Región Científica

e-ISSN: 2954-6168
Región Científica. 2025. 4(1), 2025388
doi: 10.58763/rc2025388

Cross docking as a logistics strategy. Analysis on Nacex, FedEx and Maersk

Cross docking como estrategia logística. Análisis en Nacex, FedEx y Maersk

Karolynne Huayhua Machaca[1], Piazolli Manchego Pacco[1], Marjori Sugey Pro Aragón[1], Andrea Stephanie Villegas Calla[1], Jesús Zapata Chávez[1]

ABSTRACT

Cross docking is a logistics strategy that involves receiving goods and shipping them directly to final destinations, minimizing storage, delivery times and additional handling. In the trade and logistics industry, efficient order delivery plays a key role in customer satisfaction and business success. The objective of the research is to perform a comparative analysis of the implementation of cross docking as a logistics strategy in order delivery in three important companies: Nacex, FedEx and Maersk. A documentary review is carried out in the following databases: ScienceDirect, SciELO, Google Scholar and Dialnet, the thematic descriptors used were: "order delivery", "cross docking", "distribution logistics", "cross docking in supply chains", "Nacex", "FedEx" and "Maersk" and the combinations among them, without language restriction. The concepts related to cross docking are defined through a comparative analysis of the companies Nacex, FedEx and Maersk, and elements that highlight its importance are identified. The adoption of this strategy results in a competitive advantage that translates into greater customer satisfaction and sustainable growth in the highly competitive logistics and trade market.

Keywords: cross docking, FedEx, logistics, Maersk, Nacex, supply chain.

JEL Classification: L81; L91

Received: 31-07-2024 **Revised:** 05-11-2024 **Accepted:** 15-12-2024 **Published:** 03-01-2025

Editor: Carlos Alberto Gómez Cano

RESUMEN

El cross docking es una estrategia logística que implica recibir mercancías y enviarlas directamente a los destinos finales, minimizando el almacenamiento, los tiempos de entrega y el manejo adicional. En la industria del comercio y la logística, la entrega eficiente de pedidos desempeña un papel fundamental para la satisfacción del cliente y el éxito empresarial. El objetivo de la investigación es realizar un análisis comparativo de la implementación del cross docking como estrategia logística en la entrega de pedidos en tres importantes empresas: Nacex, FedEx y Maersk. Se desarrolla una revisión documental en las bases de datos: ScienceDirect, SciELO, Google Scholar y Dialnet; los descriptores temáticos utilizados fueron: "entrega de pedido", "cross docking", "logística de distribución", "cross docking en las cadenas de suministro", "Nacex", "FedEx" y "Maersk" y las combinaciones entre ellos, sin restricción idiomática. Se definen los conceptos relacionados con el cross docking mediante un análisis comparativo en las empresas Nacex, FedEx y Maersk; se identifican elementos que resaltan su importancia. La adopción de esta estrategia resulta una ventaja competitiva que se traduce en mayor satisfacción del cliente y un crecimiento sostenible en el mercado altamente competitivo de la logística y el comercio.

Palabras clave: cross docking, cadena de suministro, FedEx, logística, Maersk, Nacex.

Clasificación JEL: L81; L91

[1]Universidad Nacional de San Agustín. Arequipa, Perú

Cite as: Huayhua, K., Manchego, P., Pro, M., Villegas, A. y Zapata, J. (2025). Cross docking como estrategia logística. Análisis en Nacex, FedEx y Maersk. Región Científica, 4(1), 2025388. https://doi.org/10.58763/rc2025388

INTRODUCTION

In the fields of logistics and trade, efficient order fulfillment is crucial to ensuring customer satisfaction (Asha et al., 2023; Sumrit & Sowijit, 2023) and business success (Bajomo et al., 2022). In recent years, a logistics strategy known as cross-docking has emerged (Ahmed et al., 2024; Hosseini-Nasab et al., 2023; Liu & Li, 2023), which has proven highly effective in improving supply chain efficiency (Núñez-Merino et al., 2022) and accelerating delivery times (Dang & Yeo, 2018).

Recently, the design of logistics systems with the implementation of cross-docking has focused on reducing delivery times and total costs by consolidating and transferring products to customers through intermediate nodes (Cen et al., 2023; Hosseini-Nasab et al., 2023).

However, there is variability in the approaches and practices implemented by different companies in the use of cross-docking (Ahmed et al., 2024; Lyu & Huang, 2023; Yu et al., 2023). Therefore, a comparative analysis of how Nacex, FedEx, and Maersk apply this strategy in their order fulfillment processes is essential. Understanding the differences and similarities between these leading companies in their cross-docking practices can provide valuable insights for improving the efficiency and quality of delivery services.

This study will explore in detail how Nacex, FedEx, and Maersk (Notteboom, 2006) implement cross-docking in their logistics operations (Theophilus et al., 2021). Focusing on key aspects such as order receiving and consolidation, this information is analyzed and then classified into one of the existing types of cross-docking. Understanding the strategies and practices of these companies provides a clear view of how cross-docking has influenced their delivery processes and how it can be effectively applied in different business contexts.

This research seeks to clarify that the efficient use of cross-docking at Nacex, FedEx, and Maersk is directly related to improved order delivery efficiency, which translates into greater customer satisfaction and increased profitability. Furthermore, the comparative table seeks to identify significant differences and similarities in the strategies and approaches used by each company. The comparative analysis of the case studies is expected to demonstrate that companies that properly implement cross-docking achieve reduced delivery times and minimize storage and handling costs.

The objective of this research is to conduct a comparative analysis of the implementation of cross-docking as a logistics strategy for order delivery at three major companies: Nacex, FedEx, and Maersk.

METHODOLOGY

The research is conducted using a qualitative paradigm (Million & Raoult, 2020; Whiffin et al., 2022), based on a document review (Gao et al., 2023) with a correlational and comparative approach, with the aim of analyzing the use of cross-docking as a logistics strategy in these three major companies.

The document review was conducted using the following databases: ScienceDirect, SciELO, Google Scholar, and Dialnet. The thematic descriptors used were: “order delivery,” “cross-docking,” “distribution logistics,” “cross-docking in supply chains,” “Nacex,” “FedEx,” and “Maersk,” and combinations thereof, without language restriction. Fifty articles were selected from the 2006–2024 time period, and a complete in-depth review determined their relevance to the research. This review has three main objectives:

- Define the term logistics and its importance.
- Define the cross-docking strategy and types.
- Analyze the feasibility of applying cross-docking in companies.

A review of the official websites of the companies studied was conducted to analyze information regarding order receiving and delivery processes, as well as specific details related to cross-docking use in each company. All this information is correlated through a comparative analysis between these three companies, highlighting deficiencies and similarities. Additionally, key aspects of the companies’ supply chains and logistics systems are described.

RESULTS AND DISCUSSION

Logistics plays an essential role in the trade of goods (Wu et al., 2024). It has evolved and been defined from different perspectives. Aguirre and Rodríguez (2007) define it as the part of the supply chain that plans, organizes, and controls the effectiveness of material, information, and financial flows, as well as storage and service subsystems, in order to meet customer requirements.

Therefore, logistics promotes quality processes (Tang et al., 2021; Giovanis et al., 2013) through the proper organization of its material, information, and financial resources to achieve satisfactory and successful procedures with its suppliers (Piechota et al., 2021), the company itself (Tsang et al., 2023), and its customers (Balouei Jamkhaneh et al., 2022; Meng et al., 2010).

Logistics management has evolved, and among its current challenges (Sánchez Suárez et al., 2021), it develops strategies that reduce costs and increase service levels in terms of quantity, quality, and delivery times, among other indicators (Qazi, 2022; Roh et al., 2022; Wuennenberg et al., 2023). Among the strategies that have become widespread is cross-docking (Kalenatic et al., 2008); a logistics strategy streamlines processes and influences distribution systems by managing alternatives that eliminate storage (Castellucci et al., 2021; Neamatian Monemi et al., 2023; Shahabi-Shahmiri et al., 2021).

Cross-docking is a distribution system that aims to reduce distribution time from warehouse to dispatch (Alpan et al., 2011; Luo et al., 2019). It influences the efficiency of input or product distribution (Kusolpuchong et al., 2019), inventory management strategies (Sánchez Suárez et al., 2023), and planning distribution without storage; an element that prevents damage to goods and boosts productivity, profitability, and market competitiveness (Gunawan et al., 2022).

The implementation of cross-docking in supply chains requires strengthening the collaboration and integration of stakeholders (suppliers, production, distribution, customers) (Dehghani Jeshvaghani et al., 2023), inventory management, demand forecasting (Vanajakumari et al., 2022), and distribution route analysis (Mousavi & Tavakkoli-Moghaddam, 2013), thereby shortening delivery times between suppliers—a factor that impacts customer satisfaction (Drechsler & Holzapfel, 2023; Essghaier et al., 2021).

An analysis of the co-occurrence of keywords in the research consulted (table 1) shows the relationship of cross-docking with the concepts of “company”, “logistics”, “distribution”, “strategy”, “time” and “storage”, secondly, it is related to “transport”, “costs”, “efficiency”, “inventory” and “management”.

Table 1.
Top 12 keywords identified

Keywords	Frequency
Cross-docking	92
Company	52
Logistics	37
Distribution	34
Strategy	28
Time	21
Storage	16
Transportation	10
Costs	11
Efficiency	7
Inventory	6
Management	4

Source: own elaboration

There are several types of cross-docking, according to Van Belle et al. (2012):

- Transfer cross-docking: distribution is carried out by provisioning delivery vehicles without prior storage. Its use is most appropriate when products are destined for a single end customer and come from different suppliers or geolocations. Its purpose is coordinating and integrating distributions to optimize transportation and reduce storage costs. It can be used for perishable or fast-moving products.
- Consolidation cross-docking: distribution is carried out by consolidating cargo from different suppliers, located in different locations, for subsequent transfer to delivery vehicles. Distribution centers are used as a point for grouping similar or related products. Its purpose is to maximize the use of space on delivery vehicles and reduce costs by sending full loads instead of partial shipments. It can be used when products have predictable demand or when large volumes of similar products are required.
- Distribution cross-docking: distribution is carried out by disaggregating shipments into smaller units destined for different final destinations. Products are sorted and repackaged according to orders or delivery routes. This factor, incidentally, impacts delivery efficiency. Its purpose is to speed up product distribution through a delivery network; it is used in retail distribution industries, where products must be shipped to different stores or points of sale.

- Mixed cross-docking: products from different suppliers or locations are received at distribution centers and mixed or combined to create a complete load or order before being transferred to delivery vehicles. Its purpose is to optimize space utilization and maximize transportation efficiency; it is used when products are similar or compatible and can be combined into a single load for a final destination. For example, in the fashion industry, different clothing and accessories items can be combined to create complete orders for stores.

These are the main types of cross-docking, and companies can adapt them to their specific needs. The choice of which type of cross-docking to use will depend on factors such as product type, demand, suppliers, final destinations, and the company's logistical requirements.

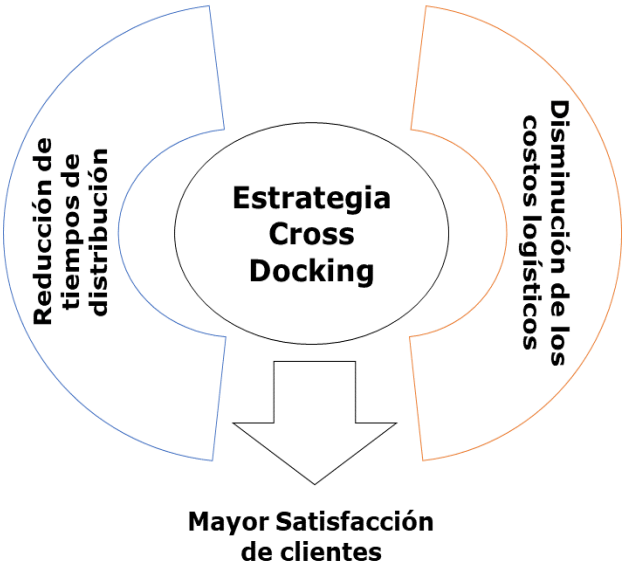
Importance of cross-docking

The adoption of cross-docking strategies, both at the strategic level in supply chain management and at the operational level in logistics systems management, brings significant benefits (Vanajakumari et al., 2022). One of the most significant benefits is the reduction in delivery times and logistics costs, including storage. The time it takes to enter information into the IT system used (Li et al., 2024) increases distribution and delivery cycles, an element that influences the freshness of goods (food safety) and the increase in supply (availability). Figure 1 shows the main advantages of adopting this strategy in supply chain and logistics systems management. Furthermore, the cross-docking logistics process provides advantages and benefits when there is proper coordination between the companies that use it: manufacturers, distributors, and carriers.

The benefits of cross-docking for products such as fresh food and medicines, according to Battarra et al. (2022) and Vanvuchelen et al. (2023), are:

- Reduced delivery times and increased product supply.
- Reduced costs for the logistics subsystem, distribution, and materials handling.
- Reduced inventory management efforts by avoiding stockpiling products or inputs.

Figure 1.
Main advantages of adopting cross-docking strategies



Source: own elaboration.
Note: the figure appears in its original language.

Companies have strived to design logistics systems that offer rapid responses to changes in their environment (Pravia & de la Cruz, 2021), with a degree of stability, flexibility, and time-tested responsiveness (Rodríguez Romero et al., 2022). For companies, having large quantities of merchandise in their warehouses can provide peace of mind, assuming they will always meet their customers' demands. However, this can lead to high storage costs, capital immobilization, and low inventory turnover rates, increasing the risk of breakage, obsolescence, and theft.

Crossdocking systems can be measured through financial indicators, cash flow analysis, income statement analysis, cost-benefit analysis, etc. (Katsela & Pålsson, 2021). Effectively monitoring these indicators and system performance will help maintain low inventory levels and increase customer satisfaction more quickly (Bentahar & Benzidia, 2018). Using cross-docking as a solution for traditional companies that require storage is a good option, due to the reduction or even elimination of storage costs. At the same time, always maintaining a timely inventory does not diminish market satisfaction.

Feasibility of cross-docking

In order to carry out a good cross-docking strategy, the factors of the company in question must be evaluated; these factors, when applied, will determine whether cross-docking will actually be profitable or not. The process of implementing the Cross-docking model involves several key elements that must be considered to ensure its success:

- The first element is the economic evaluation, which involves analyzing costs, cash flows, and return on investment over a given period. Since cross-docking requires a significant investment in technical resources and information technology, it is essential to determine whether the expected benefits will exceed this investment. If not, implementing this model may not be advisable.
- The second crucial element is senior management commitment. It is necessary to establish a strategy for the distribution of logistics units and enable an effective flow of information between the companies involved in the implementation of cross-docking. To achieve this, it is essential that the companies' senior management be the main drivers of the project. Their support and leadership are essential for the entire organization to be committed and work together to achieve the expected success after implementing this strategy.
- The third important element refers to the horizontal composition of the organization. It is a priority that all areas and departments involved are actively involved and collaborate with each other to ensure efficient execution. This element is closely related to senior management commitment, as when an organization aligns and coordinates its efforts in a common direction, the results can be much more satisfactory. Collaboration between different areas ensures a smooth and optimized implementation of the cross-docking model.

In summary, successful cross-docking implementation requires a careful economic assessment, senior management commitment and leadership, and a horizontal organizational structure that promotes collaboration and teamwork. These elements complement each other and are critical to ensuring the cross-docking model is viable and efficient at each implementation phase.

Analysis of the Cross-Docking Strategy Implementation

A comparative analysis was conducted on the implementation of a cross-docking strategy at Nacex, FedEx, and Maersk (table 2).

Table 2.
Comparative analysis in the implementation of a cross-docking strategy

	Nacex	FedEx	Maersk
Activity (what does the company do?)	Express courier services for parcels and documents between companies (B2B) and individuals (B2C); we offer a wide range of national, international, and value-added services that adapt to the most demanding delivery needs in the market.	Courier and logistics services primarily focused on express shipping services; it provides a wide range of services, including express shipping of packages and air and sea freight documents.	A global business group operating in diverse areas, particularly in the fields of transportation and energy, it is particularly famous for its role in maritime transport. Its goal is to revolutionize the movement of food, products, data, and materials that are critical to the livelihoods of people, businesses, and economies globally.
Length of service	It began operations in 1995, when the first 110 franchises opened, already with 8 logistics platforms.	It was founded in 1971 by Frederick W. Smith in Little Rock, Arkansas, United States. In its early years, the company focused on providing express delivery services for documents and packages using cargo aircraft.	It was founded in 1904 by Arnold Peter Moller. Since 1996, it has established itself as the largest ocean freight transport company in the world. Although its headquarters are located in Copenhagen, Denmark.

Size of the chain (franchises)	NACEX currently has a fleet of more than 1600 vehicles and more than 3000 employees, as well as a network of 31 platforms and more than 300 franchises in Spain, Portugal, and Andorra.	The company operates an extensive transportation and distribution network spanning more than 220 countries and territories worldwide.	Maersk global coverage: More than 50 countries in both warehousing and distribution. Regional coverage: Africa, Asia-Pacific, Europe, Latin America, North America, and West Central Asia. More than 300 ports worldwide.
Order reception and delivery process	The facilities cover an area of 12 140 m² for the sorting and distribution of goods. The facility has 114 docks, 104 for vans, and 10 for trucks, allowing more than 110 vehicles to simultaneously load and unload goods and documentation from national and international origins and destinations. It features a video coding sorting system that detects unread or incorrect labels; 153 Full HD digital cameras (13 of which can record in 360°); and a sorting system capable of processing up to 32 000 packages per hour.	Shipments arrive by plane from different locations around the world to a distribution center. They are then unloaded and transported via a conveyor belt for sorting. The packages are scanned and sorted according to their destination. The shipments then continue on their way to distribution or are stored if necessary. In parallel, packages are prepared for delivery in different cities around the world and then loaded onto urban distribution vehicles that will deliver the packages to the recipient's address.	Maersk offers a wide variety of data integration solutions that allow you to connect and synchronize information across different products, such as Supply Chain Management, Ocean Freight, Warehousing, and Distribution, among others. Within ocean freight, one of the services it offers is the Flex Hub process, which is described as follows: Origin: Booking. Navigation: Receive real-time cargo updates during ocean transport. Hub port: A Maersk representative will manage the retention of containers until final selection. Final destination: Once the final time and location are selected, the delivery is completed, in accordance with the contract.
Type of cross-docking applied	Nacex applies consolidation cross-docking when receiving packages from eight different destinations. Distribution cross-docking is also identified since each package is sent to the corresponding destination.	FedEx applies consolidation cross-docking by grouping package loads from different locations around the world into a single distribution center, and at the same time applies distribution cross-docking by sending each package load to the corresponding location.	Cross-docking is used by Flex Hub because it minimizes storage costs and delivers shorter delivery times from the hub to its key markets.

Source: own elaboration

Nacex

It specializes in express parcel and document delivery, focusing on national and international services. It primarily uses cross-docking for consolidation and distribution in its delivery process. With a network of more than 300 franchises and platforms, it has reduced delivery times and improved product availability.

FedEx

As a multinational courier and logistics services company, it offers a wide range of express shipping services worldwide. In its cross-docking process, it applies both consolidation—grouping package loads from different locations worldwide in a single distribution center—and distribution, sending each load to its corresponding location. Its broad global coverage and extensive transportation network have allowed it to maintain a prominent market position.

Maersk

This is a global business group that excels particularly in maritime transport. Its order fulfillment process, called Flex Hub, uses cross-docking to minimize storage costs and accelerate delivery times. With a presence in more than 50 countries and extensive regional coverage, Maersk has revolutionized the movement of goods and materials globally.

All three companies have found cross-docking to be a valuable logistics strategy for improving the efficiency of their order fulfillment processes and meeting their customers' needs quickly and effectively. Each has adapted this

strategy to its specific characteristics and requirements, allowing them to gain competitive advantages in the highly competitive logistics and trade market. By properly implementing cross-docking, Nacex, FedEx, and Maersk have demonstrated that they can reduce costs, improve customer satisfaction, and maintain sustainable growth in the logistics sector.

CONCLUSIONS

Cross-docking can be used as a streamlined logistics strategy by manufacturers, distributors, and transporters to increase their profitability in an organized manner, due to its impact on cost and time reduction. This helps maintain quality, customer satisfaction, and organizational success by streamlining delivery processes and minimizing storage, optimizing delivery times, resulting in a competitive advantage for companies.

FedEx's combination of consolidation and distribution cross-docking demonstrates its adoption of a comprehensive and flexible logistics strategy to meet the diverse needs of its customers and the specific needs of shipments. In this way, FedEx optimizes the flow of products and shipments from its distribution centers to final destinations without the arrival of disorganized packages or prolonged storage, which is essential to maintaining competitiveness in the courier and transportation sector. The successful implementation of cross-docking in these companies has demonstrated significant benefits, such as reduced delivery times, lower storage costs, resource optimization, and improved customer satisfaction. Achieving this success over time requires senior management commitment and flexible and adaptable supply chains.

REFERENCES

Aguirre, D. M. C., y Rodríguez, A. J. U. (2007). Logística de operaciones: Integrando las decisiones estratégicas para la competitividad. Ingeniería Industrial, 28(1), 6. https://dialnet.unirioja.es/servlet/articulo?codigo=4786815

Ahmed, F., Huynh, N., Ferrell, W., Badyal, V., y Padmanabhan, B. (2024). Vehicle re-routing under disruption in cross-dock network with time constraints. Expert Systems with Applications, 237, 121517. https://doi.org/10.1016/j.eswa.2023.121517

Alpan, G., Ladier, A.-L., Larbi, R., y Penz, B. (2011). Heuristic solutions for transshipment problems in a multiple door cross docking warehouse. Computers & Industrial Engineering, 61(2), 402-408. https://doi.org/10.1016/j.cie.2010.09.010

Asha, A. A., Dulal, M., y Habib, D. A. (2023). The influence of sustainable supply chain management, technology orientation, and organizational culture on the delivery product quality-customer satisfaction nexus. Cleaner Logistics and Supply Chain, 7, 100107. https://doi.org/10.1016/j.clscn.2023.100107

Bajomo, M., Ogbeyemi, A., y Zhang, W. (2022). A systems dynamics approach to the management of material procurement for Engineering, Procurement and Construction industry. International Journal of Production Economics, 244, 108390. https://doi.org/10.1016/j.ijpe.2021.108390

Balouei Jamkhaneh, H., Shahin, R., y Tortorella, G. L. (2022). Analysis of Logistics 4.0 service quality and its sustainability enabler scenarios in emerging economy. Cleaner Logistics and Supply Chain, 4, 100053. https://doi.org/10.1016/j.clscn.2022.100053

Battarra, I., Accorsi, R., Lupi, G., Manzini, R., y Sirri, G. (2022). Location-allocation problem in a multi-terminal cross-dock distribution network for palletized perishables delivery. Transportation Research Procedia, 67, 172-181. https://doi.org/10.1016/j.trpro.2022.12.048

Bentahar, O., y Benzidia, S. (2018). Sustainable supply chain management: Trends and challenges. Transportation Research Part E: Logistics and Transportation Review, 119, 202-204. https://doi.org/10.1016/j.tre.2018.05.005

Castellucci, P. B., Costa, A. M., y Toledo, F. (2021). Network scheduling problem with cross-docking and loading constraints. Computers & Operations Research, 132, 105271. https://doi.org/10.1016/j.cor.2021.105271

Cen, X., Zhou, G., Ji, B., Yu, S. S., Zhang, Z., y Fang, X. (2023). Modelling and heuristically solving three-dimensional loading constrained vehicle routing problem with cross-docking. Advanced Engineering Informatics, 57, 102029. https://doi.org/10.1016/j.aei.2023.102029

Dang, V. L., y Yeo, G. T. (2018). Weighing the Key Factors to Improve Vietnam's Logistics System. The Asian Journal of Shipping and Logistics, 34(4), 308-316. https://doi.org/10.1016/j.ajsl.2018.12.004

Dehghani Jeshvaghani, M., Amiri, M., Khalili-Damghani, K., y Olfat, L. (2023). A robust possibilistic multi-echelon multi-product multi-period production-inventory-routing problem considering internal operations of cross-docks: Case study of FMCG supply chain. Computers & Industrial Engineering, 179, 109206. https://doi.org/10.1016/j.cie.2023.109206

Drechsler, M., y Holzapfel, A. (2023). Horticultural supply chain network design of small and medium-sized enterprises. Sustainability Analytics and Modeling, 3, 100014. https://doi.org/10.1016/j.samod.2022.100014

Essghaier, F., Allaoui, H., y Goncalves, G. (2021). Truck to door assignment in a shared cross-dock under uncertainty. Expert Systems with Applications, 182, 114889. https://doi.org/10.1016/j.eswa.2021.114889

Gao, J., Pham, Q. H. P., y Polio, C. (2023). The role of theory in structuring literature reviews in qualitative and quantitative research articles. Journal of English for Academic Purposes, 63, 101243. https://doi.org/10.1016/j.jeap.2023.101243

Giovanis, A. N., Tomaras, P., y Zondiros, D. (2013). Suppliers Logistics Service Quality Performance and its Effect on Retailers' Behavioral Intentions. Procedia - Social and Behavioral Sciences, 73, 302-309. https://doi.org/10.1016/j.sbspro.2013.02.056

Gunawan, A., Widjaja, A. T., Vansteenwegen, P., y Yu, V. F. (2022). Two-phase matheuristic for the vehicle routing problem with reverse cross-docking. Annals of Mathematics and Artificial Intelligence, 90(7-9), 915-949. https://doi.org/10.1007/s10472-021-09753-3

Hosseini-Nasab, H., Nasrollahi, S., Fakhrzad, M. B., y Honarvar, M. (2023). Transportation cost reduction using cross-docks linking. Journal of Engineering Research, 11(1), 100015. https://doi.org/10.1016/j.jer.2023.100015

Kalenatic, D., Bello, C. A. L., Rodríguez, L. J. G., y Velasco, F. J. R. (2008). Localización de una plataforma de cross docking en el contexto de logística focalizada utilizando distancias euclidianas. Ciencia e Ingeniería Neogranadina, 18(1), 17-34. https://doi.org/10.18359/rcin.1066

Katsela, K., y Pålsson, H. (2021). Viable business models for city logistics: Exploring the cost structure and the economy of scale in a Swedish initiative. Research in Transportation Economics, 90, 100857. https://doi.org/10.1016/j.retrec.2020.100857

Kusolpuchong, S., Chusap, K., Alhawari, O., y Suer, G. (2019). A Genetic Algorithm Approach for Multi Objective Cross Dock Scheduling in Supply Chains. Procedia Manufacturing, 39, 1139-1148. https://doi.org/10.1016/j.promfg.2020.01.356

Li, M., Hao, J.-K., y Wu, Q. (2024). A flow based formulation and a reinforcement learning based strategic oscillation for cross-dock door assignment. European Journal of Operational Research, 312(2), 473-492. https://doi.org/10.1016/j.ejor.2023.07.014

Liu, T., y Li, D. (2023). Study on the new implementation mode of cross-docking based on blockchain technology. Computers & Industrial Engineering, 180, 109249. https://doi.org/10.1016/j.cie.2023.109249

Luo, H., Yang, X., y Wang, K. (2019). Synchronized scheduling of make to order plant and cross-docking warehouse. Computers & Industrial Engineering, 138, 106108. https://doi.org/10.1016/j.cie.2019.106108

Lyu, Z., y Huang, G. Q. (2023). Cross-docking based factory logistics unitisation process: An approximate dynamic programming approach. European Journal of Operational Research, 311(1), 112-124. https://doi.org/10.1016/j.ejor.2023.04.030

Meng, S.-M., Liang, G.-S., Lin, K., y Chen, S.-Y. (2010). Criteria for services of air cargo logistics providers: How do they relate to client satisfaction? Journal of Air Transport Management, 16(5), 284-286. https://doi.org/10.1016/j.jairtraman.2010.02.003

Million, M., y Raoult, D. (2020). Gut dysbiosis in severe acute malnutrition is not an immaturity: The irreversible quantitative-qualitative paradigm shift. Human Microbiome Journal, 15, 100067. https://doi.org/10.1016/j.humic.2019.100067

Mousavi, S. M., y Tavakkoli-Moghaddam, R. (2013). A hybrid simulated annealing algorithm for location and routing scheduling problems with cross-docking in the supply chain. Journal of Manufacturing Systems, 32(2), 335-347. https://doi.org/10.1016/j.jmsy.2012.12.002

Neamatian Monemi, R., Gelareh, S., y Maculan, N. (2023). A machine learning based branch-cut-and-Benders for dock assignment and truck scheduling problem in cross-docks. Transportation Research Part E: Logistics and Transportation Review, 178, 103263. https://doi.org/10.1016/j.tre.2023.103263

Notteboom, T. (2006). Chapter 2 Strategic Challenges to Container Ports in a Changing Market Environment. Research in Transportation Economics, 17, 29-52. https://doi.org/10.1016/S0739-8859(06)17002-X

Núñez-Merino, M., Maqueira-Marín, J. M., Moyano-Fuentes, J., y Castaño-Moraga, C. A. (2022). Industry 4.0 and supply chain. A Systematic Science Mapping analysis. Technological Forecasting and Social Change, 181, 121788. https://doi.org/10.1016/j.techfore.2022.121788

Piechota, S., Glas, A. H., y Essig, M. (2021). Questioning the relevance of supplier satisfaction for preferred customer treatment: Antecedent effects of comparative alternatives and multi-dimensionality. Journal of Purchasing and Supply Management, 27(1), 100672. https://doi.org/10.1016/j.pursup.2021.100672

Pravia, M. P., y de la Cruz, L. O. V. (2021). Gestión de riesgos en encadenamientos productivos sostenibles. Revista Venezolana de Gerencia: RVG, 26(96), 1396-1412. https://dialnet.unirioja.es/servlet/articulo?codigo=8890567

Qazi, A. (2022). Adoption of a probabilistic network model investigating country risk drivers that influence logistics performance indicators. Environmental Impact Assessment Review, 94, 106760. https://doi.org/10.1016/j.eiar.2022.106760

Rodríguez Romero, Y., Cespón Castro, R., y Tovar Perilla, N. J. (2022). Estudio empírico sobre curvas de aprendizaje en sistemas de gestión logística. Ingeniare. Revista chilena de ingeniería, 30(4), 794-802. http://dx.doi.org/10.4067/S0718-33052022000400794

Roh, S., Lin, H. H., y Jang, H. (2022). Performance indicators for humanitarian relief logistics in Taiwan. The Asian Journal of Shipping and Logistics, 38(3), 173-180. https://doi.org/10.1016/j.ajsl.2022.06.002

Sánchez Suárez, Y., Pérez Castañeira, J. A., Sangroni Laguardia, N., Cruz Blanco, C., y Medina Nogueira, Y. E. (2021). Retos actuales de la logística y la cadena de suministro. Ingeniería Industrial, XLII(1), 1-12. https://rii.cujae.edu.cu/index.php/revistaind/article/download/1079/992

Sánchez Suárez, Y., Trujillo García, L., Marqués León, M., y Pancorbo Sandoval, J. A. (2023). Planificación del Sistema de Inventarios. Caso de Estudio Photoclub Flash, División Comercial Hicacos. Economía y Negocios, 14(1), 26-39. http://doi.org/10.29019/eyn.v14i1.1092

Shahabi-Shahmiri, R., Asian, S., Tavakkoli-Moghaddam, R., Mousavi, S. M., y Rajabzadeh, M. (2021). A routing and scheduling problem for cross-docking networks with perishable products, heterogeneous vehicles and split delivery. Computers & Industrial Engineering, 157, 107299. https://doi.org/10.1016/j.cie.2021.107299

Sumrit, D., y Sowijit, K. (2023). Winning customer satisfaction toward omnichannel logistics service quality based on an integrated importance-performance analysis and three-factor theory: Insight from Thailand. Asia Pacific Management Review. https://doi.org/10.1016/j.apmrv.2023.03.003

Tang, Y. M., Chau, K. Y., Xu, D., y Liu, X. (2021). Consumer perceptions to support IoT based smart parcel locker logistics in China. Journal of Retailing and Consumer Services, 62, 102659. https://doi.org/10.1016/j.jretconser.2021.102659

Theophilus, O., Dulebenets, M. A., Pasha, J., Lau, Y.-y., Fathollahi-Fard, A. M., y Mazaheri, A. (2021). Truck scheduling

optimization at a cold-chain cross-docking terminal with product perishability considerations. Computers & Industrial Engineering, 156, 107240. https://doi.org/10.1016/j.cie.2021.107240

Tsang, Y. P., Fan, Y., y Feng, Z. P. (2023). Bridging the gap: Building environmental, social and governance capabilities in small and medium logistics companies. Journal of Environmental Management, 338, 117758. https://doi.org/10.1016/j.jenvman.2023.117758

Van Belle, J., Valckenaers, P., y Cattrysse, D. (2012). Cross-docking: State of the art. Omega, 40(6), 827-846. https://doi.org/10.1016/j.omega.2012.01.005

Vanajakumari, M., Sun, H., Jones, A., y Sriskandarajah, C. (2022). Supply chain planning: A case for Hybrid Cross-Docks. Omega, 108, 102585. https://doi.org/10.1016/j.omega.2021.102585

Vanvuchelen, N., De Boeck, K., y Boute, R. N. (2023). Cluster-based lateral transshipments for the Zambian health supply chain. European Journal of Operational Research. https://doi.org/10.1016/j.ejor.2023.08.005

Whiffin, C. J., Smith, B. G., Selveindran, S. M., ... y Kolias, A. G. (2022). The Value and Potential of Qualitative Research Methods in Neurosurgery. World Neurosurgery, 161, 441-449. https://doi.org/10.1016/j.wneu.2021.12.040

Wu, Y., Huang, J., y Chen, X. (2024). The information value of logistics platforms in a freight matching market. European Journal of Operational Research, 312(1), 227-239. https://doi.org/10.1016/j.ejor.2023.06.043

Wuennenberg, M., Muehlbauer, K., Fottner, J., y Meissner, S. (2023). Towards predictive analytics in internal logistics – An approach for the data-driven determination of key performance indicators. CIRP Journal of Manufacturing Science and Technology, 44, 116-125. https://doi.org/10.1016/j.cirpj.2023.05.005

Yu, V. F., Anh, P. T., Gunawan, A., y Han, H. (2023). A simulated annealing with variable neighborhood descent approach for the heterogeneous fleet vehicle routing problem with multiple forward/reverse cross-docks. Expert Systems with Applications, 121631. https://doi.org/10.1016/j.eswa.2023.121631

FINANCING
The authors received no financing for the development of this research.

CONFLICT OF INTEREST STATEMENT
The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION
Conceptualization: Karolynne Huayhua Machaca and Jesús Zapata Chávez.
Data curation: Piazolli Manchego Pacco and Marjori Sugey Pro Aragón.
Formal analysis: Karolynne Huayhua Machaca and Andrea Stephanie Villegas Calla.
Research: Piazolli Manchego Pacco, Marjori Sugey Pro Aragón and Andrea Stephanie Villegas Calla.
Methodology: Karolynne Huayhua Machaca and Piazolli Manchego Pacco.
Validation: Karolynne Huayhua Machaca and Piazolli Manchego Pacco.
Writing - original draft: Karolynne Huayhua Machaca and Andrea Stephanie Villegas Calla.
Proofreading and editing: Marjori Sugey Pro Aragón and Jesús Zapata Chávez.