped Samsung strengthen its mobile ecosystem and expand its presence in the Windows market. This alliance enabled Samsung to integrate Microsoft's services and applications into its devices. For example, Samsung Galaxy products can utilize Microsoft's Office, OneDrive, and Outlook applications, creating an integrated experience and enhancing productivity and entertainment capabilities for users (techsignin.com, 2019). Samsung and Microsoft shared knowledge and technology to develop new products and services. They collaborated on research and development of new technologies in the mobile and cloud fields and worked together in areas such as artificial intelligence, the Internet of Things (IoT), and enterprise solutions. This alliance created opportunities for market expansion for both Samsung and Microsoft. Samsung gained access to customers using the Windows operating system, strengthening its presence in the enterprise market. At the same time, Microsoft was able to reach Samsung users and expand its services on Samsung devices.

Strategic alliance in the logistics industry

A logistics alliance refers to a collaborative network of skilled professionals in the trading industry who join forces to efficiently and effectively oversee the management and delivery of products for companies. Businesses can engage or become members of logistics alliance groups, enabling them to empower these alliances to offer support, establish robust supply chains, and provide valuable business advice (Heuberger, 2017). The alliance of logistics companies, also known as joint ventures or multilateral transportation partnerships, is a form of strategic cooperation among logistics companies aiming to create a multinational or global network to provide transportation and logistics services. In the alliance, logistics companies agree to collaborate and share resources, networks, technology, and expertise to establish a global transportation infrastructure. By combining the resources and capabilities of each company, the alliance creates a powerful system capable of delivering wide-ranging cargo transportation services. When participating in strategic alliances, companies typically share the common goal of expanding their operational scope, transcending geographical boundaries, and providing global cargo transportation services. Through a multinational or global network, the alliance is capable of serving customers in multiple countries and regions. By sharing resources and technology, the alliance can optimize cargo transportation processes. This includes enhancing responsiveness, reducing delivery time, improving warehouse management, and optimizing the utilization of transportation resources such as trucks, containers, and warehouses. Logistics companies can offer integrated services ranging from sea, air, and road transportation to logistics services and supply chain management. Customers can leverage comprehensive services and obtain global solutions from a single source. The parties involved can share resources such as warehouses, transportation vehicles, and IT systems. They can also share knowledge and expertise to enhance capabilities and service quality.

The collaboration between logistics companies can bring multiple benefits to all parties involved, including both the companies themselves and their customers. By strengthening operational scale, providing comprehensive services, and enhancing competitiveness, strategic partnerships among logistics companies are becoming a prevalent trend worldwide. In 2017, United Parcel Service Inc. (UPS) and S.F. Express Holding established a joint venture and partnership to develop and provident international courier services, initially from China to the United States (Moss, 2017). This agreement also expanded plans to explore other destinations. These two courier operators stated that through this collaboration, they would leverage the benefits of their respective additional networks, service portfolios, technologies, and logistics expertise. UPS and SF shared the belief that the integration of their services would create a robust network by combining the strengths of SF, one of the largest and fastest-growing courier networks in the world, with UPS's global integrated network spanning over 220 countries (Carey, 2017). UPS and SF hoped to capitalize on the advantages of both companies to enhance service quality and meet the increasing demands of customers. Wang Wei, the third wealthiest individual in China, stated that the country's government estimated the revenue from the delivery sector to reach $116 billion in 2020, doubling the figure of $51 billion from the previous year. The global partnership between UPS and SF enabled both companies to seize significant potential from the development of China's delivery market. Mr. McCullough, a key figure at UPS, shared that SF Express's local network would provide businesses and individuals in China with delivery options they previously couldn't access from other sources (Moss, 2017). He also revealed that UPS's business operations in China had grown by 30% in the first quarter. UPS primarily targets medium and large-sized companies in China, while SF Express is connected to an extensive network consisting of smaller merchants scattered throughout the country. This collaboration helps provide diverse and flexible delivery solutions to meet the specific needs of different customer segments in China's rapidly developing market.

Another instance involves DHL and Lufthansa Cargo joining forces to create a joint venture in 2007, with the objective of offering express delivery and air freight services. Initially, this venture was referred to as NewCo but later rebranded as "AeroLogic." (Lufthansa-cargo, 2013). DHL Express and Lufthansa Cargo AG shared the risks of operating dedicated cargo aircraft. These aircraft achieved high utilization rates by conducting flights during the week for DHL and weekend flights for Lufthansa Cargo. The joint venture’s strategic coordination and operations were clear, for example, optimizing aircraft utilization through shared activities (DHL Express on weekdays and Lufthansa Cargo on weekends). Thanks to the implemented business model, administrative burdens were significantly reduced, providing AeroLogic with lower cost bases compared to other specialized cargo carriers. From Lufthansa Cargo's perspective, AeroLogic's operations allowed the airline to reduce operating costs while transferring the related benefits to their customers. The streamlined company enabled the partners to access both new and existing markets. Both companies could participate in the rapidly growing express delivery and freight transportation market segment. Before the joint venture, DHL Express faced disadvantage in competing with its main rivals, FedEx and United Parcel Service (UPS), as they did not have their extensive long-haul cargo transportation network. This collaboration overcame that deficiency while providing DHL with the opportunity to utilize underutilized capacities on long-haul flights for regular air cargo transportation and a method relied upon to some extent by major express carriers. AeroLogic had a competitive advantage in exclusively transporting goods on behalf of its partners, benefiting from a low-cost basis and operating a modern and efficient fleet of Boeing B777-200LRF aircraft. For Lufthansa Cargo, the joint venture provided a more direct means of entering the high-productivity air express market and allowed for the development of a long-haul continental network for regular air cargo transportation. Flight schedules and fleet size were optimized for both parties. The two partners contributed additional technical skills, market expertise, and resources, exhibiting a high level of cooperation between them. Advertising and marketing costs did not apply because AeroLogic only transported goods on behalf of the joint venture partners (Baxter and Srisaeng, 2018).

Shipping line alliances are groups of shipping companies that cooperate with each other to achieve common goals that benefit all parties involved, including themselves and their customers. These alliances aim to provide better freight rates, more efficient routes, and improved transit times for customers' shipments. In the global trade landscape, there are currently three prominent ocean carrier alliances: the 2M Alliance, the Ocean Alliance, and The Alliance (Miller, 2023). These alliances have significantly impacted the shipping industry by bringing various advantages to large container vessels and major ports. One of the primary benefits of shipping line alliances is improved resource allocation. By collaborating and pooling their resources, the member companies can optimize the use of vessels, containers, and terminal facilities. This enhanced coordination and efficiency resulted in reduced operating costs for the participating shipping lines. The cost savings can be achieved through economies of scale, as larger volumes of cargo can be consolidated and transported more efficiently. Another advantage of shipping line alliances is expanded service coverage. By joining forces, the member companies can offer a broader network of routes and destinations to their customers. This expanded coverage enables businesses of all sizes to access major trade routes worldwide. It benefits large enterprises that require extensive global connectivity and smaller shippers who may rely on specific international trade routes for their shipments. Operating costs in the shipping industry are subject to fluctuations based on various factors, such as changes in the global economy or political environments at key transportation hubs. However, the presence of shipping line alliances helps mitigate these challenges. With alliances representing shippers across different regions, the impact of economic or political disruptions can be better managed. The alliances provide stability and alternative options for shipping companies, ensuring uninterrupted services even when specific routes are affected. Shipping line alliances bring significant benefits to both major shipping lines and smaller shippers. Larger companies can leverage the combined resources and capabilities of all alliance members, enabling them to optimize their operations and offer comprehensive services to their customers. On the other hand, smaller shippers can benefit from the expanded service coverage and resources without the need to make significant investments in scaling up their own fleet or infrastructure. These alliances are crucial when considering the overall operating costs for shipping companies. Transportation costs typically constitute a substantial portion of the total operational expenses, accounting for over 67%. Within this percentage, bunker fuel costs make up 46%, while port fees comprise the remaining 21% (Indochinapost, 2023). Both cost components are subject to fluctuations and can significantly impact the profitability of shipping operations. However, companies can work together through shipping line alliances to mitigate these cost fluctuations and achieve better cost efficiencies. In challenging economic conditions, where shipping lines may face constraints on specific routes for consecutive weeks, the importance of alliances becomes even more apparent. By utilizing shared resources, such as networks, terminals, and vessels, along specific routes, shipping line alliances help reduce variable costs and maintain service reliability. This collaborative approach ensures that vessels can be deployed strategically, optimizing route schedules and minimizing disruptions.

The above examples illustrate how alliances and collaborations globally, and specifically within the logistics industry, are increasingly being recognized as strategic choices by many enterprises due to the benefits they bring. Vietnam also has cases where businesses in this field collaborated and achieved good results. In August 2022, Vietnam Post, the national postal company of Vietnam, signed a cooperative agreement with Vinatex, the Vietnam National Textile and Garment Group, and VIMC, the Vietnam Maritime Corporation (BBT, 2022). This agreement is significant as it not only aims to capitalize on the strengths of each party to enhance business efficiency within their respective fields but also holds the promise of numerous benefits for customers and contributes to the sustainable and robust development of the country's economy and society. The collaboration also aims to implement the policy of prioritizing the use of services and products among conglomerates, corporations, banks, and units within the business community. Therefore, the collaboration among the three companies not only leverages the strengths of each party to enhance business efficiency in their respective fields but also brings many benefits to customers and contributes to the motivation for economic development. With a network of nearly 13,000 service points covering even remote villages, communes, and islands, along with a comprehensive and synchronized infrastructure for delivery services, Vietnam Post will provide products and services that meet the maximum needs of Vinatex and VIMC. These include logistics delivery, and collection and disbursement services, digital payment services, communication and advertising services development, and more. Through these offerings, Vietnam Post aims to optimize costs, improve operational efficiency, and enhance the customer experience for Vinatex and VIMC. According to the cooperative agreement with Vinatex, Vietnam Post will provide comprehensive logistics services in various areas. Specifically, Vietnam Post will offer comprehensive logistics services to Vinatex, including international transportation services, warehouse management, distribution of goods to retail stores, showrooms, supermarkets, professional warehouse management services, distribution transport systems to sales points, e-commerce warehousing, and goods delivery system for online sales channels. Furthermore, with its national digital platform, Postmart.vn, Vietnam Post will closely collaborate with Vinatex to develop an online-to-offline sales channel and establish a chain of Vietnam Post - Vinatex branded stores targeting premium, mid-range, and affordable customer segments across the postal network. In return, Vinatex commits to providing high-quality products and services to Vietnam Post, including supplying goods and providing design and uniform tailoring services for the company's officers and employees at competitive prices while ensuring quality. Vinatex also offers benefits to branches and member units when using products and services from Vinatex. According to the cooperative agreement with VIMC, Vietnam Post will provide comprehensive logistics services based on the strengths of each party, including warehouse services, infrastructure, and vehicles. These services will cater to customer needs, such as sea and road transportation, customs warehouses, distribution centers, and e-commerce warehousing. In particular, Vietnam Post will leverage its strengths in Full Container Load (FCL) and Less than Container Load (LCL) transportation in various regions and routes, as well as its extensive network and coverage throughout Vietnam, including international air freight services. Vietnam Post and VIMC will collaborate in implementing cargo transportation services by sea, domestic and international road transport, as well as port-related services nationwide.

In September 2018, SENDO JSC announced a strategic partnership with DHL eCommerce Vietnam, a member of DHL Global Forwarding (DHL ECOMMERCE, 2018). The transportation company would allocate over 300 Red Lotus - DHL delivery points nationwide to address the challenges of speed and delivery costs. Mr. Thomas Harris, the CEO of DHL E-commerce Vietnam, stated that the strategic collaboration between Red Lotus and DHL aimed to enhance convenience in online commerce rather than simply supporting delivery services. Instead of waiting for a courier to pick up the goods for delivery, sellers could proactively send the finalized orders through these delivery points. With DHL's high-quality distribution and transportation network, products on the SENDO JSC platform could reach buyers in Ho Chi Minh City, Hanoi, and other locations on the same day or the next day. This solution not only shortened delivery time but also enhanced the service's reputation. Additionally, Red Lotus helped sellers optimize costs by reducing shipping fees by 20% for shops that used the SENDO JSC - DHL delivery points to send their goods. Mr. Tran Hai Linh, the CEO of SENDO JSC, emphasized that partnering with DHL, an experienced international transportation provider, allowed the company to leverage resources in terms of human capital, technology, and processes to achieve its market expansion goals. Logistics is one of the crucial factors determining the differentiation and success of e-commerce. Therefore, e-commerce businesses are heavily investing in logistics by improving service quality to provide convenience, speed, and affordability. With this trend, e-commerce consumers are benefiting more and more. Sendo.vn is an e-commerce platform managed and operated by a Vietnamese team, experiencing rapid growth. The company focuses on connecting with logistics partners to create an increasingly diverse ecosystem of utility services, ensuring customer rights and benefits. Enhancing the partnerships among logistics firms, as well as between logistics companies and the manufacturing and export sectors, will generate additional prospects for experience sharing and fostering mutual trust. This, in turn, will facilitate the establishment of a network comprising influential enterprises capable of leading the market.

2.2. Literature Review on Methods

2.2.1. Data Envelopment Analysis (DEA) Methods

The DEA analysis was developed in 1978 following the initiative of Charnes-Cooper- Rhodes (CCR) (Charnes, Cooper and Rhodes, 1978). However, its origins can be traced back more than 20 years prior to that. In 1957, Farrell introduced the concept of using the Production Possibility Frontier (PPF) as a criterion for evaluating the (relative) efficiency of companies within the same industry (Farrell, 1957). According to this concept, companies that reach the limit are considered efficient (or more efficient), while those that do not reach the PPF are considered inefficient (compared to other companies). The CCR method (1978) later applied non-parametric linear optimization to construct the PPF based on known data about a group of specific companies (DMUs) and calculate the efficiency scores for those companies. In 1984, Banker-Charnes-Cooper (BCC) improved the model by incorporating the concept of returns to scale into the calculations, providing a more specific view of the efficiency of the analyzed DMUs (Banker, Charnes and Cooper, 1984). Since then, the CCR and BCC models, primarily the latter, have been widely applied and developed in various fields for efficiency/performance analysis, including banking, insurance, education, healthcare, and transportation. The principle of calculating and comparing the efficiency of DMUs involves using performance measures to calculate/compare the outputs obtained in relation to the given inputs. For example, labor productivity can be calculated as the ratio of output to labor input, and the rate of return can be measured as the ratio of profit to capital, and so on.

However, a business or production unit DMU often utilizes a combination of input factors to achieve a range of output factors (multi-variable model). Therefore, evaluating the efficiency of such DMUs typically requires considering multiple different efficiency indicators (composite evaluation). Since these efficiency indicators are constructed based on various factors with different natures, and measurement units (such as capital and factory area), evaluating and comparing DMUs necessitates converting them to a common monetary unit like this thesis. DEA is a versatile method that can be applied to both quantitative and qualitative variables. This flexibility makes DEA a valuable tool for analyzing the efficiency of DMUs across a wide range of sectors, including social sectors such as education, healthcare, and insurance, as well as economic sectors such as banking, securities, and business operations. One of the key advantages of DEA is that it is based on observed data, allowing it to be applied even with small sample sizes. This sets DEA apart from regression analysis methods that often require larger sample sizes for accurate results. The ability to work with small sample sizes makes DEA particularly useful for conducting in-depth analyses at regional or local levels. For example, DEA can be used to analyze the efficiency of economies within the ASEAN region, different departments within a single company, or the consolidated financial reports of logistics companies in Vietnam. DEA provides a comprehensive approach to efficiency analysis by considering multiple inputs and outputs simultaneously. It allows decision-makers to evaluate the performance of DMUs by comparing their efficiency scores. By identifying inefficient units, DEA can highlight areas for improvement and provide insights for resource allocation and performance enhancement. Furthermore, DEA's applicability to qualitative variables makes it an even more powerful tool. While traditional quantitative analysis methods may struggle to incorporate qualitative factors, DEA can handle both quantitative and qualitative variables in its efficiency evaluations. This capability enables organizations to consider a wide range of factors, such as service quality, customer satisfaction, and employee expertise, in their efficiency assessments.

Over the years, DEA methods have undergone various changes and modifications with the introduction of different models. One notable example is (Tone, 2001) non-radial model, which brought about SBM and facilitated the measurement of input excess and output deficit. Despite these advancements, early models faced a limitation wherein they assigned the same score (equal to 1) for all units situated on the efficient frontier, making it impossible to differentiate between the performances of efficient DMUs. The need to accurately evaluate the performance of efficient DMUs led to the development of several super-efficiency models. In 2002, Tone made further advancements to the model and introduced a new and enhanced version known as the Super-SBM model (Tone, 2002). This improved model not only enables the measurement of efficiency for various samples but also facilitates a comparison of the efficiency levels among these samples, allowing the efficiency of effective samples to surpass a value of 1. The Super-SBM model offers two distinct advantages that are lacking in other DEA models. Firstly, it can directly handle input excess and output shortfall by incorporating the slacks into the objective function. Secondly, the Super-SBM provides a clear efficiency ranking for each efficient unit in comparison to other DMUs. Considering these two significant advantages, the authors apply the Super-SBM model to evaluate efficiency. The Super-SBM approach enables the determination of efficiency by considering the input/output slacks, providing a more comprehensive assessment compared to traditional radial measures. By utilizing this non-radial super-efficiency model, the software calculates the non-negative sequences, which are crucial for evaluating the efficiency of each DMU. Once the efficiency scores are computed, the DMUs' performances are ranked within the Super-SBM model. This ranking allows for a direct comparison of the efficiency levels of different units, providing valuable insights into their relative performance (Archibald and Crook, 2011). The Super-SBM model, being considered an appropriate version of DEA, offers a comprehensive representation of efficiency allocation for each unit, highlighting their strengths and weaknesses compared to other DMUs. By employing the Super-SBM model within the DEA framework, decision-makers gain a more nuanced understanding of the efficiency levels and performance variations among DMUs. This information is instrumental in identifying best practices, benchmarking performance, and determining areas for improvement. Moreover, the ranking of DMUs helps in identifying the most efficient units that can serve as potential partners for strategic alliances or sources of inspiration for enhancing efficiency within the targeted company.

2.2.2. Resampling forecasting method

To provide an estimation of future values, the Resampling model within the DEA offers a unique integrated approach that combines value forecasting and performance evaluation of DMUs during a specified period. This model goes beyond conventional DEA models by supporting the estimation of future scores and providing insights into the confidence level associated with each DMU's performance (Tone and Ouenniche, 2016); continuous development and integration in the latest version, 15.1 of DEA Solver Pro. This integration enables simultaneous value forecasting and performance estimation, making it a valuable tool for decision-making and planning. The Resampling model stands out from other models due to its distinctive ability to estimate future values and efficiency levels, providing a comprehensive understanding of a DMU's performance trajectory over time.

To employ the Resampling model, a historical time matrix is constructed, incorporating data on input and output variables across different time periods. This matrix serves as the foundation for capturing the trends and patterns necessary for forecasting future values accurately. By leveraging this historical data, the Resampling model applies statistical resampling techniques to simulate possible future scenarios, and allows for robust estimation of future values and their associated uncertainties. By integrating value forecasting and performance estimation, the Resampling model offers decision-makers a holistic perspective on the potential outcomes of different strategies and interventions. It provides valuable insights into the future performance of DMUs, enabling more informed decision-making, resource allocation, and performance improvement efforts. The Resampling model has a distinctive advantage over other models as it has the ability to estimate future values and efficiency.

With its predictive capabilities, the Resampling model has been applied to estimate the investment fund performance (Lamb and Tee, 2012), the macroeconomic performance of developed and developing countries in Asia (Wang and Le, 2018), and the business performance of financial companies in Taiwan (Hsieh and Chiu, 2019). The current study introduces a novel approach to predicting the performance of strategic alliances by leveraging historical data and employing new resampling models within the DEA framework. Traditional DEA models have been widely used to evaluate the effectiveness of DMUs based on past data. However, Truong et al. (2021) proposed two resampling models that enhance the existing approach. The first model utilizes historical data, such as past-present information, to estimate data variations. It incorporates chronological order weights derived from the Lucas series. The second model focuses on prospects, aiming to forecast the future efficiency score and its confidence interval for each DMU. By integrating these resampling models with the Super-SBM model, this study goes beyond previous research efforts, which have failed to provide a comprehensive understanding of macroeconomic performance spanning the past, present, and future. Therefore, this study stands as the pioneering endeavor in assessing and forecasting the relative performance of Asian developing economies. It considers all the macro indicators, enabling a holistic view of global macroeconomic performance. This study introduces a novel contribution through the utilization of the resampling model, which is a newly developed DEA model incorporated in the authors' research. The concept of resampling models was introduced by (Tone and Ouenniche, 2016). These models propose innovative approaches for assessing the confidence intervals of DEA scores by considering various data variations. The first model employs past-present data to estimate data variations and incorporates chronological order weights based on the Lucas series. The second model focuses on future prospects, aiming to forecast the future efficiency score and its associated confidence interval for each DMU. The research aims to integrate the widely recognized Super-SBM model in DEA with two novel resampling models to create "a comprehensive model that combines the assessment and forecasting of strategic alliances performance" from past, present, and future. As far as the author knows, there has been rare prior research conducted on this specific topic. This not only introduces a novel perspective to the realm of strategic alliance performance but also has the potential to be extended to other areas of research.

This thesis presents an integration of DEA models to forecast the business efficiency of logistics companies in Vietnam for the next five years (2023-2027). The authors utilize the Super-SBM model and the Past-Present model to combine ranking and performance evaluation on an annual basis from 2013 to 2022, and the study collected data from 22 logistics companies listed on the Vietnam stock market. The data was gathered from the website (Vietstock.vn, 2023). The research employed the Resampling prediction model within DEA to calculate the business efficiency. The authors selected appropriate input and output factors for the model. Statistical data on the input and output variables of the real estate companies. The financial indicators collected for the companies revealed different scales of business operations. Thus, each company had different alliance strategies and opted for suitable alliances.

2.3. Research Gaps

The choice of input and output variables for assessing DMUs holds significant importance as they must effectively capture the performance of these units. In this study, the authors sought guidance from previous research on strategic alliances to identify appropriate variables for both inputs and outputs. Presented in **Table 2.2** provides a summary of the input and output variables utilized in previous research studies to evaluate DMUs.

Table 2. 2: List of related studies

No.	Authors	Inputs	Outputs	Methods	Sample and Region
1	Wang et al. (2020)	Charter Capital, Total Asset, Selling Expense, General and Administrative Expense2020	Revenue Profit before tax	DEA Super-SBM-I-V model and GM (1,1)	Viet Nam, 16 companies in the Vietnam estate industry in the time period 2012-2017
2	Nguyen and Tran (2019)	Total assets, Liability, and COGS	Revenue and Operating profit	Malmquist, GM (1,1) and Super SBM	Viet Nam, 10 Logistic companies over six consecutive years (2011–2016)
3	Nguyen (2020)	Total asset, Total liability, Total operating expense	Revenue, Net income, Total equity	GM (1,1) and DEA-Super-SBM	15 businesses were chosen by Vietnam between 2013 and 2017 for 5-year data.
4	Wang et al. (2016)	Fixed assets, COGS, Operating expenses, and Long-term investment	Revenues, Total equity, and Net incomes	GM (1,1) and DEA-Super-SBM	International, The top 20 global automotive companies for four consecutive financial years (2009–2012)
5	Nguyen et al. (2015)	Fixed assets, Operating expenses, and COGS	Revenues, Operating income, and Retained earnings	GM (1,1), DEA and Super-SBM	20 EMS, capable of giving comprehensive data for four consecutive years, 2009 to 2012
6	Le et al. (2014)	Fixed assets, Capital, and Operating expenses	Net sales and Earnings per share (EPS)	GM (1,1) and DEA - Super-SBM	11 companies in the garment industry from financial statements of Vietnam published stock market during the period 2007 to 2010
7	Nguyen et al. (2020)	Fixed assets, COGS, Capital, Operating Costs	Net sales; Net profits	GM (1,1) and DEA Super-SBM	17 Vietnamese steel companies during the period of 2011–2019
8	Nguyen and Tran (2017)	Expenditure and Equity capital	Net income, Net profit, EPS	GM (1,1) and DEA Super-SBM	14 typical qualified companies for five continuous years (2010-2014)

9	Wang et al. (2022)	Fixed assets, Operating Cost, and COGS	Revenues and Operating profit	DEA and Grey Theory	Ten major coal mining projects of VINACOMIN during 2017–2021
10	Wang et al. (2018)	Property plant and equipment (PP&E), COGS, Operating expenses (OPEX), and Long-term investment (LINV)	Gross profit (GP), net income (NI), common stock (CS), and retained earnings (RE)	GM (1,1), DEA and Super-SBM	The 35 biggest aerospace and military firms in the world's four most recent financial years (2012–2015)
11	Wang et al. (2021)	Total asset, Operating expense, R&D expenses, and Employees	Revenue and Gross profit	DEA-Super-SBM and Resampling Model	The realistic public data of 20 companies were collected from 2015 to 2019 in the I.C. packaging and testing industry.
12	Wang et al. (2008)	Assets, R&D Expenses, and Costs	Profits	Super-SBM, Grey System Theory, and DEA	8 TFT-LCD companies in Taiwan with five years of data (2003-2007)
13	Wang et al. (2016)	Fixed asset, R&D expenses, Cost of goods sold, Operating expense	Revenue, Retained earnings, and Net income	GM (1,1) and DEA - Super-SBM	20 companies are collected from 2011 to 2014
14	Wang et al. (2015)	Fixed assets, Operating expenses, and COGS	Revenues, Operating income, Retained earnings	GM (1,1) and DEA- Super-SBM	20 firms in the Electronic Manufacturing Service (EMS) sector operated throughout the course of four years (2009–2012)
15	Wang et al. (2008)	Employees, Total fixed assets, Total assets, R&D expense, Operating expense, and COGS	Net sales, Gross profit, Operating income, and Retained earning	DEA and GM (1,1)	11 companies of the Photovoltaic Industry during 2001- 2006
16	Nguyen et al. (2021)	Current assets, Non-current assets, Fixed assets, Liabilities, owner's equity, and Charter capital	Net revenue, Gross profit, Operating profit, and Net profit after tax	Super-SBM model	32 securities firms that were active between 2016 and 2019

17	Wang et al. (2018)	Total Assets Total Liabilities Total Equity	SG&A Expenses Revenue	DEA- SBM-I-V and GM (1,1)	11 public ASEAN aviation companies, according to realistic statistics, operated throughout the course of four years (2013–2016).
18	Min et al. (2016)	Operating Expenses (in thousand U.S. dollars) and Underutilization (in percentage)	Passengers, revenue passenger kilometers, Operating revenue, Service rating	DEA	Eight airlines for SkyTeam, 27 for Star Alliance, nine for Oneworld, and 15 for non-member airlines
19	Nguyen (2020)	Total assets, COGS, Total expense; Owners' equity	Net sales (N.S.); Profit after tax (P.T.)	DEA model, ARIMA model, and grey forecasting	14 companies with the data of enterprises in the period of 2015–2018
20	Tran (2018)	Fixed assets, COGS, operating costs	Net sales, Operating profit, Net profits	GM (1,1) and DEA - Super-SBM	11 fertilizer industry with five periods of data (2012-2016)

According to **Table 2.2**, in previous studies, authors often select a set of similar inputs and outputs. This approach is reasonable as it serves as a foundation for determining the effectiveness of strategic alliances. Most authors tend to select fixed assets, operating expenses and cost of goods sold as input factors, while revenue and gross profit factors are chosen as outputs. However, there are still differences due to the characteristics of the industry that previous research authors have investigated. Furthermore, these differences also vary depending on the research objectives concerning alliance strategies that the authors aim to achieve. In the research thesis on the strategic alliances between companies in the global aerospace and defence industry, authors often incorporate additional factors such as property, plant, and equipment, long-term investment into their input analysis. Analyzing the utilization and efficiency of these resources helps researchers evaluate the collaborative capabilities and competitive advantages gained through such alliances. A long-term investment is another important factor considered in theses related to alliances within the global aerospace and defence sector. This includes investments in joint research and development (R&D), technological advancements, and shared infrastructure. By examining the impact of long-term investments, researchers gain insights into the innovation potential, synergistic effects, and market positioning of companies engaged in strategic alliances (Wang et al., 2018). In research theses on strategic alliances between companies in the IC Packaging and Testing industry and the Photovoltaic industry, authors often include additional factors such as R&D expenses as inputs. This factor sheds light on the innovation potential and competitiveness of companies engaged in strategic alliances. It helps researchers understand the impact of collaborative R&D efforts on product development, quality improvement, and market positioning (Wang and Wu, 2008; Wang et al., 2021). In the thesis on airline strategic alliances, authors commonly select Passengers, Revenue Passenger Kilometers, and Service Rating as output factors. Passengers and revenue passenger kilometers are important measures of customer demand and market share. They provide insights into the number of passengers and the distance travelled by them, respectively. By analyzing these variables, researchers can evaluate the alliance's ability to attract and retain customers, expand its reach, and increase its overall market presence. Service Rating is a crucial factor that measures customer satisfaction and perception of service quality. It allows researchers to assess the impact of business on service standards, customer experience, and overall satisfaction. By considering these output factors, authors gain a comprehensive understanding of the outcomes and impacts of airline strategic alliances. These variables provide valuable insights into the alliance's ability to drive customer demand, enhance market competitiveness, and deliver superior service experiences. Such research findings are instrumental in guiding decision-making processes for airline industry stakeholders involved in strategic alliances (Min and Joo, 2016). Based on the table, the authors observed that previous theses on strategic alliances still lack diversity in the selection of input and output variables. The large number of variables used was ten (Wang and Wu, 2008), while some articles only utilized three variables (Wang and Lee, 2008). Some articles relied on data from a considerably outdated time series without regular updates. Additionally, the data collection period was relatively short, typically ranging from 3 to 5 years.

Thesis on alliance logistics companies using DEA Resampling is exceedingly rare in the academic landscape. The field of logistics and supply chain management is vast and diverse, encompassing various aspects such as transportation, inventory management, and strategic alliances. However, the application of DEA Resampling, specifically within the context of alliance logistics companies, remains largely unexplored. DEA Resampling is a powerful analytical tool that allows for the assessment of the efficiency and performance of organizations by comparing them to a benchmark set. Its potential application in analyzing the efficiency of alliance logistics companies holds great promise, yet the scarcity of research in this area indicates a significant gap in knowledge. Therefore, conducting a thesis on this subject would not only contribute valuable insights to the academic community but also provide practical implications for improving the efficiency and effectiveness of alliance logistics companies. Previous dissertations on Alliances have typically relied on a limited set of inputs and outputs to analyze the phenomenon. However, these studies often suffer from a crucial limitation; the data used is outdated, particularly concerning financial information. This drawback undermines the accuracy and relevance of their findings, as the dynamics of alliances and their financial implications can change over time.

This study is groundbreaking and provides updated insights into the current situation. By incorporating a larger volume of input and output data, it presents a more comprehensive view of the effectiveness of the alliance campaign of logistics companies. The study's findings shed light on the impact and success of collaborative efforts within the logistics industry. The increased data analysis allows for a more accurate assessment of the campaign's outcomes, helping to inform future strategic decisions and enhance overall logistics operations. This study represents a significant contribution to the field, highlighting the importance of collaboration and emphasizing the potential benefits that can be achieved through alliance campaigns among logistics companies.

2.4. Conclusion

This study applies the DEA model, incorporating the Super-SBM method, to assess the operational efficiency and effectiveness of DMUs. The DEA model is widely utilized for evaluating the relative performance of DMUs, and the Super-SBM method enhances its accuracy. Grounded in the principles of input-output analysis, this method has gained prominence as a performance evaluation technique with extensive potential. To forecast and evaluate performance scores before and after the implementation of a future strategic alliance, the authors employ the Resampling method. With applications in numerous domains and the ability to yield significant results, the Resampling method is employed in this study. Furthermore, the resampling method is utilized within DEA, alongside the Super-SBM to assess the past performance of the DMUs.

CHAPTER 3: METODOLOGY

3.1. Research Procedure

In the research, researchers have applied the resampling model in DEA to establish a systematic evaluation and forecasting method. The steps related to data collection and input-output selection constitute the initial task of the study. DEA is a linear programming method used to evaluate the efficiency of DMUs within a framework that incorporates multiple inputs and outputs.

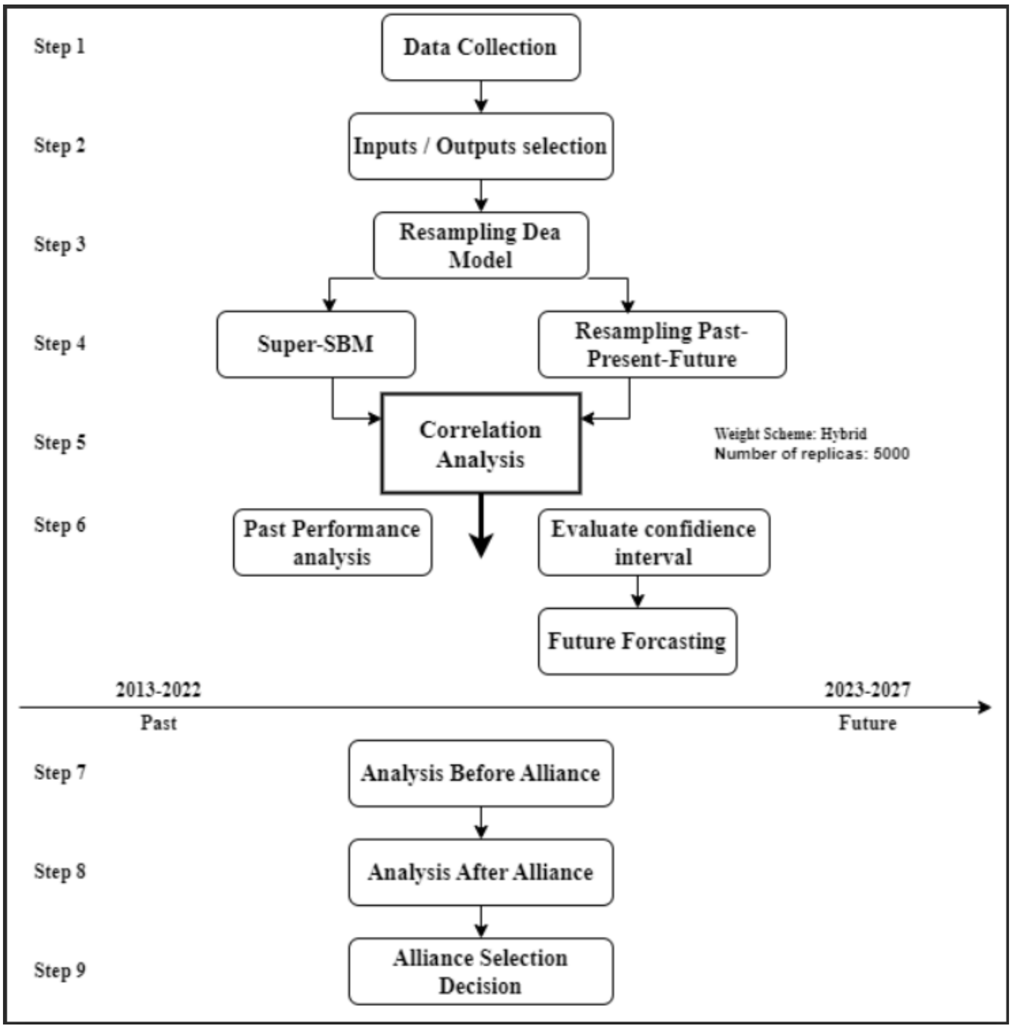


Figure 3. 1: Proposed research framework

Step 1: Data Collection

In the initial step of the study, the researchers defined the research topic and the scope of their investigation. Researchers have identified 22 logistics enterprises in Vietnam as 22 DMUs and collected data on key financial indicators that directly affect the performance of these DMUs for ten consecutive years from 2013 to 2022. This comprehensive data collection process is mainly collected from Vietstock.com.

Step 2: Input and output variable selection

This step involved the selection of a specific DMU for evaluation and designing suitable models to assess its effectiveness. To evaluate the operational effectiveness of logistic enterprises, the author group chooses a total of 15 variables from VietStock, including seven input variables and eight output variables that are suitable considering the logistics industry's features.

Step 3: Computation using DEA-Solver Version 13

The researchers utilized the DEA-Solver software, specifically Version 13, to perform the computation process. This step involved establishing the weights of the Input and Output factors within the selected DMU.

Step 4: The two-stage DEA model combines Super-SBM with the Resampling method

To enhance the accuracy and reliability of the results, the researchers integrated the Resampling model into their analysis. This model was applied alongside the Super-SBM model to support the computation process. By combining these models, the researchers were able to forecast the future efficiency score and determine the associated confidence interval for each DMU.

Step 5: Correlation Coefficient Testing

The researchers conducted correlation coefficient testing further to explore the relationship between the input and output values. This testing procedure allowed them to examine and assess the degree of correlation between these variables. By understanding the correlation, the researchers gained insights into the interplay between inputs and outputs.

Step 6: Performance Evaluation and Forecasting

The researchers utilized the Super-SBM model to assess the historical performance of DMUs from 2013 to 2022. Subsequently, the Resampling model was employed to forecast data for 2023 to 2027. These predicted results were then integrated into the DEA model to evaluate the efficiency of each DMU both before and after the implication of the alliance.

Step 7: Analysis before the alliance

Operational results from the past were calculated and compared between the target company and 21 other competing companies. The Resampling model is applied to the actual data, and DMUs are ranked based on the efficiency achieved.

Step 8: Analysis after Alliance

Virtual alliances are formed by combining the target DMU with 21 other DMUs. The performance of virtual alliances is compared with the existing company.

Step 9: Analyze and make alliance selection decisions

Proposals based on the analysis results were made in this step, but qualitative feasibility was not assumed. Further in-depth analysis was conducted to carefully examine potential alliance methods from different perspectives. Based on the analysis from the perspective of the two sides to make the selection of appropriate strategic alliances.

3.2. Data collection

This study focuses on the selection of 22 logistics companies for the empirical analysis, as presented in **Table 3.1.** The dataset is collected exclusively from the annual financial statements available on the website (Vietstock.vn, 2023) during the period from 2013 to 2022.

Table 3. 1: List of DMUs

No.	DMUs	Company name	Website
1	DMU1	An Giang Port JSC	https://angiangport.com.vn/
2	DMU2	Dinh Vu Port Investment and Development JSC	https://www.dinhvuport.com.vn/
3	DMU3	DoanXa Port JSC	https://doanxaport.com.vn/
4	DMU4	International Gas Product Shipping JSC	https://www.gasshipping.com.vn/
5	DMU5	Hai An Transport & Stevedoring JSC	https://haiants.vn/
6	DMU6	Hai Phong Cement Transport & Trading JSC	https://vtxmhp.com
7	DMU7	Logistics Vicem JSC	https://www.vantaihatien.com.vn/
8	DMU8	Danang Airports Services JSC	https://www.masco.com.vn
9	DMU9	Noi Bai Cargo Terminal Service JSC	http://www.noibaicargo.com.vn/
10	DMU10	Dong Nai Port JSC	http://www.dongnai-port.com/
11	DMU11	Petrolimex Hanoi Transportation & Trading JSC	https://petajicohanoi.petrolimex.com.vn/
12	DMU12	Petrolimex Joint Stock Tanker Company	https://pjtaco.petrolimex.com.vn/

13	DMU13	Hai Phong Petrolimex Transportation & Services JSC	https://ptshp.petrolimex.com.vn/
14	DMU14	Petrovietnam Transportation Corporation	https://www.pvtrans.com/
15	DMU15	Sea & Air Freight International	http://www.safi.com.vn/
16	DMU16	Superdong Fast Ferry Kieng Giang JSC	https://superdong.com.vn/
17	DMU17	Tan Cang Logistics & Stevedoring JSC	http://tancanglogistics.com/
18	DMU18	Transimex Corporation	https://transimex.com.vn/
19	DMU19	Vietnam Petroleum Transport JSC	http://www.vipco.com.vn/
20	DMU20	Vietnam Maritime Development JSC	http://vimadeco.com.vn/
21	DMU21	Vietnam Sun Corporation	https://www.vinasuntaxi.com
22	DMU22	Viet Nam Ocean Shipping JSC	https://vosco.com.vn/

The authors have outlined the inputs and outputs they have specifically opted for in connection to this study in **Table 3.2.**

Table 3. 2: Definition of inputs/outputs variables

No.	Name	Define	References
1	(I) Total Liabilities (TL)	Total liabilities refer to the aggregate amount of debts and obligations that a company or individual owes to other parties.	(Ross et al., 2019)
2	(I) Total Equity (TE)	Total equity, also known as shareholders' equity or owner's equity, represents the residual interest in the assets of a company or individual after deducting liabilities.	
3	(I) Selling, General, and Administrative Expenses (SG&A)	SG&A expenses encompass various costs associated with selling, marketing, general administration, and other administrative functions within the company.	
4	(I) Cost of Goods Sold (COGS)	COGS is an accounting term that represents the direct costs incurred in producing or acquiring the goods or services sold by a company.	

5	(I) Inventory Turnover (IT)	Inventory turnover, also known as inventory turnover ratio or stock turnover, is a financial metric that measures how efficiently a company manages its inventory.
6	(I) Days Sales Outstanding (DSO)	DSO known as the Average Collection Period, is a financial metric that measures the average number of days it takes for a company to collect payment from its customers after making a sale
7	(I) Days Payable Outstanding (DPO)	DPO is a financial metric used to measure the average number of days it takes a company to pay its suppliers and vendors for the goods and services it purchases.
8	(O) Revenues (REV)	Revenues, also known as sales or turnover, are the income generated by a company from its core business activities.
9	(O) Net Profit Margin (NPM)	NPM is a financial metric that measures the profitability and efficiency of a company by determining the percentage of each revenue dollar that is converted into net profit.
10	(O) Return on Assets (ROA)	ROA is a financial ratio that measures a company's profitability in relation to its total assets.
11	(O) Return on Equity (ROE)	ROE is a financial ratio that measures the profitability of a company in relation to its shareholders' equity. It shows the rate of return earned by the company on the equity invested by its shareholders.
12	(O) Earnings Per Share (EPS)	EPS is a financial metric that measures the portion of a company's profit allocated to each outstanding share of common stock.

13	(O) Debt-to-Equity Ratio (DER)	DER is a financial ratio that compares a company's total debt to its total equity. It is used to assess a company's leverage or financial risk.
14	(O) Current Ratio (CR)	CR is a financial ratio that measures a company's ability to pay its short-term liabilities using its short-term assets. It assesses a company's liquidity and short-term solvency by comparing its current assets to its current liabilities.
15	(O) Quick Ratio (QR)	QR known as the Acid-Test Ratio or Quick Asset Ratio, is a financial metric used to assess a company's short-term liquidity position.

3.3. DEA Models

3.3.1. DEA Originality

Performance Evaluation and Tradeoffs

Performance evaluation plays a vital role in every business operation by pinpointing areas for improvement and enhancing efficiency. Businesses employ performance measures or metrics to assess their performance in terms of resource utilization, product/service quality, customer satisfaction, and other outcomes. In today's tremendously competitive global market, performance evaluation is essential for businesses to maintain their competitive edge. By continually facilitate operations process, businesses can survive in this industry.

While single-measure-based gap analysis is commonly used in performance evaluation, it is not always sufficient since a business's performance is a multifaceted phenomenon that requires the consideration of multiple criteria. For instance, the revenue generated by a retail store does not necessarily indicate whether the inventory management and customer service practices are efficient. Each business operation has specific performance measures or metrics that involve tradeoffs, interactions, or substitutions. Benchmarking and performance evaluation serve as valuable tools in identifying these tradeoffs and enhancing operational efficiency.

For example, let's consider the tradeoff between the expense of improving technology and the time it takes to produce goods in the manufacturing process. Achieving an efficient production process may require investing in advanced technology to enhance productivity and reduce production time. However, improving technology can come with significant initial costs.

For instance, a manufacturing company may decide to invest in state-of-the-art machinery and advanced technology to automate production processes. This could entail a substantial upfront expenditure to acquire new equipment and implement complex technological systems. However, once the technology is deployed and operational, the company can save production time and reduce labor costs. **Figure 3.2** illustrates alternate supply chain operations S1, S2, S3, and S, and the best-practice (efficient) frontier or tradeoff curve determined by them.

Through performance evaluation, the company can determine the optimal level of efficiency in terms of technology improvement and production time. The efficient frontier represents the best balance between the expense of technology improvement and production time. If the company is operating with an inefficient strategy (e.g., point S), performance evaluation can suggest improvement directions (such as moving to S1, S2, S3, or other points along the efficient frontier) to enhance efficiency and bring the strategy to the efficient frontier.

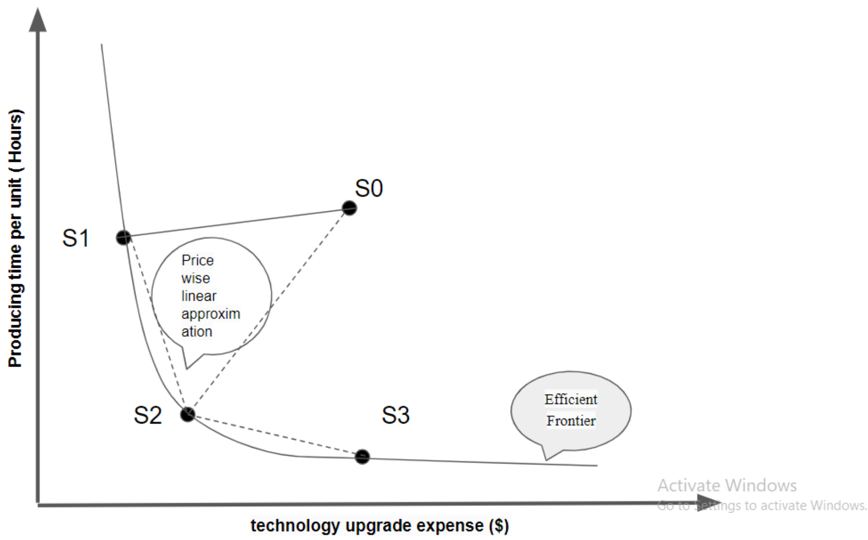


Figure 3. 2: (Example) Best efficient frontier of supply chain operations

Optimization techniques can be used to estimate the efficient frontier of a business operation if we have information on the functional forms of the relationships among various performance measures. For example, stockout levels and inventory turns are mutually dependent variables with tradeoffs that technological and process innovations can shift. However, such information is not always available, making it difficult to characterize business operations and processes fully. Performance evaluation aims to evaluate and benchmark the current operation internally and externally to identify best practices, which can be empirically identified based on observations of one business operation over time or similar operations at a specific period (Din and Cretan, 2010).

Parametric & Non-parametric

In statistics, there are two main methods: parametric and non-parametric.

Parametric method: This method is used when we assume that the data follows a specific distribution and has fixed parameters. Parametric methods require prior knowledge of the population distribution and utilize statistics based on these parameters. For example, in parametric hypothesis testing, we make assumptions about a normal distribution to apply paired t-tests, independent t-tests, ANOVA, or linear regression (Asmare, 2018).

Non-parametric method: This method does not make assumptions about the distribution of the data. Instead, non-parametric methods use statistics based on ranks or percentiles to compare and analyze the data. For example, in non-parametric hypothesis testing, we can use the Mann-Whitney U test, Wilcoxon signed-rank test, sign test, or Kruskal-Wallis test (Asmare, 2018).

The choice between parametric and non-parametric methods depends on factors such as assumptions about the data distribution, sample size, asymmetry or uncertainty of the data, and the objective of the statistical study.

The parametric test is mostly used when the data conforms to a normal distribution and exhibits equal variances across groups; parametric tests are appropriate. These tests offer increased statistical power and can be employed even with a limited sample size. Conversely, non-parametric tests are suitable in situations where the data does not adhere to a normal distribution, is measured on dissimilar scales, or when the distribution of the population is unknown.

Performance Metrics Classified as Inputs and Outputs

In the DEA methodology, performance metrics need to be classified as either inputs or outputs. However, it is crucial to ensure that the chosen metrics accurately reflect the process being studied. While inputs and outputs are generally well-defined in a production or service process, this may not be the case in benchmarking scenarios. The efficient DMUs identified by DEA may not necessarily form a "production frontier" but rather establish a "best-practice frontier." Therefore, it is necessary to categorize performance metrics as inputs or outputs when applying DEA.

DEA aims to minimize inputs and maximize outputs, but there are exceptions to this rule. For instance, pollutants generated by a production process are considered undesirable outputs and need to be minimized. Additionally, in certain situations, a factor may simultaneously function as both an input and an output.

If the underlying DEA problem represents a production process, it becomes easier to identify the inputs and outputs. However, in the case of a general benchmarking problem, the inputs typically consist of performance measures of the "less-the-better" type, while the outputs usually involve measures of the "more-the-better" type.

Number of DMUs vs. Number of Inputs and Outputs

The DEA approach generally recommends twice as many DMUs as inputs and outputs (see Golany and Roll 1989). Banker et al. (1984) recommend that the number of DMUs is three times the total number of inputs and outputs. However, such a rule is optional and is mainly formed on the basis of statistics, and researchers do not require this principle to be necessarily met. There are some special studies where large numbers of DMUs provide a more significant effect. Sometimes, the population size is small and only permits one to add actual DMUs within a certain point. However, if the user wishes to reduce the number or proportion of efficient DMUs, various DEA models can help; for example, weight restrictions may be useful in such cases.

Unlike statistical regression analysis, which focuses on estimating the mean behavior of a set of DMUs, sample size can be important as it attempts to estimate the average behavior of a set of DMUs. However, when using the DEA as a comparison tool, the DEA focuses on the performance of each DMU. Therefore, the sample size or the number of DMUs evaluated may not matter. For example, if there are, only a few companies in a particular market and management decides to use inputs and outputs. If more than one-third are needed, the DEA comparisons may still be valid (Cook and Zhu, 2010). One fact remains that whatever form the production frontier takes, it is beyond the best practice frontier. It is also true that if one adds DMU to an existing set, that DMU will be either inefficient or efficient. In the former case, the best practice frontier does not shift, and nothing new is learned about the production frontier.

In summary, DEA is not viewed as a regression model but a frontier-based linear programming-based optimization technique. Applying a sample size requirement to DEA is irrelevant, which should be viewed as a benchmarking tool focusing on individual performance. A significant portion of DMUs will likely be deemed as efficient.

3.3.2. Super-SBM Model

Tone (2001) proposed a different DEA model known as. Unlike the conventional CCR or BCC models (Charnes, Cooper and Rhodes, 1978), the Super-SBM model does not make the assumption of proportional changes in inputs and outputs. Instead, it introduces the concept of slacks directly into the model. By being non-radial and non-oriented, the Super-SBM model overcomes the limitations of radial and directional deviations. It captures the essence of efficiency evaluation and aims to maximize actual profits. This particular model utilizes a non-radial estimation approach and takes into account the disparities between input and output elements, known as slacks. The resulting efficiency value obtained from the model falls within the range of 0 to 1. A score of 1 signifies that the decision-making unit is operating at the frontier and has no slacks in either input or output components.

The Super-SBM model deals with n DMUs with the input and output, setting inputs ($A = a_{hk}$) and outputs ($B = b_{hk}$). A and B must be positive and R^+, henceforth the production possibility is denoted as below:

$$P = (A, B) \tag{1}$$

Subject to (s.t):

$$a \geq A\lambda, b \leq B\lambda, \lambda \geq 0$$

Here, λ is a non-negative vector in R^+.

$$a_0 = A\lambda + z^-;$$
$$b_0 = B\lambda - z^+ \tag{2}$$
$$\{\lambda, z^-, z^+ \geq 0\}$$

The vectors z^+ and z^- belong to R^+ in order to define input excess and output shortfall with the condition $A \geq 0, \lambda \geq 0$, which satisfies $a_0 \geq z^-$.

Following z^+, z^- and, ρ is formulated as below:

$$\rho = \frac{1 - \frac{1}{m}\sum_{h=1}^{m} z_h^- / a_{h0}}{1 - \frac{1}{z}\sum_{h=1}^{z} z_h^+ / b_{h0}} \tag{3}$$

$(0 < \rho \leq 1)$

The efficiency of (a_0, b_0) is calculated following:

$$\text{Min } \rho = \frac{1-\frac{1}{m}\sum_{h=1}^{m} z_h^- / a_{h0}}{1-\frac{1}{z}\sum_{h=1}^{z} z_h^+ / b_{h0}} \quad (4)$$

$$s.t: \begin{cases} a_0 = A\lambda + z^- \\ b_0 = B\lambda + z^+ \\ \lambda,\ z^-, z^+ \geq 0 \end{cases}$$

Setting up an optimal solution for the Super-SBM model is $\rho^*, \lambda^*, z^{-^*},\ z^{+^*}$. X DMU is defined as the Super-SBM model efficiency when it is based on the optimal solution under the condition $\rho^* = 1, z^{-^*} = 0,\ z^{+^*} = 0$ and no input excess, and there is no output shortfall in any optimal solution.

$$Min\ \delta = \frac{\frac{1}{m}\sum_{h=1}^{m} \bar{a}_{h/a_{h0}}}{\frac{1}{z}\sum_{h=1}^{z} \bar{b}_{h/b_{h0}}} \quad (5)$$

Subject to:

$$\bar{a} \geq \sum_{k=1,\neq 0}^{n} \lambda_k a_k\ , \bar{b} \leq \sum_{k=1,\neq 0}^{n} \lambda_k b_k$$

$$\bar{a} \geq a_0, \overline{b}\ \leq b_0, \bar{b} \geq 0, \lambda \geq 0$$

When the output r has no position, it is denoted as $\overline{b_r^+} = b_r^+ = 1$. Tone (2001) described the Super-SBM model as follows:

$$Min\ \delta = \frac{1}{\frac{1}{z}\sum_{r=1}^{z} \overline{b_r / b_{r0}}} \quad (6)$$

Whereas

$$\bar{a} \geq \sum_{k=1,\neq 0}^{n} \lambda_k a_k, \overline{b} \geq \sum_{k=1,\neq 0}^{n} \lambda_k b_k$$

$$\{\bar{a} = a_0; 0 \leq \bar{b} \leq b_0; \lambda \geq 0\}$$

3.3.3. DEA Resampling Model

The process of conducting DEA calculations can still result in measurement errors if not performed with meticulous care. To address these errors and enhance the accuracy of DEA efficiency estimators, Simar and Wilson (1998) introduced bootstrap methods. These methods involve repeated sampling to obtain optimal sample allocations, aiming to eliminate measurement errors in the results. Despite being a form of resampling, there are concerns regarding the method's ability to fully capture the data's characteristics. Another resampling method, known as resampling past–present and resampling past–present–future, was proposed by Tone (2016). These approaches are based on the resampling approach and utilize the Super-SBM model to establish confidence intervals for DEA scores across past and present periods. The past–present–future model expands upon the past–present model and enables the prediction of future efficiency for DMUs. This resampling technique proves to be more accurate in prediction compared to gray prediction methods. By taking into account the data's characteristics, such as lower and upper limits or reference weights, the resampling model effectively mitigates the presence of outliers. Notably, few previous studies have explored the potential of establishing a strategic alliance with a resampling model.

3.3.3.1. Historical (Past-Present Model)

The matrix $(X^t, Y^t)(t = 1, \ldots, t)$ is defined as a collection of historical data of resampling where $t = 1$ is the first period and $t = t$ is the last period. The number of the DMUs is n, with the input vector $X^t = (x_1^t, \ldots, x_n^t)$ $(x_d^t \in R^a)$ and the output vector $Y^t = (y_1^t, \ldots, y_n^t)$ $(x_d^t \in R^b)$ are respectively input and output vectors of DMU_d. W_t is used to represent a temporal weight that increases with t.

The Past-Present Model can be summarized as follows:

Initialization Step:

Choose an appropriate DEA model and calculate the Efficiency Scores for the DMUs in the most recent period.

Select a suitable weighting strategy to balance the available information from the past and present. The weight W_t is set to period t and the weights are assumed to increase in t. For this, Lucas number series $(h_1, \ldots, h_t)$ (a variant of the Fibonacci series) is the chosen weight scheme, which is defined as follows:

$$h_{t+2} = h_t + h_{t+1}(t = 1, \ldots, t, t-2; h_1 = 1,\ h_2 = 2) \qquad (7)$$

H represents the total of the series: $H = \sum_{t=1}^{t} h_t$. Then, the weight W_t is as follows:

$$W_t = {}^{h_t}/_{H} \, (t = 1, \ldots, t) \quad (8)$$

Choose the number of replicas to be drawn from the past-present data.

Iterative Step:

The confidence interval is calculated by bootstrapping previous data. Because these replicas correctly replicate the dataset, a first analysis is required to determine its features. The 95 percent confidence interval may be computed using Fisher's transformation (Fisher, 1915). The resampled data will be assessed based on its correlation with the corresponding data. If the correlation value falls within a specific interval, the resampled data will be deemed acceptable. Conversely, if the correlation value falls outside of this interval, the resampled data will be rejected and discarded. This approach ensures that any inappropriate samples from the previous period are eliminated during the sampling process. Although the use of a 95% confidence interval is not mandatory, opting for a narrower interval will result in the resampled data being more closely aligned with the data from the last period (Fisher, 1915).

3.3.3.2. Forecasting (Past - Present - Future Model)

After utilizing historical data from the Past-Present Model, we continue to forecast the "future" data, (X^{t+1}, Y^{t+1}) which is calculated by taking past-present data (X^t, Y^t) with $(t = 1, \ldots, t)$ and assessing the DMUs efficiency value in the future period alongside their confidence intervals. $F^t(t = 1, \ldots, t)$ is defined as historical data from a DMU with accurate input and output. F^{t+1} is forecasted from $F^t(t = 1, \ldots, t)$.

There are three resampling techniques:

- Trend analysis: a simple linear least square regression.
- Weighted average: weight by Lucas number.
- Average of trend and weighted average.

We evaluate the super-efficiency of the "future" DMU (X^{t+1}, Y^{t+1}) by applying the forecasting model and obtaining the data set.

3.4. Forecasting Accuracy

Forecasting inevitably involves errors due to the challenge of predicting the future with incomplete information. Therefore, this study utilizes the MAPE as a metric to assess the precision of a technique for generating fitted values in time series analysis. MAPE serves as a common measure to evaluate the accuracy of forecasts. Stevenson's book explicitly defines MAPE as the average absolute percentage error, providing a means to gauge the accuracy of fitted values in time series analysis, particularly in relation to trends (Stevenson, 2009).

$$MAPE = \frac{1}{n}\sum\frac{|Actual - Forecast|}{Actual} \times 100 \qquad (9)$$

n is forecasting number of steps.

The parameters of MAPE state out the forecasting ability as follows in **Table 3.3**

Table 3. 3: MAPE value efficiencies in forecasting results

MAPE (%)	Forecast Results
<10	Highly accurate results
10-20	Good results
20-50	Reasonable results
>50	Weak and inaccurate results

3.5. Conclusion

In this step-by-step procedure, the researchers have undertaken a comprehensive approach to assess the effectiveness and efficiency of logistics enterprises in Vietnam. By combining various methodologies such as DEA-Solver computation, Super-SBM, and correlation coefficient testing, the study has provided a robust framework for evaluating the performance of 22 firms in the logistics industry.

The integration of resampling models with the Super-SBM model has enhanced the reliability and predictive nature of the analysis, enabling the researchers to forecast future efficiency scores and associated confidence intervals for each DMU. This approach has allowed for a thorough examination of the historical performance from 2013 to 2022 and projections for 2023 to 2027.

By comparing the operational results between the target company and 21 other competing companies, the researchers have gained valuable insights into the relative efficiency and competitiveness within the industry. Additionally, the establishment of a new alliance and the comparison with the existing company has shed light on potential performance improvements through collaboration.

Overall, this study's methodology showcases a rigorous and systematic process that leverages both qualitative and data-driven techniques to assess the effectiveness and potential improvements of logistics enterprises in Vietnam. The next chapter will present the findings and data analysis, providing valuable insights for the industry and future research endeavors.

CHAPTER 4: ANALYSIS AND FINDINGS

4.1. Results of DEA Resampling Model

4.1.1. Testing Replicas and Correlation

The given table represents a correlation matrix, showing the correlation coefficients between various variables. Each row and column in the table represents a variable, and the corresponding cell shows the correlation coefficient between the variables. By academic theory, the Correlation coefficient ranges from -1 to 1, where -1 indicates a perfect negative correlation, 1 indicates a perfect positive correlation, and 0 indicates no correlation. When the correlation coefficient is close to 1, it suggests a strong positive relationship between the variables. For example, in the given **Table 4.1**, the correlation coefficient between TL and TE is 0.9473, indicating a strong positive correlation between these two variables. In contrast, when the correlation coefficient is close to -1, it suggests a strong negative relationship between the variables. For example, in the given table, the correlation coefficient between TL and DER is -0.2107, indicating a strong negative correlation between these two variables. Finally, with the correlation coefficient close to 0, it suggests no linear relationship between the variables. For example, in the given **Table 4.1**, the correlation coefficient between TL and IT is -0.0876, indicating a weak or no linear relationship between these two variables. Based on the correlation coefficients in the table, it appears that TL and TE, TL and COGS, TL and SG&A, TE and REV, TE and COGS, and REV and COGS have relatively strong positive correlations. On the other hand, TL and DER, CR and DER, QR and DER, and CR and QR have relatively strong negative correlations. It's important to note that correlation coefficients only measure linear relationships between variables and do not imply causation. Additionally, correlation coefficients do not capture the strength or direction of nonlinear relationships.

The correlation coefficients provided offer insights into the relationships between various inputs and outputs. Based on the indicated table, the authors analyze and interpret the correlation coefficients and their implications. Total liabilities have a strong positive correlation with total equity, meaning that as total equity increases, total liabilities also tend to increase. There is also a moderately positive correlation with COGS and SG&A. This suggests that as COGS and SG&A increase, total liabilities also tend to increase. The correlation with revenue is relatively weak, indicating that revenue has a limited impact on total liabilities. Total equity exhibits a strong positive correlation with total liabilities. This means that as TL increases, TE also tends to increase. There are also moderately positive correlations between net profit margin and return on equity. This implies that as NPM and ROE increase, TE also tends to increase. The correlation with return on assets is relatively weak, suggesting that ROA has a limited impact on total equity. SG&A expenses exhibit positive correlations with TL, COGS, and REV. The strongest correlation is observed with COGS, followed by TL and REV. This indicates that as TL, COGS, and REV increase, SG&A expenses also tend to increase. These findings suggest that TL, COGS, and REV increases require higher SG&A expenses to support business operations. The COGS exhibits positive correlations with TL, SG&A, and REV. The strongest correlation is observed with SG&A, followed by REV and TL. This suggests that as TL, SG&A, and REV increase, the COGS also tends to increase. This implies that higher TL, SG&A, and REV lead to higher production costs and expenses related to goods sold. Revenue exhibits positive correlations with SG&A, COGS, and TL. The strongest correlation is observed with COGS, followed by SG&A and TL. This suggests that revenue also tends to increase as SG&A, COGS, and TL increase. These findings indicate that higher investments in SG&A, higher production costs, and higher TL may contribute to increased revenue. It's important to note that correlation does not imply causation, and other factors not considered in the analysis could also influence these relationships. The correlations provide a quantitative understanding of the statistical relationships between the inputs and outputs but may not capture the complete dynamics of the system.

These main inputs provide a general understanding of the relationships between the variables mentioned in the correlation coefficient table. It's important to note that these relationships are based on correlation coefficients and may not capture the entire complexity of the relationships between inputs and outputs. Further analysis and consideration of other factors are necessary to fully understand the dynamics and causality between these variables. It's also worth noting that these relationships may vary in different contexts or industries. The specific nature of the business, market conditions, and other external factors can influence the relationships between inputs and outputs. Therefore, it's important to interpret the results within the specific context of the study and consider any industry-specific factors that may impact the relationships observed. Additionally, it's essential to conduct further research and analysis to validate the observed correlations and explore potential underlying mechanisms. A comprehensive understanding of the inputs and outputs can provide valuable insights for decision-making and strategic planning, enabling businesses to optimize their operations, manage risks, and enhance their financial performance. In conclusion, the discussion graph highlights the key inputs for each output variable and their relationships based on the correlation coefficients. However, it is crucial to approach these relationships with caution and conduct further analysis to account for contextual factors and validate the observed correlations.

To assess the relationships between the input and output variables, Pearson correlation coefficients have been utilized in this analysis. The average Pearson correlation coefficients, calculated from the data spanning 2013 to 2022, are presented in **Table 4.1**. These coefficients serve as measures of the degree and direction of the linear relationship between the variables.

The correlation coefficients range from -1 to 1, providing information about the strength and nature of the relationship. A coefficient of 1 indicates a perfect positive linear relationship, suggesting that as one variable increases, the other also increases in a consistent and proportional manner. On the other hand, a coefficient of -1 signifies a perfect negative linear relationship, implying that as one variable increases, the other decreases in a consistent and proportional manner. A coefficient of 0 indicates no linear relationship between the variables. In **Table 4.1**, the correlation coefficients display the strength and direction of the relationships between the various pairs of variables. For example, a coefficient of 0.9473 between TL and TE suggests a strong positive correlation between TL and TE. This means that as TL increases, TE also tends to increase in a relatively consistent and proportional manner. Conversely, a coefficient of -0.2107 between DER and CR indicates a moderate negative correlation between the DER and the CR. This implies that as the DER increases, the CR tends to decrease, albeit in a less consistent and proportional manner compared to a strong negative correlation.

By examining the correlation coefficients in **Table 4.1**, analysts can gain insights into the relationships between the variables under consideration. These coefficients provide a quantitative understanding of the degree and direction of the linear associations, aiding in the interpretation and evaluation of the financial data.

Table 4. 1: Correlation Matrix

Input/output	TL	TE	SG&A	COGS	IT	DSO	DPO	REV	NPM	ROA	ROE	EPS	DER	CR	QR
TL	1	0.9473	0.6529	0.7587	-0.0876	-0.1071	0.1242	0.1242	0.1242	0.0130	0.1652	0.1178	0.2112	-0.2107	-0.2109
TE	0.9473	1	0.4819	0.5741	-0.2042	-0.1249	-0.0175	0.9573	0.2356	0.0775	0.1835	0.1891	0.0457	-0.1169	-0.1142
SG&A	0.6529	0.4819	1	0.9490	0.3335	-0.0496	0.6070	0.5798	0.1019	0.1361	0.2456	0.1313	0.1787	-0.0164	-0.0202
COGS	0.7587	0.5741	0.9490	1	0.2496	-0.0598	0.4947	0.6867	-0.0194	0.0132	0.1347	0.0494	0.2412	-0.1116	-0.1160
IT	-0.0876	-0.2042	0.3335	0.2496	1	0.1429	0.5232	-0.1438	0.0155	0.1382	0.1599	0.3591	0.0317	-0.0868	-0.0838
DSO	-0.1071	-0.1249	-0.0496	-0.0598	0.1429	1	0.3246	-0.1753	-0.0419	-0.1858	-0.2533	-0.1843	-0.3402	-0.0777	-0.0599
DPO	0.1242	-0.0175	0.6070	0.4947	0.5232	0.3246	1	0.0609	0.0165	-0.0162	0.1231	0.1223	0.2748	-0.1918	-0.1927

REV	0.9738	0.9573	0.5798	0.6867	-0.1438	-0.1753	0.0609	1	0.0867	0.0985	0.2496	0.2008	0.1836	-0.2515	-0.2529
NPM	0.0789	0.2356	0.1019	-0.0194	0.0155	-0.0419	0.0165	0.0867	1	0.6367	0.5778	0.6019	-0.4361	0.1227	0.1397
ROA	0.0130	0.0775	0.1361	0.0132	0.1382	-0.1858	-0.0162	0.0985	0.6367	1	0.9238	0.7649	-0.2602	-0.0995	-0.0934
ROE	0.1652	0.1835	0.2456	0.1347	0.1599	-0.2533	0.1231	0.2496	0.5778	0.9238	1	0.8287	-0.0547	-0.2451	-0.2433
EPS	0.1178	0.1891	0.1313	0.0494	0.3591	-0.1843	0.1223	0.2008	0.6019	0.7649	0.8287	1	-0.1394	-0.2070	-0.1992
DER	0.2112	0.0457	0.1787	0.2412	0.0317	-0.3402	0.2748	0.1836	-0.4361	-0.2602	-0.0547	-0.1394	1	-0.5472	-0.5610
CR	-0.2107	-0.1169	-0.0164	-0.1116	-0.0868	-0.0777	-0.1918	-0.2515	0.1227	-0.0995	-0.2451	-0.2070	-0.5472	1	0.9994
QR	-0.2109	-0.1142	-0.0202	-0.1160	-0.0838	-0.0599	-0.1927	-0.2529	0.1397	-0.0934	-0.2433	-0.1992	-0.5610	0.9994	1

Table 4.2 provides the lower and upper bounds of the 95% confidence intervals for the Pearson correlation coefficients. These confidence intervals are asymmetric and based on estimates of undistorted standard errors. The Fisher method is used to calculate these confidence intervals, taking into account the skewness of the distribution. Each entry in **Table 4.2** represents the lower and upper bounds of the 95% confidence interval for the corresponding correlation coefficient. For example, the correlation coefficient between TL and TE has a 95% confidence interval ranging from 0.8752 to 0.9782. It is important to note that the confidence intervals provide a range of values within which the true population correlation coefficient is likely to lie with a 95% level of confidence. The asymmetry of the intervals is due to the skewness of the distribution toward zero. These confidence intervals help in assessing the uncertainty associated with the estimated correlation coefficients. They provide a range of plausible values for the population correlation, taking into account the sampling variability.

Table 4. 2: Lower/Upper bounds of 95% confidence for Correlation

Input/output	TL	TE	SG&A	COGS	IT	DSO	DPO	REV	NPM	ROA	ROE	EPS	DER	CR	QR
TL		0.8752	0.3191	0.4957	-0.4911	-0.5059	-0.3138	0.9367	-0.3545	-0.4108	-0.2756	-0.3197	-0.2310	-0.5807	-0.5808
TE	0.9782		0.0757	0.2012	-0.5762	-0.5192	-0.4359	0.8983	-0.2066	-0.3557	-0.2580	-0.2527	-0.3833	-0.5132	-0.5112
SG&A	0.8426	0.7510		0.8791	-0.1025	-0.4616	0.2492	0.2094	-0.3340	-0.3029	-0.1963	-0.3074	-0.2627	-0.4350	-0.4381
COGS	0.8943	0.8017	0.9789		-0.1923	-0.4696	0.0923	0.3730	-0.4375	-0.4107	-0.3042	-0.3801	-0.2009	-0.5093	-0.5125
IT	0.3468	0.2379	0.6620	0.6073		-0.2966	0.1304	-0.5331	-0.4088	-0.3009	-0.2806	-0.0737	-0.3952	-0.4905	-0.4881
DSO	0.3293	0.3132	0.3799	0.3712	0.5324		-0.1123	-0.5558	-0.4555	-0.5633	-0.6098	-0.5622	-0.6662	-0.4835	-0.4697
DPO	0.5187	0.4071	0.8190	0.7582	0.7741	0.6564		-0.3702	-0.4079	-0.4348	-0.3149	-0.3155	-0.1660	-0.5675	-0.5681
REV	0.9892	0.9824	0.8047	0.8595	0.2958	0.2660	0.4704		-0.3477	-0.3371	-0.1923	-0.2413	-0.2579	-0.6086	-0.6095
NPM	0.4844	0.5978	0.5020	0.4055	0.4343	0.3865	0.4351	0.4903		0.2940	0.2065	0.2416	-0.7245	-0.3152	-0.2995
ROA	0.4323	0.4833	0.5274	0.4324	0.5290	0.2558	0.4082	0.4994	0.8343		0.8226	0.5067	-0.6144	-0.5001	-0.4955
ROE	0.5486	0.5617	0.6046	0.5264	0.5448	0.1885	0.5178	0.6073	0.8037	0.9683		0.6257	-0.4655	-0.6043	-0.6030
EPS	0.5139	0.5656	0.5239	0.4614	0.6780	0.2573	0.5173	0.5738	0.8163	0.8972	0.9266		-0.5299	-0.5781	-0.5727
DER	0.5811	0.4584	0.5582	0.6016	0.4473	0.0951	0.6241	0.5617	-0.0177	0.1813	0.3756	0.2998		-0.7872	-0.7947
CR	0.2315	0.3205	0.4080	0.3253	0.3475	0.3555	0.2500	0.1903	0.5176	0.3362	0.1969	0.2352	-0.1632		0.9985
QR	0.2313	0.3230	0.4048	0.3213	0.3502	0.3711	0.2492	0.1888	0.5301	0.3416	0.1987	0.2428	-0.1826	0.9997	

Table 4.3 compares the results obtained from 500 and 5000 replicas in a study. Historical data from 22 logistics companies in Vietnam over a ten-year period (2013-2022) was used to calculate efficiency scores using DEA Resample Super-SBM. The table displays DEA scores for each DMU with both replica scenarios, along with the absolute difference in the "Difference" column. Significant differences at a 95% confidence level are indicated, leading the authors to choose 5000 replicas. The DEA scores are nearly identical between the two scenarios, indicating robustness. However, the correlation coefficients show significant differences, as shown in the "97.50%" and "2.50%" columns. Some coefficients exceed 0.05, suggesting an impact of replica quantity. Thus, the study concludes that using 5000 replicas is more appropriate for accurate and reliable results, despite minimal differences in DEA scores.

Upon analyzing **Table 4.3**, it can be observed that the DEA scores for each DMU are nearly identical between the two replica scenarios. This suggests that the efficiency scores are robust and not significantly affected by the number of replicas used. However, when comparing the correlation coefficients, the results obtained with 500 replicas and 5000 replicas show significant differences. The correlation coefficients are measured in the "97.50%" and "2.50%" columns. The differences between the correlation coefficients obtained with 500 and 5000 replicas are provided in the "Difference" column. **Table 4.3** also indicates that some correlation coefficients have noticeable differences between the two replica scenarios, exceeding 0.05. This suggests that increasing the number of replicas from 500 to 5000 has an impact on the estimated correlation coefficients. Based on these findings, the study concludes that utilizing 5000 replicas is more appropriate for the analysis. While the DEA scores remain nearly identical between 500 and 5000 replicas, the correlation coefficients show significant differences. Therefore, to ensure more accurate and reliable results, the study opts for using 5000 replicas in the analysis.

Table 4. 3: Comparisons of 500 and 5000 replicas (2013–2022)

DMU	500 replicas			5000 replicas			Difference	
	97.50%	DEA	2.50%	97.50%	DEA	2.50%	97.50%	2.50%
DMU1	3.1928	1.6258	1.5376	3.0585	1.6258	1.516	0.1343	0.0216
DMU2	1.833	1.5261	1.1978	1.8392	1.5261	1.1888	-0.0062	0.009
DMU3	4.4843	1.9572	2.0042	4.4545	1.9572	1.9762	0.0298	0.028
DMU4	1.4856	0.684	0.4593	1.4647	0.684	0.4602	0.0209	-0.0009
DMU5	3.2831	1.2728	0.721	3.056	1.2728	0.6223	0.2271	0.0987
DMU6	4.5758	1.465	1.7767	4.3466	1.465	1.7788	0.2292	-0.0021

DMU7	507.4523	0.2965	0.2925	474.9348	0.2965	0.3016	32.5175	-0.0091
DMU8	8.3031	2.2939	1.6847	8.8164	2.2939	1.6809	-0.5133	0.0038
DMU9	4.7086	3.2114	2.439	4.6968	3.2114	2.3344	0.0118	0.1046
DMU10	4.7777	1.0817	0.4127	4.4244	1.0817	0.4272	0.3533	-0.0145
DMU11	3.4215	1.8764	1.6173	3.2531	1.8764	1.6164	0.1684	0.0009
DMU12	2.1346	1.4541	1.0997	2.1215	1.4541	1.0737	0.0131	0.026
DMU13	2.5476	1.3867	1.2711	2.3498	1.3867	1.2445	0.1978	0.0266
DMU14	2.9696	1.1013	0.2972	2.9413	1.1013	0.288	0.0283	0.0092
DMU15	4.4469	1.1645	0.3792	4.3922	1.1645	0.3712	0.0547	0.008
DMU16	68.9755	34.9701	12.3258	69.2567	34.9701	13.2563	-0.2812	-0.9305
DMU17	639.1102	2.0439	0.5937	621.4143	2.0439	0.5035	17.6959	0.0902
DMU18	601.7038	2.3613	1	652.407	2.3613	1	-50.7032	0
DMU19	1.8708	1.1141	0.4298	1.8679	1.1141	0.422	0.0029	0.0078
DMU20	4.0589	0.5552	0.4438	3.687	0.5552	0.4463	0.3719	-0.0025
DMU21	459.8812	1.8995	1	406.5856	1.8995	1	53.2956	0
DMU22	2.8429	1.0374	0.6435	2.7729	1.0374	0.6053	0.07	0.0382

4.1.2. Results of DEA Resampling Model for Future Data

In this section, the outcomes obtained from the Resampling method for forthcoming data are showcased. The authors divided the time period into past-present (2013-2022) and future (2023-2027). Three different forecasts were used to predict the efficiency of the logistics companies in Vietnam for the year 2022: The three models discussed in this context include Lucas weight, Trend, and a Hybrid model is Trends combining with Lucas weight. To assess the accuracy of the prediction model, a comparison was made between the actual efficiency scores obtained using the Super-SBM and the forecasted scores. For forecasting the future operations of the 22 logistics companies mentioned in the previous section, the study employed 5000 replicas along with a 95% confidence interval. Upon calculation and comparison of the actual scores for 2022 with the forecasted scores from the three models, it was found that the actual scores of all 22 sample DMUs were within the 95% confidence interval. This suggests that the prediction model provided accurate forecasts for the efficiency scores. **Table 4.4** includes the DMUs, the 97.50% and 2.50% confidence levels for the forecasted scores using the Hybrid model, and the 97.50% and 2.50% confidence levels for the actual scores. The column labeled "Forecast-Actual" represents the variance between the forecasted scores and the actual scores. Upon examining the table, it can be seen that the actual scores for all 22 sample companies fall within the 95% confidence interval. This confirms the accuracy of the prediction model.

Among the three forecast models used in the study (Trend, Lucas weight, and Hybrid), the Lucas weight prediction demonstrated the lowest Mean Absolute Percentage Error (MAPE) of 32.8%. This indicates that the Lucas weight model had the smallest average percentage difference between the forecasted and actual efficiency scores. Based on this finding, the researchers selected the Lucas weight prediction model to predict the data for 2023-2027. The lower MAPE suggests that the Lucas weight model provided more accurate and reliable forecasts when evaluated alongside the alternative models. However, after forecasting results for the next five years, the authors notice that all variables do not fluctuate. This means that the weights assigned to the inputs and outputs remain unchanged across the resampling iterations, leading to consistent results. Therefore, the authors proposed using the Hybrid method, which has the 2nd lowest MAPE, 33%. The researchers can reasonably predict that it will continue to offer reliable projections regarding the efficiency of logistics companies in Vietnam from 2023 to 2027. The forecasting data for period 2023-2027 will be detailed in Appendix A.

Table 4. 4: Forecast scores by the Hybrid model, actual scores, and confidence interval in 2022

DMUs	97.50%	Forecast	Actual	2.50%	Forecast-Actual
DMU1	3.1113	1.7681	1.7969	1.505	0.0160
DMU2	1.8656	1.178	1.6132	1.1863	0.2698
DMU3	4.5076	2.9382	2.21559	1.8742	0.3261
DMU4	1.4668	1.0706	0.68399	0.4738	0.5652
DMU5	2.9414	1.0616	1.4177	0.6457	0.2512
DMU6	2.6345	2.0955	3.08413	1.5329	0.3206
DMU7	566.906	0.5128	0.29654	0.2922	0.7293
DMU8	9.1643	2.5795	2.48385	1.6542	0.0385
DMU9	4.5511	2.4236	3.34549	2.2873	0.2756
DMU10	1.2834	0.4975	2.30528	0.3984	0.7842
DMU11	3.1479	2.0201	2.55986	1.5909	0.2109
DMU12	2.1315	1.2427	1.58755	1.1225	0.2172
DMU13	2.3726	1.3138	1.47086	1.2423	0.1068
DMU14	2.7508	2.4862	1.7391	0.2945	0.4296

DMU15	1.7309	0.4836	1.36481	0.3507	0.6457	
DMU16	69.582	16.8135	34.97012	13.4652	0.5192	
DMU17	687.031	0.5311	1	0.4657	0.4689	
DMU18	746.955	1.1675	1	1	0.1675	
DMU19	1.8527	0.5144	1.51585	0.3891	0.6607	
DMU20	3.2254	0.6078	0.55517	0.4361	0.0948	
DMU21	331.844	1	1	1	0.0000	
DMU22	2.7572	2.0252	1.6812	0.727	0.2046	
					MAPE	**33%**

4.2. Analysis before the alliance

The DEA results obtained from the Super-SBM model in previous years provided the authors with an overall understanding of the operational status of logistics companies in Vietnam. By utilizing the DEA efficiency scores and confidence intervals, a ranking table was constructed to reflect the performance of these companies. Higher efficiency scores corresponded to higher rankings, indicating better operational performance. The evaluation of each company's performance was based on whether its efficiency score exceeded one or not. According to the ranking presented in **Table 4.5**, DMU16 emerged as the most outstanding and efficient company, attaining an efficiency score of 34.9701, which secured its first-place position. Following DMU16, DMU9 scored 3.2114, and DMU18 got 2.3613, ranked second and third in descending order. On the other hand, DMU7 obtained the lowest efficiency score of 0.2965, positioning it last among the evaluated companies. Consequently, the research team made the decision to select DMU7 as the target company for the study and forecasting. The intention was to form strategic alliances between DMU7 and the remaining companies in order to enhance their performance and rankings.

In conclusion, the analysis before forming strategic alliances revealed valuable insights into the efficiency and rankings of logistics companies in Vietnam. By targeting DMU7 for improvement through alliances, its performance, and overall ranking are expected to be enhanced in collaboration with other companies.

Table 4. 5: Efficiency and ranking before the strategic alliance

DMU	97.50%	DEA	2.50%	Rank
DMU16	69.2567	34.9701	13.2563	1
DMU9	4.6968	3.2114	2.3344	2
DMU18	652.407	2.3613	1	3
DMU8	8.8164	2.2939	1.6809	4
DMU17	621.414	2.0439	0.5035	5
DMU3	4.4545	1.9572	1.9762	6
DMU21	406.586	1.8995	1	7
DMU11	3.2531	1.8764	1.6164	8
DMU1	3.0585	1.6258	1.516	9
DMU2	1.8392	1.5261	1.1888	10
DMU6	4.3466	1.465	1.7788	11
DMU12	2.1215	1.4541	1.0737	12
DMU13	2.3498	1.3867	1.2445	13
DMU5	3.056	1.2728	0.6223	14
DMU15	4.3922	1.1645	0.3712	15
DMU19	1.8679	1.1141	0.422	16
DMU14	2.9413	1.1013	0.288	17
DMU10	4.4244	1.0817	0.4272	18
DMU22	2.7729	1.0374	0.6053	19
DMU4	1.4647	0.684	0.4602	20
DMU20	3.687	0.5552	0.4463	21
DMU7	474.935	0.2965	0.3016	22

4.3. Analysis after the alliance

After conducting a comprehensive analysis of the projected rankings and efficiency scores for the strategic alliances formed by DMU7, the following main cases can be categorized based on their effectiveness and impact on the partner companies, as presented in **Table 4.6**.

Based on the analysis results, the author divides virtual alliances into effective and ineffective groups. Among the newly established strategic alliances, it can be observed that companies such as DMU7+DMU2, DMU7+DMU5, DMU7+DMU8, DMU7+DMU9,

DMU7+DMU11, DMU7+DMU12, DMU7+DMU14, DMU7+DMU16, DMU7+DMU21 are classified as effective companies based on their effectiveness scores, as these virtual alliances have scores higher than 1. Regarding effective alliances, the most effective alliance for DMU7 is formed with DMU21, with an impressive effectiveness score of 1.4784. Additionally, other alliances related to DMU7 show effectiveness, although they almost focus more on the performance of DMU7. The alliances established with DMU2, DMU5, DMU8, DMU9, DMU11, DMU12, DMU14, and DMU16 also lead to an improvement in the ranking for DMU7, indicating that these partnership relationships are beneficial for the operational performance of DMU7. However, the performance of partner companies may be affected to varying degrees, and the overall improvement in the industry may not be significant. For companies with the potential to become partners for DMU7, the authors will conduct further analysis to select the best candidates for forming strategic alliances.

Among the ineffective companies, according to the evaluation criteria, there are 12 out of a total of 21 newly established companies do not meet the effectiveness criteria due to having efficiency scores lower than 1. This means that companies such as DMU1, DMU3, DMU4, DMU6, DMU10, DMU13, DMU15, DMU17, DMU18, DMU19, DMU20 and DMU22 do not have the potential to become strategic partners for DMU7. Consequently, these companies will be excluded from the research subjects list. Regarding ineffective alliances, one alliance that falls short of the effectiveness threshold that the authors paid attention to is the partnership between DMU7 and DMU15. Although this alliance contributes to performance improvements and promotes rank for both companies, its efficiency score of 0.551 (<1) suggests it is not aligned with the desired outcome. DMU7 may need to re-evaluate this particular alliance's value and explore alternative collaboration options.

From DMU7 as an independent entity perspective, when operating independently, DMU7 ranks 43rd with an average score of 0.458, indicating relatively low efficiency compared to other companies in the industry. It suggests that DMU7's sole focus on improving its operational performance may not be sufficient to elevate its ranking significantly. This highlights the importance of strategic alliances for DMU7 to enhance its competitiveness and industry standing.

Table 4. 6: Efficiency and ranking after the strategic alliance

DMUs	2023	2024	2025	2026	2027		
	Score	Score	Score	Score	Score	AVERAGE	RANK
DMU16	23.066	22.0623	21.3569	20.8434	20.456	21.5571	1
DMU8	2.4773	2.5109	2.5342	2.5506	2.5624	2.52708	2
DMU6	2.4593	2.4684	2.4748	2.4793	2.4826	2.47288	3
DMU9	2.6532	2.5434	2.4447	2.3739	2.3225	2.46754	4
DMU3	2.5817	2.5462	2.4487	2.3715	2.3154	2.4527	5
DMU11	2.1471	2.1593	2.1689	2.1763	2.1821	2.16674	6
DMU1	1.7129	1.707	1.7027	1.6995	1.6971	1.70384	7
DMU7+DMU21	1.4599	1.4578	1.4561	1.4549	1.454	1.45654	8
DMU22	1.3246	1.3288	1.3326	1.3358	1.3389	1.33214	9
DMU7+DMU8	0.671	0.6932	0.7189	2.1227	2.1315	1.26746	10
DMU7+DMU16	1.2562	1.263	1.2684	1.2728	1.2763	1.26734	11
DMU12	1.2795	1.2677	1.2589	1.2525	1.2477	1.26126	12
DMU13	1.2611	1.2569	1.254	1.252	1.2506	1.25492	13
DMU21	1.2053	1.2098	1.2133	1.2159	1.218	1.21246	14
DMU18	1.1892	1.1678	1.1497	1.1365	1.1267	1.15398	15
DMU2	1.2073	1.1754	1.1555	1.1407	1	1.13578	16
DMU5	1.1671	1.1317	1.1074	1.0906	1.0784	1.11504	17
DMU7+DMU12	1.1135	1.1136	1.1138	1.114	1.1142	1.11382	18
DMU7+DMU5	1.0798	1.0831	1.0857	1.0877	1.0893	1.08512	19
DMU7+DMU14	1.0448	1.0457	1.0466	1.0451	1.0437	1.04518	20
DMU14	1.0367	1.0394	1.0416	1.0433	1.0446	1.04112	21
DMU7+DMU9	1.0327	1.0359	1.0377	1.0391	1.0406	1.0372	22
DMU7+DMU11	1.0298	1.0324	1.0346	1.0363	1.0375	1.03412	23
DMU7+DMU2	1.0234	1.026	1.0289	1.0317	1.0343	1.02886	24
DMU7+DMU18	1.0628	1.0594	1.057	1.055	0.7193	0.9907	25
DMU4	1.0404	0.8818	0.8623	0.8504	0.8407	0.89512	26
DMU7+DMU3	0.6522	0.6731	0.6925	0.7163	0.7332	0.69346	27
DMU7+DMU22	0.7277	0.6944	0.6752	0.6745	0.6749	0.68934	28
DMU7+DMU4	0.7037	0.6778	0.6642	0.654	0.6464	0.66922	29

DMU19	0.6305	0.6204	0.6079	0.599	0.5927	0.6101	30
DMU20	0.6028	0.6051	0.6068	0.6086	0.6102	0.6067	31
DMU17	0.6374	0.6026	0.5772	0.5585	0.5445	0.58404	32
DMU7+DMU6	0.5645	0.5753	0.5851	0.5938	0.6011	0.58396	33
DMU7+DMU13	0.5966	0.571	0.5513	0.5361	0.5243	0.55586	34
DMU7+DMU15	0.5652	0.5563	0.5495	0.5442	0.5402	0.55108	35
DMU7+DMU17	0.5818	0.541	0.5197	0.5059	0.4958	0.52884	36
DMU7+DMU1	0.5098	0.5148	0.5194	0.5234	0.5267	0.51882	37
DMU10	0.532	0.5219	0.5142	0.5082	0.5028	0.51582	38
DMU7+DMU19	0.5074	0.5034	0.5027	0.5007	0.4982	0.50248	39
DMU7	0.4924	0.4967	0.4997	0.5017	0.5034	0.49878	40
DMU15	0.5056	0.495	0.487	0.4815	0.4775	0.48932	41
DMU7+DMU10	0.4977	0.4871	0.4793	0.4735	0.4692	0.48136	42
DMU7+DMU20	0.4469	0.441	0.4362	0.4327	0.4301	0.43738	43

4.4. Alliance strategy selection

Based on the research findings and future forecasts, the authors have dedicated a section to analyzing and evaluating the selection of strategic partners specifically for DMU7. As mentioned above, out of the total of 21 newly established companies, nine are classified as effective, indicating that there are nine logistics companies that could become important strategic partners to help DMU7 improve its performance and ranking. However, this perspective focuses on the subjective aspect of DMU7 and not on the partners' viewpoint. When forming an alliance, it should be a win-win collaboration between two partners, meaning that the coalition should be mutually beneficial, and this cooperation should improve the situation, performance, and ranking of both allies. Based on **Table 4.7**, only DMU21 and DMU14 among the potential partners meet the requirements for forming a cooperative partnership with DMU7. Once the alliance is established, the effectiveness scores for DMU7+DMU14 and DMU7+DMU21 are 1.1045 and 1.4565, respectively. These scores exceed 1, indicating an improvement in the performance of both companies and an elevation in their rankings. In terms of future rankings, DMU21 is forecasted to have an individual ranking of 15. However, by allying with DMU7, the DMU7+DMU21 partnership achieves a significantly better ranking of 8. Similarly, the DMU7+DMU14 alliance improves the ranking of DMU14 from 21 to 20. The remaining alliances formed by DMU7 with DMU2, DMU5, DMU8, DMU9, DMU11, DMU12, and DMU16 achieve efficiency scores higher than one but will be categorized as ineffective. These alliances result in DMU7's improved performance at the expense of the partner companies' efficiency and ranking. As a result, these alliances may face challenges in achieving long-term sustainability. From DMU7 from an independent entity perspective, when operating independently, DMU7 ranks 40th with an average score of 0.4987, indicating relatively low efficiency compared to other companies in the industry. It suggests that DMU7's sole focus on improving its operational performance may not be sufficient to elevate its ranking significantly. This highlights the importance of strategic alliances for DMU7 to enhance its competitiveness and industry standing.

Table 4. 7: Ranking comparison before and after alliance of potential partners

DMU	The ranking of partner	The ranking of the alliance
DMU7+DMU21	15	8
DMU7+DMU8	2	10
DMU7+DMU16	1	11
DMU7+DMU12	12	18
DMU7+DMU5	17	19
DMU7+DMU14	21	20
DMU7+DMU9	4	22
DMU7+DMU11	6	23
DMU7+DMU2	16	24

In conclusion, the analysis of strategic alliances reveals that the alliances with DMU21 and DMU14 appear to be the most promising and mutually beneficial for DMU7. It demonstrates a significant improvement in both companies' performance, as the effectiveness score exceeds 1. However, it is important to note that the results for other alliances involving DMU7 are mixed. Some partnerships are effective for DMU7 but may compromise the performance of the partner companies. On the other hand, some alliances prove ineffective and fail to generate substantial improvements for any of the involved parties. This suggests that DMU7's focus on enhancing its operational performance might limit its ability to establish alliances that foster overall industry improvement. It is crucial to conduct a comprehensive evaluation to ensure the selection and formation of strategic alliances that yield positive outcomes for all stakeholders. This evaluation should consider the potential impact on both DMU7 and its partner companies and the overall industry. By considering the broader perspective and seeking alliances that promote mutual growth and improvement, DMU7 can maximize the benefits derived from strategic partnerships and contribute to the advancement of the entire industry.

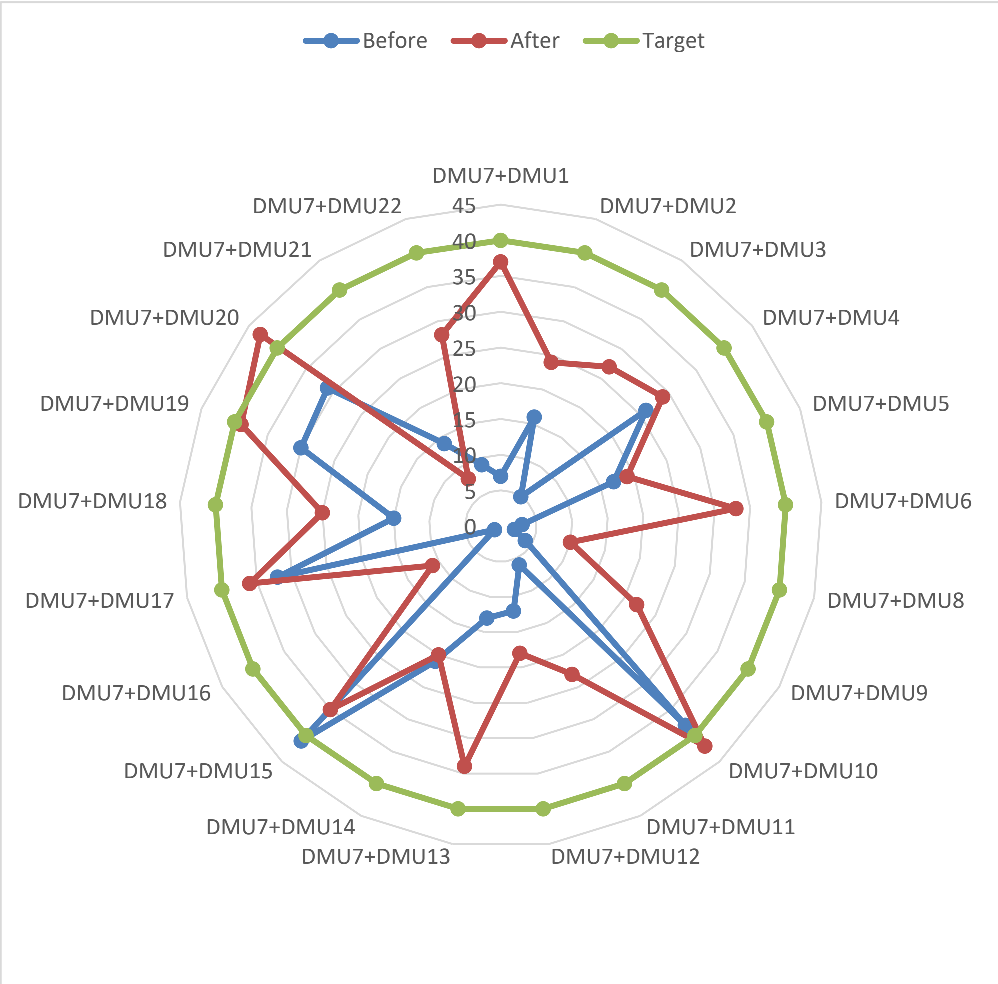
The radar comparison chart in **Figure 4.1** more obviously illustrates the change in the ranking of the above DMUs before and after the alliance in the scenario after forecasting for the next five years. In the radar chart, those points closer to the center are ranked higher. After forecasting, the green line represents the rank of the target DMU, the blue line stands for the rank of partner DMUs, and the red line presents the rank of virtual alliances. Combined with **Table 4.6**, there were 11 alliances in the "effective" group such as DMU7+DMU2, DMU7+DMU5, DMU7+DMU8, DMU7+DMU9, DMU7+DMU11, DMU7+DMU12, DMU7+DMU14, DMU7+DMU16, DMU7+DMU21. The alliances in the "ineffective" group were DMU7+DMU1, DMU7+DMU3, DMU7+DMU4, DMU7+DMU6, DMU7+DMU10, DMU7+DMU13, DMU7+DMU15, DMU7+DMU17, DMU7+DMU18, DMU7+DMU19, DMU7+DMU20 and DMU7+DMU22. The blue point was closer to the center than the red point in the radar chart, indicating that almost all DMUs operating independently will be more effective than alliances with the target DMUs.

Figure 4. 1: The comparison of changes in ranking

4.5. Discussion

The findings of this study make a valuable contribution to the existing body of knowledge on strategic alliances in the logistics industry. By comparing forecasted results and evaluating the effectiveness of strategic partnerships, this study aligns with previous research conducted in the field (Taylor, 2005; Wang et al., 2018; Nguyen et al., 2018; Ho et al., 2022; Wang et al., 2022).

Firstly, this study highlights the significance of strategic alliances in enhancing operational efficiency and performance, which is consistent with previous research (Wang et al., 2018; Tran, 2018; Wang et al., 2021). The role of alliances in improving competitiveness and generating mutual benefits for participating firms has been emphasized in previous studies. The findings support the notion that forming strategic alliances can lead to improved efficiency and effectiveness in the logistics sector (Nguyen and Tran, 2019; Ho et al., 2022). It is worth noting that previous studies, such as the one conducted by Ho et al.



(2022), focused solely on identifying the virtual alliance with the highest efficiency score for the target company without considering the potential negative impact on the selected partners. In contrast, the findings of this study carefully weigh the benefits for both parties in a feasible virtual strategic alliance. Even though certain virtual alliances may indicate higher efficiency scores for the target company, if the partners involved have poor performance, it may not be the optimal solution for both sides.

Secondly, this study utilizes the Resampling forecasting model, which is a non-parametric approach based on DEA-Super-SBM. This innovative approach adds to the existing literature on forecasting and selecting suitable alliance partners (Wang et al., 2022). While previous studies have employed various methods such as time-series forecasting models, Grey forecasting models, and machine-learning techniques for forecasting and assessing alliance effectiveness (Nguyen et al., 2015; Nguyen, 2020; Nguyen et al., 2021; Lin et al., 2021), the use of the Resampling model in this study provides a unique perspective and contributes to the methodological advancement in the field. Resampling models offer several significant advantages in statistical analysis. They effectively address the challenge of imbalanced data by adjusting the class distribution, and enhancing the performance of machine learning models.

Additionally, Resampling models have the capability to generate synthetic data, augmenting smaller or less diverse datasets to improve model generalization and reduce overfitting. These models provide estimates of uncertainty and variability, facilitating the calculation of confidence intervals and supporting hypothesis testing. Moreover, Resampling techniques can effectively handle missing data by imputing or estimating missing values, preventing bias and loss of information. Finally, Resampling methods enable reliable assessment of model performance, allowing for the evaluation of accuracy, precision, recall, and other essential metrics. Collectively, the utilization of resampling models contributes to more robust analyses, enhancing the reliability, validity, and accuracy of statistical inference across diverse research fields and data analysis endeavors.

Furthermore, this study considers the perspective of both the target company and partner companies when evaluating alliance effectiveness. This approach is in line with the growing recognition in previous research that successful alliances should benefit all participating parties (Wang et al., 2021). By assessing the impact of alliances on the performance of both the target company and its partners, the study provides a comprehensive analysis of alliance effectiveness, which aligns with the principles of mutual gains and cooperation emphasized in previous studies. Additionally, this study considers the specific context of logistics companies in Vietnam, highlighting the challenges faced by logistics companies in operating independently and lacking necessary connectivity. This finding resonates with previous studies (Vu, 2019; Ho et al., 2022) that have identified the need for collaboration and strategic alliances in the Vietnamese logistics industry. By addressing these specific challenges, the study offers insights and recommendations that are relevant to the local context and can contribute to the development of the logistics sector in Vietnam.

It is worth noting that while this study presents valuable findings and aligns with previous research, there may be variations in specific results and outcomes due to differences in methodologies, sample sizes, and other contextual factors (Nguyen et al., 2015; Nguyen, 2020; Kayral et al., 2021; Nguyen et al., 2021). Therefore, further research and comparative analysis across multiple studies are necessary to gain a more comprehensive understanding of strategic alliances in the logistics industry and to validate and build upon the findings presented in this study.

CHAPTER 5: CONCLUSION

5.1. Summary of findings & answer the research questions

In order to select the appropriate strategic alliance, the research questions raised in the first chapter will be answered as follows:

Question 1: What is the efficiency score of the 22 logistics companies in Vietnam from 2013 to 2022?

In this study, the authors used the Supper-SBM method to evaluate the performance scores of 22 logistics companies in Vietnam for ten consecutive years, from 2013 to 2022. **Table 4.5** shows the efficiency scores and rankings of 22 logistics companies in Vietnam from 2013 to 2022. The results show that 19 logistics enterprises operated effectively in the period from 2013 to 2022. In which DMU16 is the company it performed the best with an efficiency score of 34,9701, followed by DMU9 and DMU18, which ranked second and third with an efficiency score of 3.2114 and 2.3613, respectively. The three worstperforming companies are DMU4, DMU20, and DMU7, respectively, with efficiency scores of 0.684, 0.5552, and 0.2965. Choosing the right strategic alliance will be an effective strategy so that underperforming companies can improve their performance scores. Company DMU7 is the company with the lowest efficiency score selected as the target DMU. Implementing a strategic alliance for DMU7 with the remaining DMUs creates 21 new strategic alliances corresponding to the 21 virtual DMUs formed.

Question 2: What will be the efficiency scores before and after the implementation of the strategic alliance in the next five years, from 2023 to 2027?

After the formation of the 21 alliances, the Resampling method is used to forecast data and efficiency scores before and after implementing the strategic alliances over the next five years, from 2023 to 2027. **Table 4.6** illustrates the efficiency scores before and after the strategic alliance implementation phase from 2023 to 2027. The results indicate that in the upcoming five years, DMU16 will remain the most efficient operating company, with an efficiency score of 21.5571. The second and third positions are held by DMU8 and DMU6, with efficiency scores of 2.5271 and 2.4729, respectively. The three companies with the lowest efficiency scores are DMU15, the virtual alliance of DMU7+DMU10, and DMU7+DMU20, with efficiency scores of 0.4893, 0.4813, and 0.4373, respectively. DMU7, which is the target DMU in the next five years, is forecasted to have an efficiency score of 0.4987, corresponding to the 40th position out of 43 DMUs. DMU7, if operated independently, will still operate inefficiently. This demonstrates that implementing a strategic alliance for DMU7 is essential to improving its performance.

Question 3: Which strategic alliances are appropriate for selection?

The companies DMU21, DMU8, DMU16, DMU12, DMU5, DMU14, DMU9, DMU11, and DMU2 are all suitable companies for the target company DMU7 to establish a strategic alliance because virtual alliances have operational effectiveness greater than 1. The remaining virtual alliances, although some increase the effectiveness score of DMU7, are still not selected because their effectiveness score is lower than 1. Even when implementing a strategic alliance between DMU7, DMU10, and DMU20, these two virtual alliances also decrease the effectiveness score of DMU7 compared to when it operates independently. This shows that choosing the wrong strategic alliance will decrease the performance of both.

However, from the perspective of strategic alliance partners considered suitable for DMU7, companies DMU8, DMU16, DMU12, DMU5, DMU9, DMU11, and DMU2 all have lower performance scores compared to when these companies will operate independently in the next five years. In addition, it is also evident when the rank of these virtual alliances is lower than its own when operating independently. This proves that the performance score of companies when choosing a strategic alliance with DMU7 is not appropriate. Only DMU21 and DMU14 improved their efficiency scores when implementing a strategic alliance with DMU7 compared with them operating independently in the next five years. Specifically, the DMU21 improved its efficiency score to 1.4565 instead of 1.2124 when operating independently. The rank of the virtual alliance has also been improved to 8th instead of 14th. DMU14 improves the efficiency score to 1.0451 instead of 1.0411. Its rank also improved from 20th to 21st.

In summary, there are nine virtual alliances that can improve the effectiveness score of DMU7 by making the effectiveness score of the alliance greater than 1, but when considered comprehensively and beneficial for both parties, only DMU21 and DMU14 are the right choices as they help increase efficiency scores for both companies over the next five years. This result also proves that choosing the right alliance is important to improve the performance of the business, and the results also help to achieve the research purpose.

5.2. Conclusion

Strategic alliances in the logistics industry make it simpler to transfer goods internationally by linking diverse enterprises in the global supply chain. The growth rate of the logistics industry in the global market is positive because of the combination of alliance strategies. However, in Vietnam, the use of this strategy is still very limited. That is why this study focused on strategic alliance perspectives to improve the operational efficiency of businesses in the context of the Vietnamese Logistics industry. The Resampling forecasting method based on the Super-SBM model was applied to forecast and evaluate performance scores before and after implementing a future strategic alliance.

The study utilizes data from ten years, from 2013 to 2022, of 22 logistics companies in Vietnam. Based on the DEA results from the past-present data, DMU7, with the lowest efficiency score, was selected as the target company. The authors formed alliances between DMU7 and the remaining DMUs to create scenarios and forecast these virtual alliances for the next five years, from 2023 to 2027. The ultimate result showed that only the DMU7+DMU21 virtual alliance was the most effective, ranked 8th, with an efficiency score of 1.4784 > 1. Additionally, DMU7 can consider selecting DMU14 as a potential partner; the alliance DMU7+DMU14 achieved a score of 1.045, ranking 20th. The rankings of

DMU7, DMU14, and DMU21 were simultaneously improved. Without allying, DMU7 would remain at the low rank, while DMU21 would be ranked 15th, and DMU14 would stand at 21st. Although the remaining virtual alliances had efficiency scores greater than 1, they only benefited the target company and affected the efficiency performance of the partner companies. In conclusion, the study suggests that for the target company, Logistics Vicem JSC (DMU7), only Vietnam Sun Corporation (DMU21) and Petrovietnam Transmission Corporation (DMU14) are suitable strategic partners if these companies aim to improve their efficiency in the future.

5.3. Implication

The results of this research have important implications for policymakers in the field of logistics in Vietnam today. Using the DEA Super-SBM method first for inputs and outputs has allowed logistics companies in Vietnam to look back at their performance scores for ten consecutive years, from 2013 to 2022. This result helps them assess past and present performance levels and then develop different methods to improve their company's performance. Moreover, this study uses the Resampling method to evaluate the performance scores of logistics companies in Vietnam in the next five years, from 2023 to 2027. The future is what strategy developers always want to have to be able to guide their companies strategically. In addition, from an investor's perspective, seeing companies' performance in the future allows them to make important decisions to invest effectively. Strategic alliances are seen as an effective way to improve business performance. Research has forecast the performance of strategic alliances over the next five years based on the Resampling method. Logistics Vicem JSC (DMU7) was selected as the target DMU for a strategic alliance with the remaining companies. Research results indicate that Vietnam Sun Corporation is an appropriate strategic alliance; Petrovietnam Transportation Corporation can also be considered. Vicem JSC, when operating independently in the next five years, will still be inefficient, while Vietnam Sun Corporation, in the next five years, will operate more effectively in a strategic alliance with Vicem JSC than operating independently. The research results have once again shown the importance and effectiveness of choosing the right strategic alliance to improve the performance of the enterprise while also bringing practical meaning to the developer. Strategic developers for both companies may consider implementing a strategic alliance. Resampling can continue to be used to make strategic alliances with other underperforming companies to help them find the right strategic alliance.

This research method is not only applicable to logistics companies in Vietnam but also to logistics companies globally. The research results will provide additional knowledge and contribute to the development of the logistics industry in Vietnam and the global logistics industry.

This research's implications extend to theoretical and managerial aspects, offering valuable insights into the logistics industry. The theoretical implications highlight the significance of strategic alliances as a determining factor in the effectiveness and success of logistics enterprises. By utilizing the DEA Super-SBM model and Resampling forecasting, this study contributes to the existing body of knowledge by providing a novel and innovative approach to selecting suitable alliance partners. The findings shed light on the financial performance and projected effectiveness of potential partners, enabling researchers and scholars to expand their understanding of alliance evaluation and decision-making processes.

From a managerial perspective, this research has practical implications that can guide logistics company managers' strategic decision-making. The systematic approach proposed in this study equips managers with a structured framework for identifying and evaluating alliance partners. Managers can leverage shared resources, expertise, and networks to enhance operational efficiency, competitiveness, and market reach by forming alliances with recommended partners. Moreover, alliances provide opportunities for risk diversification and resilience building, as well as fostering a collaborative culture that promotes knowledge sharing and continuous learning within the organization.

The findings of this research also have implications for strategic planning and long-term growth. By selecting appropriate alliance partners based on the DEA-Super-SBM model and sampling forecasting, managers can align their organizations with partners that complement their strengths and address their weaknesses. This strategic alignment allows for resource optimization, improved operational performance, and the realization of synergies that contribute to sustainable growth and profitability. Additionally, the research findings emphasize the importance of considering both the target and the partner companies' viewpoints in alliance formation. This holistic approach enables managers to assess the potential benefits and risks from various angles, ensuring a mutually beneficial and successful alliance.

5.4. Limitations and Future Work

Despite the valuable insights provided by this research, there are certain limitations that should be acknowledged. First, the study focuses solely on logistics companies in

Vietnam, which limits the generalizability of the findings to other geographical contexts. The effectiveness of the proposed approach may vary in different regions with distinct market characteristics, regulatory frameworks, and business environments. Future research should aim to validate the model and methodology in diverse settings to enhance their applicability and reliability. Second, this study only focuses on utilizing the Super-SBM method combined with Resampling to forecast future data. Although the DEA method is widely used, there will be more efficient methods for performance computation in the future. Similarly, the Resampling forecasting method might be replaced in the future with more accurate and efficient forecasting approaches. With the advancement of modern techniques, performance computation and data forecasting methods can also be combined to enhance accuracy and efficiency. Third, the selection of alliance partners is based solely on quantitative measures derived from financial statements. While financial indicators are important measures of performance, they may not capture the full complexity of strategic alliances and their potential outcomes. Other important factors, such as compatibility of organizational culture, strategic fit, and trust between partners, are not explicitly considered in this research. Integrating qualitative assessments and incorporating a broader range of criteria for partner selection could yield more robust and accurate recommendations for alliance formation.

This research opens up several avenues for future work in the fields of logistics and strategic alliance management. First, expanding the scope of analysis to include a larger sample of logistics companies from different countries and regions would enhance the external validity of the findings and provide a broader perspective on alliance formation and effectiveness. Second, the Super-SBM method is effectively and widely used to assess the operational efficiency of businesses, and the Resampling method is employed for data forecasting. However, with the advancement of forecasting techniques in the future, replacing these methods with other modern forecasting approaches may enhance the accuracy and effectiveness of research. Third, integrating qualitative research methods, such as interviews or case studies, could provide a deeper understanding of the challenges, opportunities, and complexities involved in alliance formation and management. This qualitative perspective would complement the quantitative analysis and offer rich insights into the human and relational aspects of strategic alliances. Additionally, considering the impact of digitalization and technological advancements on strategic alliances in the logistics industry would be an interesting area for future research. The evolving landscape of digital technologies and data-driven decision-making is reshaping the way alliances are formed, managed, and evaluated. Exploring the role of digital platforms, data sharing, and analytics in alliance effectiveness could provide valuable insights for practitioners and researchers. As a result, future research should strive to address the limitations of this study and further advance the understanding of strategic alliances in the logistics industry. By incorporating diverse contexts, qualitative methodologies, and emerging trends, researchers can continue to enhance the effectiveness and applicability of alliance evaluation and decision-making models, contributing to the knowledge base of logistics management and strategic alliance literature.

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APPENDICES

APPENDIX A: Future period by Hybrid

Table A-1: Forecasting data for 2023 by Hybrid

Table A-2: Forecasting data for 2024 by Hybrid

Table A-3: Forecasting data for 2025 by Hybrid

Table A-4: Forecasting data for 2026 by Hybrid

Table A-5: Forecasting data for 2027 by Hybrid

Table A-1. Forecasting data for 2023 by Hybrid

DMU	TL	TE	SG&A	COGS	IT	DSO	DPO	REV	NPM	ROA	ROE	EPS	DER	CR	QR
DMU1	7.7E+09	1.5E+11	1.1E+10	5.4E+10	22.595	0.181	4.413	7.2E+10	0.092	0.043	0.046	433.366	0.052	10.225	9.656
DMU2	1.3E+11	1.2E+12	5.6E+10	2.9E+11	30.595	0.101	20.141	5.9E+11	0.458	0.209	0.243	6673.552	0.117	8.224	8.117
DMU3	2.2E+10	4.4E+11	1.6E+10	7.0E+10	19.937	0.166	27.231	1.1E+11	0.409	0.106	0.118	2423.040	0.056	13.276	13.085
DMU4	4.7E+11	5.4E+11	4.7E+10	1.4E+12	77.062	0.079	27.975	1.5E+12	0.043	0.069	0.128	1491.507	0.815	2.249	2.127
DMU5	1.0E+12	1.6E+12	7.2E+10	1.0E+12	21.416	0.110	33.573	1.6E+12	0.248	0.148	0.280	6594.019	0.620	2.019	1.718
DMU6	4.4E+09	4.1E+10	6.8E+09	7.9E+10	81.887	0.173	5.719	8.7E+10	0.014	0.027	0.030	586.851	0.107	6.583	6.245
DMU7	8.0E+10	3.3E+11	1.5E+10	1.8E+11	114.337	0.537	55.563	2.7E+11	0.094	0.059	0.074	1699.315	0.246	4.203	4.171
DMU8	5.4E+10	4.3E+10	1.7E+10	1.3E+11	19.184	0.074	35.447	1.6E+11	0.055	0.111	0.239	3658.951	1.323	0.703	0.523
DMU9	7.7E+10	4.4E+11	7.5E+10	3.5E+11	108.280	0.079	11.385	7.1E+11	0.346	0.482	0.571	10032.346	0.177	4.977	4.841
DMU10	3.7E+11	6.0E+11	6.2E+10	5.1E+11	883.434	0.120	54.080	7.4E+11	0.190	0.143	0.245	7644.624	0.641	1.240	1.234
DMU11	1.0E+11	1.2E+11	4.1E+10	9.4E+11	100.237	0.036	7.526	1.0E+12	0.021	0.092	0.178	3203.707	0.885	1.087	0.933
DMU12	2.1E+11	2.4E+11	2.5E+10	5.6E+11	17.894	0.038	15.757	6.2E+11	0.043	0.061	0.124	1423.947	0.943	1.732	1.346
DMU13	1.5E+11	9.3E+10	2.4E+10	3.0E+11	16.966	0.049	35.384	3.5E+11	0.021	0.029	0.077	1270.971	1.647	0.944	0.653
DMU14	5.4E+12	6.0E+12	3.0E+11	6.3E+12	49.779	0.119	40.775	7.4E+12	0.106	0.068	0.139	1958.717	0.975	1.923	1.857
DMU15	2.3E+11	5.2E+11	1.1E+11	1.0E+12	857.857	0.167	45.987	1.2E+12	0.092	0.145	0.229	7210.004	0.502	2.176	2.101
DMU16	1.4E+10	7.7E+11	4.6E+10	2.2E+11	10.495	0.002	5.038	3.3E+11	0.215	0.112	0.126	1947.173	0.018	24.189	21.833
DMU17	6.3E+11	6.0E+11	3.2E+10	6.0E+11	117.566	0.167	45.983	1.1E+12	0.105	0.124	0.183	3409.838	1.081	1.794	1.757
DMU18	1.4E+12	2.5E+12	4.1E+10	9.6E+11	172.725	0.104	17.708	3.1E+12	0.160	0.101	0.180	5102.673	0.604	1.594	1.558
DMU19	4.1E+11	1.1E+12	5.8E+10	5.9E+11	7.056	0.111	17.879	7.1E+11	0.149	0.074	0.101	1533.661	0.370	3.755	3.258
DMU20	1.0E+11	1.5E+11	1.3E+10	2.0E+11	100.358	0.209	29.699	2.2E+11	0.045	0.040	0.067	1039.773	0.665	2.840	2.784
DMU21	7.7E+11	1.4E+12	4.5E+06	7.7E+07	0.031	0.147	0.068	1.9E+12	0.068	0.058	0.098	2093.059	0.520	2.023	1.950
DMU22	2.3E+12	9.9E+11	1.3E+11	1.5E+12	14.005	0.106	77.265	1.8E+12	0.116	0.079	0.221	1548.534	2.917	1.288	1.127
DMU7+DMU1	8.8E+10	4.7E+11	2.2E+10	2.1E+11	49.633	0.454	47.323	3.4E+11	0.093	0.055	0.065	2132.681	0.185	4.509	4.439
DMU7+DMU2	2.1E+11	1.5E+12	6.3E+10	4.1E+11	37.647	0.236	82.532	8.6E+11	0.341	0.173	0.204	8372.867	0.143	6.411	6.338
DMU7+DMU3	1.0E+11	7.6E+11	2.7E+10	2.2E+11	39.465	0.418	47.940	3.9E+11	0.181	0.083	0.097	4122.355	0.136	5.958	5.894
DMU7+DMU4	5.5E+11	8.6E+11	5.5E+10	1.5E+12	76.764	0.150	40.769	1.8E+12	0.051	0.066	0.107	3190.822	0.603	2.748	2.654
DMU7+DMU5	1.1E+12	1.9E+12	8.0E+10	1.1E+12	19.637	0.197	69.378	1.9E+12	0.221	0.135	0.238	8293.334	0.542	2.389	2.144
DMU7+DMU6	8.4E+10	3.7E+11	2.0E+10	2.3E+11	78.181	0.443	43.943	3.6E+11	0.072	0.056	0.069	2286.166	0.230	4.225	4.178
DMU7+DMU8	1.3E+11	3.7E+11	2.7E+10	2.5E+11	35.849	0.361	351.614	4.3E+11	0.073	0.066	0.091	4873.278	0.365	2.852	2.768
DMU7+DMU9	1.6E+11	7.6E+11	8.1E+10	4.8E+11	102.189	0.203	76.302	9.8E+11	0.277	0.295	0.358	11731.661	0.206	4.489	4.412
DMU7+DMU10	4.5E+11	9.3E+11	7.0E+10	6.3E+11	303.613	0.244	431.162	1.0E+12	0.165	0.119	0.184	9343.940	0.486	1.985	1.975
DMU7+DMU11	1.8E+11	4.4E+11	4.9E+10	1.1E+12	99.182	0.142	26.138	1.3E+12	0.035	0.071	0.101	4903.022	0.407	2.523	2.437
DMU7+DMU12	2.9E+11	5.6E+11	3.4E+10	6.8E+11	18.550	0.192	54.771	9.0E+11	0.059	0.060	0.093	3123.262	0.520	2.786	2.565
DMU7+DMU13	2.3E+11	4.2E+11	3.4E+10	4.3E+11	21.695	0.262	118.392	6.2E+11	0.052	0.048	0.075	2970.286	0.555	2.640	2.491
DMU7+DMU14	5.5E+12	6.4E+12	3.0E+11	6.4E+12	50.045	0.134	43.402	7.7E+12	0.105	0.068	0.136	3658.032	0.931	1.988	1.924
DMU7+DMU15	3.1E+11	8.5E+11	1.1E+11	1.1E+12	272.090	0.245	73.871	1.5E+12	0.094	0.117	0.170	8909.320	0.383	2.632	2.574
DMU7+DMU16	9.3E+10	1.1E+12	5.4E+10	3.6E+11	12.437	0.248	90.369	6.0E+11	0.164	0.088	0.102	3540.791	0.088	7.133	6.807
DMU7+DMU17	7.1E+11	9.3E+11	3.0E+10	6.4E+11	99.234	0.243	65.682	1.3E+12	0.103	0.103	0.144	5109.153	0.778	2.380	2.346
DMU7+DMU18	1.5E+12	2.8E+12	3.7E+10	9.6E+11	149.619	0.164	37.889	3.4E+12	0.148	0.097	0.164	6801.988	0.546	1.890	1.858
DMU7+DMU19	4.9E+11	1.5E+12	6.5E+10	7.1E+11	8.443	0.227	46.882	9.8E+11	0.134	0.070	0.095	3232.976	0.341	3.635	3.297
DMU7+DMU20	1.8E+11	4.7E+11	2.6E+10	3.2E+11	94.877	0.382	225.702	5.0E+11	0.069	0.052	0.072	2739.088	0.378	3.626	3.585
DMU7+DMU21	8.5E+11	1.8E+12	4.5E+06	7.7E+07	0.031	0.198	0.068	2.1E+12	0.063	0.055	0.089	3307.387	0.473	2.285	2.225
DMU7+DMU22	2.4E+12	1.3E+12	1.4E+11	1.6E+12	15.148	0.163	82.164	2.0E+12	0.106	0.073	0.176	2808.748	2.093	1.533	1.386

Table A-2. Forecasting data for 2024 by Hybrid

DMU	TL	TE	SG&A	COGS	IT	DSO	DPO	REV	NPM	ROA	ROE	EPS	DER	CR	QR
DMU1	7.8E+09	1.5E+11	1.1E+10	5.4E+10	23.010	0.180	4.443	7.2E+10	0.093	0.044	0.047	446.327	0.052	10.025	9.464
DMU2	1.3E+11	1.2E+12	5.5E+10	2.9E+11	30.672	0.101	20.120	5.9E+11	0.457	0.211	0.246	6657.810	0.120	8.088	7.981
DMU3	2.2E+10	4.3E+11	1.6E+10	7.1E+10	20.419	0.164	27.357	1.2E+11	0.406	0.108	0.121	2511.359	0.058	13.204	13.014
DMU4	4.5E+11	5.3E+11	4.6E+10	1.4E+12	76.919	0.079	27.761	1.5E+12	0.044	0.071	0.129	1495.122	0.800	2.304	2.179
DMU5	1.0E+12	1.5E+12	7.0E+10	9.9E+11	21.309	0.111	34.161	1.6E+12	0.247	0.147	0.277	6446.814	0.616	2.017	1.718
DMU6	4.5E+09	4.1E+10	6.8E+09	7.9E+10	83.936	0.171	5.730	8.7E+10	0.014	0.027	0.031	601.994	0.108	6.471	6.137
DMU7	7.9E+10	3.2E+11	1.5E+10	1.7E+11	109.626	0.542	53.314	2.7E+11	0.097	0.060	0.075	1719.389	0.243	4.234	4.200
DMU8	5.5E+10	4.4E+10	1.8E+10	1.3E+11	19.318	0.074	34.993	1.6E+11	0.059	0.120	0.257	3969.634	1.308	0.721	0.538
DMU9	7.6E+10	4.4E+11	7.5E+10	3.5E+11	106.881	0.079	11.679	7.1E+11	0.348	0.486	0.577	10226.728	0.176	4.986	4.853
DMU10	3.6E+11	5.9E+11	6.2E+10	4.9E+11	888.516	0.121	54.114	7.3E+11	0.189	0.141	0.242	7494.542	0.648	1.224	1.218
DMU11	1.0E+11	1.2E+11	4.1E+10	9.4E+11	100.119	0.036	7.600	1.0E+12	0.020	0.091	0.177	3206.161	0.898	1.067	0.914
DMU12	2.1E+11	2.3E+11	2.4E+10	5.5E+11	18.103	0.039	15.804	6.1E+11	0.044	0.062	0.127	1448.862	0.953	1.798	1.416
DMU13	1.5E+11	9.3E+10	2.4E+10	3.0E+11	16.757	0.050	35.068	3.4E+11	0.020	0.028	0.075	1237.081	1.627	0.972	0.673
DMU14	5.4E+12	5.9E+12	2.9E+11	6.2E+12	49.899	0.119	40.960	7.4E+12	0.104	0.068	0.138	1931.452	0.994	1.919	1.854
DMU15	2.3E+11	5.1E+11	1.1E+11	9.8E+11	854.142	0.167	45.378	1.2E+12	0.091	0.142	0.225	7017.049	0.514	2.151	2.079
DMU16	1.4E+10	7.6E+11	4.5E+10	2.2E+11	10.571	0.002	5.059	3.3E+11	0.227	0.119	0.134	2079.003	0.019	23.928	21.573
DMU17	6.1E+11	6.0E+11	3.4E+10	6.1E+11	120.108	0.169	47.124	1.0E+12	0.106	0.123	0.183	3435.195	1.051	1.793	1.756
DMU18	1.4E+12	2.4E+12	4.2E+10	9.8E+11	175.169	0.105	18.434	3.0E+12	0.162	0.100	0.181	5095.503	0.609	1.589	1.551
DMU19	4.2E+11	1.1E+12	5.8E+10	5.8E+11	6.991	0.110	17.855	7.1E+11	0.148	0.073	0.100	1521.429	0.381	3.622	3.129
DMU20	1.0E+11	1.5E+11	1.3E+10	2.0E+11	98.108	0.208	29.836	2.2E+11	0.045	0.040	0.067	1039.239	0.666	2.823	2.764
DMU21	7.9E+11	1.4E+12	4.5E+06	7.7E+07	0.031	0.141	0.068	1.9E+12	0.067	0.059	0.101	2166.290	0.536	1.936	1.863
DMU22	2.4E+12	9.8E+11	1.2E+11	1.5E+12	13.997	0.105	76.527	1.8E+12	0.109	0.074	0.208	1454.321	3.002	1.268	1.107
DMU7+DMU1	8.7E+10	4.7E+11	2.1E+10	2.0E+11	47.395	0.457	45.379	3.4E+11	0.095	0.056	0.067	2165.715	0.183	4.521	4.449
DMU7+DMU2	2.1E+11	1.5E+12	6.1E+10	4.0E+11	36.582	0.237	85.066	8.6E+11	0.343	0.175	0.207	8377.199	0.145	6.345	6.271
DMU7+DMU3	1.0E+11	7.5E+11	2.6E+10	2.1E+11	37.612	0.419	45.926	3.8E+11	0.183	0.084	0.099	4230.747	0.136	5.983	5.918
DMU7+DMU4	5.3E+11	8.5E+11	5.3E+10	1.5E+12	76.040	0.151	41.016	1.7E+12	0.052	0.067	0.108	3214.510	0.592	2.799	2.704
DMU7+DMU5	1.1E+12	1.9E+12	7.7E+10	1.1E+12	18.979	0.202	72.438	1.8E+12	0.220	0.133	0.234	8166.203	0.536	2.399	2.157
DMU7+DMU6	8.3E+10	3.7E+11	1.9E+10	2.2E+11	74.500	0.446	42.078	3.6E+11	0.074	0.057	0.070	2321.383	0.228	4.243	4.195
DMU7+DMU8	1.3E+11	3.7E+11	2.6E+10	2.4E+11	34.208	0.360	372.301	4.3E+11	0.076	0.069	0.095	5221.593	0.364	2.856	2.770
DMU7+DMU9	1.6E+11	7.6E+11	7.9E+10	4.6E+11	99.096	0.203	79.675	9.8E+11	0.280	0.298	0.362	11946.116	0.205	4.509	4.433
DMU7+DMU10	4.4E+11	9.1E+11	6.8E+10	6.0E+11	297.072	0.248	472.096	9.9E+11	0.164	0.118	0.182	9213.931	0.488	1.983	1.972
DMU7+DMU11	1.8E+11	4.4E+11	4.8E+10	1.0E+12	98.207	0.141	26.208	1.3E+12	0.035	0.071	0.102	4925.550	0.408	2.507	2.420
DMU7+DMU12	2.9E+11	5.6E+11	3.3E+10	6.6E+11	18.292	0.195	56.587	8.8E+11	0.061	0.061	0.095	3168.251	0.520	2.832	2.613
DMU7+DMU13	2.3E+11	4.2E+11	3.2E+10	4.1E+11	20.813	0.264	122.945	6.1E+11	0.053	0.049	0.075	2956.470	0.549	2.672	2.519
DMU7+DMU14	5.5E+12	6.3E+12	2.9E+11	6.3E+12	50.069	0.134	43.666	7.6E+12	0.104	0.067	0.135	3650.840	0.948	1.985	1.921
DMU7+DMU15	3.1E+11	8.3E+11	1.1E+11	1.1E+12	270.689	0.247	75.255	1.4E+12	0.094	0.115	0.167	8736.438	0.388	2.614	2.558
DMU7+DMU16	9.2E+10	1.1E+12	5.2E+10	3.4E+11	11.898	0.249	92.582	6.0E+11	0.172	0.093	0.108	3698.171	0.089	7.170	6.843
DMU7+DMU17	6.9E+11	9.3E+11	3.0E+10	6.4E+11	100.444	0.246	68.198	1.3E+12	0.104	0.103	0.145	5154.584	0.758	2.377	2.343
DMU7+DMU18	1.4E+12	2.8E+12	3.8E+10	9.7E+11	151.283	0.168	40.629	3.3E+12	0.150	0.096	0.163	6814.892	0.550	1.897	1.864
DMU7+DMU19	4.9E+11	1.5E+12	6.4E+10	6.9E+11	8.220	0.226	47.545	9.8E+11	0.134	0.070	0.095	3240.817	0.349	3.545	3.207
DMU7+DMU20	1.8E+11	4.7E+11	2.5E+10	3.1E+11	90.929	0.383	239.597	4.9E+11	0.070	0.052	0.073	2758.627	0.377	3.631	3.589
DMU7+DMU21	8.7E+11	1.8E+12	4.5E+06	7.7E+07	0.031	0.191	0.068	2.2E+12	0.063	0.056	0.092	3418.250	0.485	2.205	2.146
DMU7+DMU22	2.5E+12	1.3E+12	1.3E+11	1.6E+12	15.022	0.162	81.973	2.0E+12	0.101	0.068	0.167	2710.287	2.153	1.513	1.366

Table A-3. Forecasting data for 2025 by Hybrid

DMU	TL	TE	SG&A	COGS	IT	DSO	DPO	REV	NPM	ROA	ROE	EPS	DER	CR	QR
DMU1	7.9E+09	1.5E+11	1.1E+10	5.5E+10	23.328	0.179	4.466	7.3E+10	0.094	0.045	0.048	456.270	0.053	9.870	9.316
DMU2	1.3E+11	1.2E+12	5.5E+10	2.9E+11	30.731	0.101	20.104	5.9E+11	0.456	0.212	0.248	6645.731	0.122	7.983	7.875
DMU3	2.2E+10	4.2E+11	1.6E+10	7.2E+10	20.789	0.163	27.454	1.2E+11	0.404	0.110	0.123	2579.159	0.059	13.150	12.961
DMU4	4.4E+11	5.2E+11	4.6E+10	1.3E+12	76.811	0.079	27.597	1.5E+12	0.044	0.071	0.130	1497.920	0.788	2.345	2.218
DMU5	9.7E+11	1.5E+12	6.8E+10	9.6E+11	21.226	0.112	34.613	1.5E+12	0.247	0.147	0.274	6333.225	0.612	2.016	1.719
DMU6	4.5E+09	4.1E+10	6.9E+09	7.9E+10	85.507	0.170	5.739	8.8E+10	0.014	0.028	0.031	613.670	0.109	6.385	6.053
DMU7	7.8E+10	3.2E+11	1.4E+10	1.6E+11	106.003	0.546	51.585	2.7E+11	0.099	0.061	0.076	1734.808	0.241	4.257	4.223
DMU8	5.5E+10	4.5E+10	1.8E+10	1.3E+11	19.421	0.074	34.643	1.7E+11	0.062	0.126	0.270	4208.708	1.297	0.735	0.550
DMU9	7.6E+10	4.4E+11	7.4E+10	3.5E+11	105.805	0.078	11.904	7.1E+11	0.350	0.490	0.582	10375.821	0.176	4.993	4.863
DMU10	3.6E+11	5.8E+11	6.1E+10	4.8E+11	892.438	0.122	54.141	7.1E+11	0.189	0.139	0.240	7378.977	0.653	1.211	1.206
DMU11	1.0E+11	1.1E+11	4.0E+10	9.4E+11	100.025	0.036	7.658	1.0E+12	0.020	0.091	0.177	3208.085	0.907	1.051	0.898
DMU12	2.1E+11	2.3E+11	2.4E+10	5.4E+11	18.264	0.040	15.841	6.1E+11	0.045	0.062	0.128	1468.095	0.961	1.848	1.471
DMU13	1.5E+11	9.2E+10	2.3E+10	3.0E+11	16.596	0.051	34.825	3.4E+11	0.020	0.028	0.074	1211.007	1.611	0.993	0.688
DMU14	5.4E+12	5.8E+12	2.9E+11	6.2E+12	49.992	0.118	41.103	7.3E+12	0.103	0.067	0.138	1910.482	1.008	1.917	1.852
DMU15	2.3E+11	5.0E+11	1.1E+11	9.6E+11	851.253	0.167	44.911	1.2E+12	0.090	0.139	0.222	6868.387	0.524	2.132	2.063
DMU16	1.4E+10	7.5E+11	4.5E+10	2.1E+11	10.630	0.002	5.076	3.3E+11	0.236	0.124	0.140	2180.436	0.019	23.727	21.372
DMU17	6.0E+11	6.0E+11	3.5E+10	6.1E+11	122.074	0.171	48.003	1.0E+12	0.107	0.122	0.182	3454.672	1.028	1.792	1.756
DMU18	1.3E+12	2.4E+12	4.3E+10	9.9E+11	177.073	0.106	18.993	2.9E+12	0.164	0.100	0.181	5089.932	0.613	1.585	1.546
DMU19	4.2E+11	1.1E+12	5.9E+10	5.8E+11	6.941	0.109	17.836	7.1E+11	0.147	0.071	0.100	1511.885	0.389	3.519	3.030
DMU20	1.0E+11	1.5E+11	1.3E+10	2.0E+11	96.376	0.207	29.942	2.2E+11	0.045	0.040	0.067	1038.757	0.666	2.809	2.750
DMU21	8.1E+11	1.4E+12	4.5E+06	7.7E+07	0.031	0.137	0.068	2.0E+12	0.066	0.059	0.103	2222.481	0.548	1.868	1.797
DMU22	2.5E+12	9.7E+11	1.2E+11	1.5E+12	13.990	0.104	75.957	1.8E+12	0.104	0.070	0.199	1381.717	3.067	1.253	1.092
DMU7+DMU1	8.6E+10	4.7E+11	2.0E+10	1.9E+11	45.673	0.458	43.884	3.4E+11	0.097	0.057	0.067	2191.078	0.182	4.529	4.456
DMU7+DMU2	2.1E+11	1.5E+12	6.0E+10	3.9E+11	35.762	0.237	87.017	8.5E+11	0.343	0.176	0.209	8380.539	0.147	6.294	6.220
DMU7+DMU3	1.0E+11	7.4E+11	2.5E+10	2.0E+11	36.186	0.419	44.376	3.8E+11	0.184	0.085	0.101	4313.967	0.137	6.002	5.937
DMU7+DMU4	5.2E+11	8.5E+11	5.2E+10	1.4E+12	75.484	0.152	41.204	1.7E+12	0.052	0.068	0.108	3232.728	0.582	2.839	2.742
DMU7+DMU5	1.0E+12	1.8E+12	7.4E+10	1.1E+12	18.472	0.205	74.793	1.8E+12	0.219	0.132	0.231	8068.033	0.531	2.408	2.166
DMU7+DMU6	8.2E+10	3.6E+11	1.8E+10	2.1E+11	71.667	0.448	40.643	3.5E+11	0.075	0.058	0.071	2348.479	0.226	4.258	4.209
DMU7+DMU8	1.3E+11	3.7E+11	2.5E+10	2.3E+11	32.944	0.359	388.247	4.3E+11	0.079	0.072	0.098	5489.574	0.363	2.859	2.771
DMU7+DMU9	1.5E+11	7.6E+11	7.8E+10	4.5E+11	96.718	0.203	82.266	9.7E+11	0.283	0.301	0.365	12110.629	0.204	4.524	4.448
DMU7+DMU10	4.4E+11	9.0E+11	6.6E+10	5.8E+11	292.051	0.252	503.522	9.8E+11	0.164	0.117	0.181	9113.785	0.489	1.981	1.970
DMU7+DMU11	1.8E+11	4.4E+11	4.7E+10	1.0E+12	97.454	0.141	26.263	1.3E+12	0.035	0.072	0.103	4942.893	0.408	2.495	2.407
DMU7+DMU12	2.9E+11	5.5E+11	3.1E+10	6.4E+11	18.093	0.197	57.983	8.7E+11	0.062	0.062	0.096	3202.903	0.520	2.867	2.651
DMU7+DMU13	2.3E+11	4.2E+11	3.1E+10	4.0E+11	20.133	0.266	126.452	6.0E+11	0.054	0.049	0.076	2945.815	0.543	2.696	2.541
DMU7+DMU14	5.5E+12	6.2E+12	2.9E+11	6.3E+12	50.089	0.133	43.870	7.6E+12	0.103	0.067	0.135	3645.291	0.961	1.983	1.919
DMU7+DMU15	3.1E+11	8.2E+11	1.1E+11	1.1E+12	269.609	0.250	76.320	1.4E+12	0.094	0.114	0.165	8603.195	0.392	2.600	2.546
DMU7+DMU16	9.2E+10	1.1E+12	5.1E+10	3.3E+11	11.483	0.250	94.297	5.9E+11	0.179	0.097	0.112	3819.239	0.089	7.198	6.871
DMU7+DMU17	6.8E+11	9.2E+11	3.1E+10	6.4E+11	101.384	0.248	70.137	1.3E+12	0.105	0.102	0.145	5189.481	0.743	2.374	2.341
DMU7+DMU18	1.4E+12	2.7E+12	3.8E+10	9.8E+11	152.586	0.172	42.735	3.2E+12	0.151	0.096	0.163	6824.741	0.552	1.903	1.868
DMU7+DMU19	5.0E+11	1.5E+12	6.3E+10	6.8E+11	8.049	0.226	48.056	9.7E+11	0.134	0.069	0.095	3246.693	0.355	3.475	3.139
DMU7+DMU20	1.8E+11	4.7E+11	2.4E+10	3.0E+11	87.890	0.384	250.283	4.9E+11	0.071	0.053	0.073	2773.565	0.377	3.635	3.592
DMU7+DMU21	8.8E+11	1.8E+12	4.5E+06	7.7E+07	0.031	0.186	0.068	2.3E+12	0.062	0.057	0.094	3503.347	0.495	2.143	2.085
DMU7+DMU22	2.5E+12	1.3E+12	1.3E+11	1.6E+12	14.925	0.161	81.824	2.0E+12	0.096	0.065	0.160	2634.396	2.200	1.497	1.350

Table A-4. Forecasting data for 2026 by Hybrid

DMU	TL	TE	SG&A	COGS	IT	DSO	DPO	REV	NPM	ROA	ROE	EPS	DER	CR	QR
DMU1	7.9E+09	1.5E+11	1.1E+10	5.5E+10	23.573	0.179	4.484	7.3E+10	0.094	0.046	0.048	463.890	0.053	9.752	9.203
DMU2	1.3E+11	1.1E+12	5.5E+10	2.9E+11	30.777	0.101	20.092	5.9E+11	0.455	0.213	0.250	6636.468	0.124	7.902	7.795
DMU3	2.2E+10	4.2E+11	1.6E+10	7.3E+10	21.073	0.163	27.528	1.2E+11	0.402	0.111	0.125	2631.170	0.060	13.108	12.920
DMU4	4.3E+11	5.2E+11	4.6E+10	1.3E+12	76.729	0.078	27.470	1.4E+12	0.044	0.072	0.130	1500.088	0.780	2.377	2.248
DMU5	9.4E+11	1.5E+12	6.7E+10	9.4E+11	21.161	0.113	34.962	1.5E+12	0.246	0.146	0.272	6245.511	0.610	2.016	1.719
DMU6	4.5E+09	4.1E+10	6.9E+09	8.0E+10	86.711	0.169	5.745	8.8E+10	0.014	0.028	0.032	622.678	0.110	6.319	5.988
DMU7	7.7E+10	3.2E+11	1.4E+10	1.6E+11	103.217	0.550	50.255	2.6E+11	0.100	0.062	0.077	1746.647	0.240	4.276	4.241
DMU8	5.6E+10	4.5E+10	1.8E+10	1.3E+11	19.501	0.074	34.374	1.7E+11	0.065	0.131	0.281	4392.675	1.288	0.745	0.559
DMU9	7.6E+10	4.4E+11	7.4E+10	3.5E+11	104.979	0.078	12.077	7.1E+11	0.352	0.492	0.585	10490.068	0.176	4.999	4.870
DMU10	3.6E+11	5.7E+11	6.1E+10	4.8E+11	895.467	0.123	54.162	7.0E+11	0.188	0.138	0.238	7289.976	0.657	1.202	1.196
DMU11	1.0E+11	1.1E+11	4.0E+10	9.4E+11	99.950	0.036	7.703	1.0E+12	0.020	0.090	0.177	3209.601	0.915	1.039	0.886
DMU12	2.1E+11	2.3E+11	2.4E+10	5.4E+11	18.388	0.041	15.869	6.0E+11	0.045	0.063	0.130	1482.952	0.968	1.887	1.512
DMU13	1.5E+11	9.2E+10	2.3E+10	3.0E+11	16.471	0.051	34.638	3.4E+11	0.020	0.027	0.073	1190.946	1.599	1.010	0.699
DMU14	5.4E+12	5.8E+12	2.9E+11	6.1E+12	50.064	0.118	41.212	7.3E+12	0.103	0.066	0.137	1894.358	1.019	1.915	1.850
DMU15	2.3E+11	4.9E+11	1.1E+11	9.4E+11	849.001	0.168	44.552	1.1E+12	0.090	0.137	0.219	6753.814	0.531	2.117	2.050
DMU16	1.4E+10	7.5E+11	4.5E+10	2.1E+11	10.676	0.002	5.090	3.3E+11	0.243	0.128	0.145	2258.476	0.019	23.572	21.218
DMU17	5.9E+11	6.0E+11	3.6E+10	6.2E+11	123.597	0.173	48.682	1.0E+12	0.107	0.122	0.182	3469.625	1.010	1.791	1.756
DMU18	1.3E+12	2.3E+12	4.4E+10	1.0E+12	178.563	0.106	19.425	2.9E+12	0.166	0.100	0.181	5085.593	0.617	1.582	1.542
DMU19	4.3E+11	1.1E+12	5.9E+10	5.8E+11	6.903	0.109	17.823	7.0E+11	0.146	0.071	0.099	1504.411	0.395	3.439	2.954
DMU20	1.0E+11	1.5E+11	1.3E+10	2.0E+11	95.042	0.206	30.024	2.2E+11	0.045	0.040	0.067	1038.316	0.667	2.798	2.738
DMU21	8.2E+11	1.4E+12	4.5E+06	7.7E+07	0.031	0.133	0.068	2.1E+12	0.065	0.060	0.105	2265.560	0.557	1.816	1.746
DMU22	2.5E+12	9.7E+11	1.2E+11	1.5E+12	13.985	0.103	75.516	1.8E+12	0.100	0.067	0.191	1325.745	3.117	1.241	1.081
DMU7+DMU1	8.5E+10	4.7E+11	2.0E+10	1.9E+11	44.348	0.460	42.734	3.4E+11	0.098	0.057	0.068	2210.537	0.181	4.536	4.462
DMU7+DMU2	2.1E+11	1.5E+12	5.9E+10	3.8E+11	35.131	0.237	88.518	8.5E+11	0.344	0.177	0.210	8383.116	0.148	6.255	6.181
DMU7+DMU3	9.9E+10	7.4E+11	2.4E+10	1.9E+11	35.088	0.420	43.185	3.8E+11	0.186	0.086	0.102	4377.817	0.137	6.018	5.952
DMU7+DMU4	5.1E+11	8.4E+11	5.1E+10	1.4E+12	75.059	0.152	41.349	1.7E+12	0.053	0.068	0.109	3246.735	0.575	2.870	2.771
DMU7+DMU5	1.0E+12	1.8E+12	7.2E+10	1.0E+12	18.082	0.208	76.604	1.7E+12	0.218	0.132	0.229	7992.158	0.527	2.414	2.174
DMU7+DMU6	8.2E+10	3.6E+11	1.7E+10	2.0E+11	69.486	0.449	39.540	3.5E+11	0.076	0.058	0.072	2369.326	0.225	4.269	4.219
DMU7+DMU8	1.3E+11	3.7E+11	2.4E+10	2.3E+11	31.971	0.358	400.543	4.3E+11	0.081	0.074	0.101	5695.733	0.362	2.861	2.772
DMU7+DMU9	1.5E+11	7.6E+11	7.7E+10	4.4E+11	94.889	0.203	84.257	9.7E+11	0.285	0.302	0.368	12236.715	0.203	4.536	4.460
DMU7+DMU10	4.3E+11	8.9E+11	6.5E+10	5.7E+11	288.200	0.254	527.632	9.6E+11	0.164	0.116	0.179	9036.623	0.490	1.979	1.968
DMU7+DMU11	1.8E+11	4.4E+11	4.6E+10	1.0E+12	96.872	0.140	26.307	1.3E+12	0.035	0.072	0.103	4956.248	0.408	2.485	2.397
DMU7+DMU12	2.9E+11	5.5E+11	3.0E+10	6.3E+11	17.940	0.199	59.056	8.6E+11	0.062	0.063	0.097	3229.599	0.520	2.895	2.679
DMU7+DMU13	2.3E+11	4.1E+11	3.0E+10	3.9E+11	19.610	0.268	129.156	6.0E+11	0.054	0.050	0.076	2937.593	0.539	2.715	2.557
DMU7+DMU14	5.5E+12	6.1E+12	2.8E+11	6.2E+12	50.104	0.133	44.027	7.5E+12	0.102	0.066	0.134	3641.005	0.971	1.981	1.917
DMU7+DMU15	3.1E+11	8.1E+11	1.1E+11	1.0E+12	268.777	0.251	77.140	1.4E+12	0.094	0.113	0.164	8500.461	0.394	2.589	2.537
DMU7+DMU16	9.1E+10	1.1E+12	4.9E+10	3.2E+11	11.163	0.250	95.629	5.9E+11	0.184	0.099	0.115	3912.362	0.089	7.220	6.893
DMU7+DMU17	6.7E+11	9.2E+11	3.1E+10	6.4E+11	102.115	0.250	71.631	1.3E+12	0.106	0.102	0.145	5216.272	0.731	2.373	2.340
DMU7+DMU18	1.4E+12	2.6E+12	3.8E+10	9.9E+11	153.609	0.174	44.354	3.1E+12	0.152	0.096	0.163	6832.240	0.554	1.907	1.872
DMU7+DMU19	5.1E+11	1.4E+12	6.2E+10	6.7E+11	7.917	0.226	48.451	9.7E+11	0.134	0.068	0.095	3251.058	0.360	3.422	3.086
DMU7+DMU20	1.8E+11	4.7E+11	2.3E+10	2.9E+11	85.551	0.385	258.498	4.9E+11	0.072	0.053	0.074	2784.963	0.376	3.639	3.595
DMU7+DMU21	9.0E+11	1.8E+12	4.5E+06	7.7E+07	0.031	0.182	0.068	2.3E+12	0.062	0.058	0.096	3568.618	0.502	2.096	2.037
DMU7+DMU22	2.6E+12	1.3E+12	1.3E+11	1.6E+12	14.850	0.160	81.709	2.0E+12	0.093	0.063	0.154	2575.875	2.236	1.485	1.338

Table A-5. Forecasting data for 2027 by Hybrid

DMU	TL	TE	SG&A	COGS	IT	DSO	DPO	REV	NPM	ROA	ROE	EPS	DER	CR	QR
DMU1	7.9E+09	1.5E+11	1.1E+10	5.5E+10	23.760	0.178	4.498	7.4E+10	0.095	0.046	0.049	469.718	0.053	9.660	9.115
DMU2	1.3E+11	1.1E+12	5.4E+10	2.9E+11	30.813	0.101	20.083	5.9E+11	0.455	0.214	0.252	6629.381	0.125	7.840	7.732
DMU3	2.2E+10	4.1E+11	1.6E+10	7.3E+10	21.291	0.162	27.585	1.2E+11	0.400	0.112	0.126	2670.997	0.061	13.077	12.890
DMU4	4.2E+11	5.1E+11	4.6E+10	1.3E+12	76.668	0.078	27.372	1.4E+12	0.044	0.073	0.131	1501.771	0.773	2.402	2.272
DMU5	9.2E+11	1.4E+12	6.6E+10	9.2E+11	21.110	0.113	35.231	1.4E+12	0.246	0.146	0.270	6177.772	0.608	2.015	1.719
DMU6	4.6E+09	4.1E+10	6.9E+09	8.0E+10	87.631	0.169	5.750	8.8E+10	0.014	0.028	0.032	629.627	0.111	6.267	5.938
DMU7	7.7E+10	3.2E+11	1.3E+10	1.5E+11	101.077	0.552	49.234	2.6E+11	0.102	0.062	0.078	1755.722	0.239	4.290	4.254
DMU8	5.6E+10	4.6E+10	1.8E+10	1.4E+11	19.563	0.073	34.167	1.7E+11	0.066	0.135	0.289	4534.106	1.281	0.753	0.566
DMU9	7.6E+10	4.4E+11	7.4E+10	3.5E+11	104.345	0.078	12.210	7.1E+11	0.353	0.494	0.588	10577.427	0.176	5.003	4.876
DMU10	3.6E+11	5.6E+11	6.0E+10	4.7E+11	897.806	0.123	54.179	6.9E+11	0.188	0.137	0.237	7221.481	0.661	1.194	1.189
DMU11	1.0E+11	1.1E+11	4.0E+10	9.4E+11	99.889	0.036	7.738	1.0E+12	0.020	0.090	0.177	3210.801	0.920	1.030	0.877
DMU12	2.1E+11	2.2E+11	2.4E+10	5.3E+11	18.483	0.042	15.891	6.0E+11	0.045	0.063	0.131	1494.432	0.972	1.917	1.545
DMU13	1.5E+11	9.2E+10	2.3E+10	3.0E+11	16.375	0.052	34.495	3.3E+11	0.020	0.027	0.072	1175.528	1.590	1.022	0.708
DMU14	5.4E+12	5.7E+12	2.9E+11	6.1E+12	50.120	0.118	41.297	7.2E+12	0.102	0.066	0.137	1881.973	1.028	1.913	1.848
DMU15	2.3E+11	4.9E+11	1.1E+11	9.2E+11	847.242	0.168	44.278	1.1E+12	0.089	0.136	0.217	6665.555	0.537	2.105	2.040
DMU16	1.4E+10	7.4E+11	4.5E+10	2.1E+11	10.711	0.002	5.100	3.3E+11	0.248	0.131	0.149	2318.461	0.019	23.453	21.099
DMU17	5.8E+11	6.0E+11	3.6E+10	6.2E+11	124.778	0.174	49.206	1.0E+12	0.108	0.121	0.182	3481.086	0.996	1.791	1.755
DMU18	1.3E+12	2.3E+12	4.4E+10	1.0E+12	179.732	0.106	19.758	2.8E+12	0.167	0.099	0.181	5082.205	0.619	1.579	1.539
DMU19	4.3E+11	1.1E+12	5.9E+10	5.8E+11	6.873	0.108	17.812	7.0E+11	0.146	0.070	0.099	1498.538	0.400	3.378	2.895
DMU20	1.0E+11	1.5E+11	1.2E+10	2.0E+11	94.017	0.206	30.087	2.2E+11	0.045	0.040	0.068	1037.908	0.667	2.790	2.729
DMU21	8.3E+11	1.4E+12	4.5E+06	7.7E+07	0.031	0.131	0.068	2.1E+12	0.065	0.060	0.106	2298.521	0.564	1.776	1.706
DMU22	2.5E+12	9.6E+11	1.2E+11	1.5E+12	13.982	0.102	75.177	1.7E+12	0.097	0.065	0.186	1282.611	3.155	1.232	1.072
DMU7+DMU1	8.5E+10	4.7E+11	1.9E+10	1.8E+11	43.330	0.461	41.851	3.3E+11	0.099	0.058	0.069	2225.441	0.180	4.541	4.467
DMU7+DMU2	2.1E+11	1.5E+12	5.8E+10	3.8E+11	34.646	0.237	89.672	8.5E+11	0.345	0.178	0.211	8385.103	0.149	6.225	6.151
DMU7+DMU3	9.9E+10	7.4E+11	2.3E+10	1.9E+11	34.244	0.421	42.269	3.8E+11	0.187	0.087	0.103	4426.720	0.137	6.029	5.963
DMU7+DMU4	5.0E+11	8.4E+11	5.0E+10	1.4E+12	74.733	0.153	41.460	1.7E+12	0.053	0.069	0.109	3257.493	0.570	2.893	2.794
DMU7+DMU5	1.0E+12	1.7E+12	7.0E+10	1.0E+12	17.782	0.210	77.997	1.7E+12	0.218	0.131	0.227	7933.494	0.523	2.419	2.179
DMU7+DMU6	8.1E+10	3.6E+11	1.7E+10	2.0E+11	67.810	0.450	38.692	3.5E+11	0.077	0.059	0.072	2385.349	0.224	4.278	4.227
DMU7+DMU8	1.3E+11	3.7E+11	2.4E+10	2.2E+11	31.223	0.358	410.021	4.3E+11	0.082	0.075	0.103	5854.175	0.362	2.863	2.773
DMU7+DMU9	1.5E+11	7.6E+11	7.6E+10	4.3E+11	93.484	0.203	85.783	9.7E+11	0.286	0.304	0.369	12333.149	0.203	4.545	4.470
DMU7+DMU10	4.3E+11	8.9E+11	6.4E+10	5.6E+11	285.252	0.256	546.096	9.5E+11	0.164	0.115	0.179	8977.203	0.491	1.978	1.967
DMU7+DMU11	1.8E+11	4.3E+11	4.5E+10	1.0E+12	96.422	0.140	26.341	1.3E+12	0.035	0.072	0.103	4966.523	0.408	2.478	2.389
DMU7+DMU12	2.8E+11	5.5E+11	3.0E+10	6.2E+11	17.823	0.200	59.880	8.6E+11	0.063	0.063	0.098	3250.154	0.520	2.916	2.701
DMU7+DMU13	2.2E+11	4.1E+11	3.0E+10	3.8E+11	19.207	0.269	131.238	6.0E+11	0.055	0.050	0.076	2931.250	0.536	2.730	2.570
DMU7+DMU14	5.5E+12	6.0E+12	2.8E+11	6.2E+12	50.117	0.133	44.147	7.5E+12	0.102	0.066	0.134	3637.696	0.978	1.980	1.916
DMU7+DMU15	3.1E+11	8.1E+11	1.1E+11	1.0E+12	268.135	0.252	77.771	1.4E+12	0.094	0.112	0.163	8421.278	0.396	2.581	2.529
DMU7+DMU16	9.1E+10	1.1E+12	4.9E+10	3.1E+11	10.917	0.251	96.665	5.9E+11	0.187	0.101	0.118	3983.917	0.089	7.237	6.909
DMU7+DMU17	6.6E+11	9.2E+11	3.1E+10	6.4E+11	102.684	0.251	72.781	1.3E+12	0.107	0.102	0.145	5236.808	0.722	2.371	2.339
DMU7+DMU18	1.4E+12	2.6E+12	3.8E+10	9.9E+11	154.417	0.176	45.596	3.1E+12	0.153	0.095	0.163	6837.928	0.556	1.910	1.874
DMU7+DMU19	5.1E+11	1.4E+12	6.2E+10	6.6E+11	7.815	0.226	48.755	9.6E+11	0.134	0.068	0.094	3254.261	0.364	3.381	3.045
DMU7+DMU20	1.8E+11	4.7E+11	2.3E+10	2.8E+11	83.753	0.385	264.806	4.9E+11	0.073	0.054	0.075	2793.631	0.375	3.641	3.597
DMU7+DMU21	9.1E+11	1.8E+12	4.5E+06	7.7E+07	0.031	0.179	0.068	2.4E+12	0.062	0.058	0.097	3618.590	0.508	2.060	2.001
DMU7+DMU22	2.6E+12	1.3E+12	1.3E+11	1.6E+12	14.793	0.160	81.619	2.0E+12	0.090	0.061	0.150	2530.763	2.264	1.476	1.329

LETTER OF ACCEPTANCE

15th Global Conference on Business & Social Sciences

"Contemporary Issues in Management and Social Sciences Research"

Dates: 14-15 SEPTEMBER 2023 (IN-PERSON & ONLINE)

NOVOTEL BANGKOK PLATINUM PRATUNAM, BANGKOK, THAILAND

Date: 9th June 2023

Authors: Phi-Hung Nguyen, Thi-Lua Tran, Thi-Ha Hoang, Giao-Huy Huu Nguyen, Duc-Quang Vu, Minh-Tan Ngo,
Affiliation: Faculty of Business, FPT University, 100000, Hanoi, Vietnam

Paper Title: A Novel Approach For Strategic Partner Selection In The Vietnamese Logistics Industry Using A Two-Stage Non-Parametric Model.

Dear Phi-Hung Nguyen,

Congratulations! We are pleased to confirm that the GCBSS committee has accepted your submitted paper abstract based on a double-blind peer review for an oral presentation at the 15th Global Conference on Business and Social Sciences in Novotel Bangkok Platinum Pratunam, Bangkok, Thailand.

Please note the following important guidelines:

1. Your paper abstract number is **CIMSSR-00374,** and please quote this number for all future correspondence. Please double-check the accuracy of the abstract title, address, and spelling of the author's name and name of the university and send us the corrected abstract, if necessary, by **10th June 2023**.

2. Your paper abstract will be published in the Refereed Conference Proceedings, which will be published online and in a CD form with ISBN 978-967-13147-0-8. All submitted conference full papers will go through a double-blind peer-review process by two to three competent reviewers. **All accepted** full articles would be published in any **WOS/Scopus/A-Category-indexed** journals with revisions. (Journals list available at Publication Opportunity).

3. You must send us the enclosed completed registration form and a payment slip **on or before 19th June 2023 to avail normal fee discount. Afterward, a late fee will be applied**. For more details, click here

4. The 15th GCBSS conference program will be sent to registered participants after **6th September 2023**. Two parallel presentations: Abstract-based presentation duration is 12-15 Minutes, including Discussions, and the full paper-based presentation duration is 15-20 minutes, including discussions. Please bring your flash drive, pen drive, or USB containing PowerPoint slides. We will provide an LCD projector and a computer at the venue for in-person guests. All online presentations will be conducted through Zoom.

5. Please visit the 15th GCBSS web and read all information related to Venue, Accommodation, Academic Discussion Session, Publishing in ABS & ABDC Workshop, and all other details. We look forward to meeting you at the conference.

Yours sincerely

Prof Abd Rahim

GCBSS Conference Team

Collaborators: