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EFFICIENCY OF AIR TRANSPORT IN INTEGRATED LOGISTICS SYSTEMS

Irina Suvorova, Oksana Pozniak, Kashlakova Tetiana «Efficiency of Air Transport in Integrated Logistics Systems». *The article examines the role and efficiency of air transport within integrated logistics systems, emphasizing its strategic function in ensuring speed, reliability, and global connectivity in multimodal supply chains. Air transport is positioned as a critical component that facilitates rapid movement of time-sensitive and high-value goods, particularly in sectors such as pharmaceuticals, electronics, and e-commerce. The article identifies and analyses the core advantages of air freight, including short delivery times, high schedule predictability, secure handling, and the ability to serve geographically isolated regions. In addition to highlighting these strengths, the study also outlines the main limitations of air transport, such as high operational costs, limited cargo capacity, infrastructure dependency, environmental concerns, and strict regulatory requirements. Special attention in the article is given to the integration of digital technologies and the application of the AeroSync model as an innovative conceptual framework aimed at improving operational efficiency and supporting decision-making in air logistics. The model systematizes key components of the logistics process–input factors, constraints, integration mechanisms, and performance outcomes–and serves as a scalable and versatile tool for logistics companies seeking to optimize multimodal transportation involving air freight. The study includes an in-depth analysis of real-world implementation practices by leading*

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international logistics firms such as SEKO Logistics, Omni Logistics, Noatum Logistics, and Logistics Plus. These case studies illustrate the effectiveness of combining air transport with digital platforms, analytical tools, and strategic planning to achieve higher levels of control, adaptability, and competitiveness in a global logistics environment. The findings confirm that air transport, despite its challenges, remains indispensable in modern global logistics and that its performance can be significantly enhanced through structured integration models and smart technology adoption.

***Keywords**:* air transport, logistics systems, multimodal transportation, efficiency, digitalization, AeroSync model, supply chains

Ірина Суворова, Оксана Позняк, Кашлакова Тетяна «Ефективність авіаційного транспорту в інтегрованих логістичних системах». *У статті розглядається роль та ефективність авіаційного транспорту в інтегрованих логістичних системах, з акцентом на його стратегічну функцію забезпечення швидкості, надійності та глобальної зв'язності в умовах мультимодальних ланцюгів постачання. Авіаперевезення позиціонуються як ключовий компонент, що забезпечує оперативне переміщення термінових і цінних вантажів, особливо в таких галузях, як фармацевтика, електроніка та електронна комерція. У статті визначено та проаналізовано основні переваги авіаційного транспорту, зокрема: короткі терміни доставки, висока передбачуваність графіків, безпечна обробка вантажів та здатність обслуговувати географічно ізольовані регіони. Окрім висвітлення сильних сторін, дослідження також окреслює основні обмеження авіаперевезень, серед яких: високі експлуатаційні витрати, обмежена вантажомісткість, залежність від інфраструктури, екологічні виклики та жорстке нормативне регулювання. Особливу увагу в статті приділено інтеграції цифрових технологій і застосуванню моделі AeroSync як інноваційної концептуальної основи, спрямованої на підвищення операційної ефективності та підтримку процесів прийняття рішень в авіаційній логістиці. Модель систематизує ключові компоненти логістичного процесу – вхідні фактори, обмеження, механізми інтеграції та результати – і виступає масштабованим та універсальним інструментом для логістичних компаній, які прагнуть оптимізувати мультимодальні перевезення із залученням авіатранспорту. У дослідженні представлено глибокий аналіз практик впровадження моделі у діяльність провідних міжнародних логістичних компаній, зокрема SEKO Logistics, Omni Logistics, Noatum Logistics та Logistics Plus, ці кейси ілюструють ефективність поєднання авіаперевезень із цифровими платформами, аналітичними інструментами та стратегічним плануванням для досягнення вищого рівня керованості, адаптивності та конкурентоспроможності у глобальному логістичному середовищі. Отримані результати підтверджують, що, попри існуючі виклики, авіаційний транспорт залишається незамінним елементом сучасної глобальної логістики, а його ефективність може бути суттєво підвищена завдяки впровадженню структурованих моделей інтеграції та інтелектуальних технологічних рішень.*

Ключові слова: авіаційний транспорт, логістичні системи, мультимодальні перевезення, ефективність, цифровізація, модель AeroSync, ланцюги постачання.

Intraduction. In today's world, characterized by rapid globalization, growing international competition, and the accelerated development of digital technologies, logistics plays a crucial role in ensuring the effective functioning of the global economy. Particular attention must be paid to improving logistics systems capable of providing fast, secure, and reliable cargo movement on a global scale. Amid the growing volumes of international trade, increasingly complex supply chains, and rising consumer expectations for speed and service quality, there is a pressing need to

explore new approaches to organizing logistics processes. One such direction involves the integration of various modes of transport within a unified logistics system, which enhances flexibility, optimizes costs, and ensures timely delivery. In this context, there is a growing need for a comprehensive scientific analysis of the efficiency of individual links in the logistics chain– especially the transport component, which plays a critical role in maintaining the continuity of goods flow. Given these considerations, the topic of transport efficiency in integrated logistics systems is highly relevant and requires in-depth investigation that takes into account modern challenges, trends, and technological advancements.

Analysis of the latest research and publications. In contemporary academic and applied literature, increasing attention is being paid to enhancing the efficiency of air transport within integrated logistics systems. Ukrainian researchers Krawets O.M. and Shevchenko O.V. emphasize the integration of marketing and logistics approaches to improve the competitiveness of enterprises operating in global supply chains [1]. Obruch H.V. and Sotnikov D.V. explore the role of strategic logistics management in the context of digital transformation, highlighting the need for comprehensive models of interaction among transportation components, including aviation [2]. Foreign scholars Chopra and Meindl consider air transport a critical element in the effective functioning of supply chains, especially in terms of strategy and planning [3], while Rushton, Croucher, and Baker focus on practical aspects of distribution management and the selection of optimal transport modes depending on logistics objectives [4].

Particular attention in this field is given to the report of the Intergovernmental Panel on Climate Change regarding the environmental impact of aviation [5], which underscores the necessity to evaluate transport efficiency not only from an economic but also from an ecological standpoint. Relevant approaches to digital transformation in airline logistics are presented in the work of Moghadasnian S., which examines the use of artificial intelligence and blockchain technologies to improve operational performance [6]. Ukrainian researchers Poberezhna Z., Petrova Y., and Slimani K. analyze the implementation of information technologies in the logistics processes of aviation enterprises, emphasizing the adaptation of organizations to modern digital challenges [7]. Additionally, the study by Chenyu Li [8] on the development of air logistics in cross-border e-commerce is highly relevant amid growing international cargo flows. Regular reports by IATA [9] and the World Bank [10] offer deep analytics of the air cargo market and global logistics efficiency, providing a solid analytical foundation for further research.

Objectives statement. The issue of efficient use of air transport in integrated logistics systems arises from the need to consider its specific advantages and limitations in multimodal transportation. The objective of this study is to systematize the key factors influencing the appropriateness of involving air freight, to define the conditions for its optimal functioning, and to analyze the role of digital solutions–particularly the AeroSync model–in ensuring speed, reliability, and coordination of logistics processes.

Basic material and results. Integrated logistics systems (multimodal transportation) involve the use of multiple modes of transport within a single logistics chain to ensure an optimal balance between speed, cost, and reliability [1]. Each mode of transport serves its own function: maritime transport is used for large volumes, rail transport for medium distances, road transport for the «last mile» and air transport for fast delivery over long distances.

Air transport plays a critical role in modern multimodal logistics systems due to several key advantages that distinguish it from other modes of transportation, namely:

1) offers exceptional speed, with delivery times ranging from 12 to 48 hours for

intercontinental shipments. This rapid transit capability is particularly valuable in sectors where time is a decisive factor – such as pharmaceutical logistics, electronics, and high-value goods;

2) ensures reliability. Regular flight schedules and minimal delays contribute to a high level of consistency in deliveries, which is essential for maintaining the integrity of synchronized logistics chains and fulfilling just-in-time strategies;

3) provides global accessibility, enabling companies to reach geographically isolated or infrastructure-poor regions with relative ease. This makes air transport indispensable for connecting emerging markets and supporting global supply chain expansion [5].

Collectively, these attributes position aviation as a strategic pillar within integrated logistics systems, especially in an era marked by the explosive growth of e-commerce and the rising expectations of consumers for faster, more dependable delivery services.

One of the key advantages of air transport in integrated logistics systems is its ability to meet the specific demands of the modern market – from rapid response to ensuring global reach. Compared to other modes of transport, aviation offers unique logistical benefits that are particularly relevant in the context of growing e-commerce, shortened delivery times, and increased requirements for cargo security. Table 1 presents a structured overview of the main advantages of air transport, complemented by brief descriptions and real-world examples of their practical application in logistics processes.

The outlined advantages of air transport not only underscore its functional significance within integrated and multimodal logistics systems but also highlight its growing strategic role in addressing the complex challenges of the global economy. In an era defined by digital transformation, increased customer expectations, heightened competition, and the demand for resilient and agile logistics solutions, air transport emerges as more than just a mode of delivery — it becomes a critical enabler of business continuity, market responsiveness, and global brand positioning. Its unparalleled speed and reliability offer a competitive edge in sectors where time sensitivity and supply chain precision are paramount. Moreover, the ability of air cargo to maintain stable schedules despite environmental and infrastructural uncertainties enhances the predictability of operations, which is vital for industries dependent on just-in-time logistics. The high security standards inherent to air freight also provide added value for the transport of high-value, sensitive, or perishable goods. Global accessibility further supports the development of international trade relations, while rapid delivery capabilities contribute to customer satisfaction and reinforce a company's reputation as an innovative and dependable service provider. As shown in Table 1, these advantages are not merely theoretical but are widely implemented by leading logistics operators and brands worldwide, confirming the integral role of air transport in shaping the future of global supply chains.

Table 1 – Key advantages of air transport in integrated logistics systems

No.	Advantage	Expanded Description	Practical Application Examples
1.	Speed and Urgency	Air transport provides the shortest delivery times, which is critical for perishable, urgent, or high-value cargo. Fast delivery increases overall logistics efficiency and reduces storage costs.	Fresh flowers from the Netherlands can be delivered to Japan within 12–24 hours. Amazon, FedEx, and UPS use air freight to enable two-day delivery in the e-commerce sector.
2.	Reliability and Predictability	Air freight is less dependent on weather conditions, infrastructure state, or traffic congestion, ensuring schedule stability. High flight frequency enables accurate supply chain planning.	DHL Express guarantees next-day document delivery across Europe. Qatar Airways Cargo and Emirates SkyCargo are also known for their high punctuality of cargo flights.

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3.	High Level of Security	Strict cargo handling procedures, guarded terminals, and minimal transhipments make air transport ideal for valuable and sensitive goods.	Lufthansa Cargo transports pharmaceuticals using temperature-controlled containers. Specialized certified packaging is used for jewelry and electronics by companies such as Brinks and UPS Capital.
4.	Global Accessibility	Air transport connects even the most remote regions of the world, supporting export growth and international trade. Access to a global network of airports ensures broad market coverage.	Export of microchips from Taiwan to the USA or South Korea, delivery of medical equipment from Germany to African countries, transportation of luxury goods (Chanel, Louis Vuitton) to the Middle East and North America.
5.	Marketing and Brand Value	Fast and reliable delivery enhances customer experience, increases satisfaction, and strengthens the brand's reputation as a responsive and innovative supplier.	Apple uses air freight to deliver new iPhones to over 30 countries on launch day. Zara and H&M use air transport to quickly restock new collections in select global stores.

Source: compiled by the authors

Despite its significant advantages, air transport is subject to a number of objective limitations that substantially affect its efficiency within integrated logistics systems. These constraints arise from both technical and economic factors–such as high operational costs and limited cargo capacity–as well as external conditions, including dependence on infrastructure, weather variability, and international regulatory frameworks. To comprehensively assess the appropriateness of using air freight in logistics, it is essential to consider not only its strengths but also the potential risks, limitations, and operational barriers. Figure 1 presents a structured overview of the main limiting factors that reduce the economic viability and operational resilience of air transportation in today's global environment.

The figure summarizes the main challenges of using air transport in integrated logistics systems. Despite its speed and reliability, air freight is constrained by high operational costs, limited cargo capacity, infrastructure requirements, weather-related disruptions, environmental concerns, and complex regulatory frameworks. These limitations highlight the importance of balanced multimodal strategies and the adoption of innovative solutions to ensure sustainable and efficient logistics performance.

In today's world, where global supply chains are becoming increasingly complex, the need for greater transparency in logistics processes is growing rapidly. Digital platforms play a crucial role in this context, as they enable real-time tracking of cargo movements, control over critical transportation stages, and timely response to deviations from planned routes. This is especially important in air logistics, where delivery time and schedule precision are often the key factors determining efficiency, particularly when handling high-value or time-sensitive shipments.

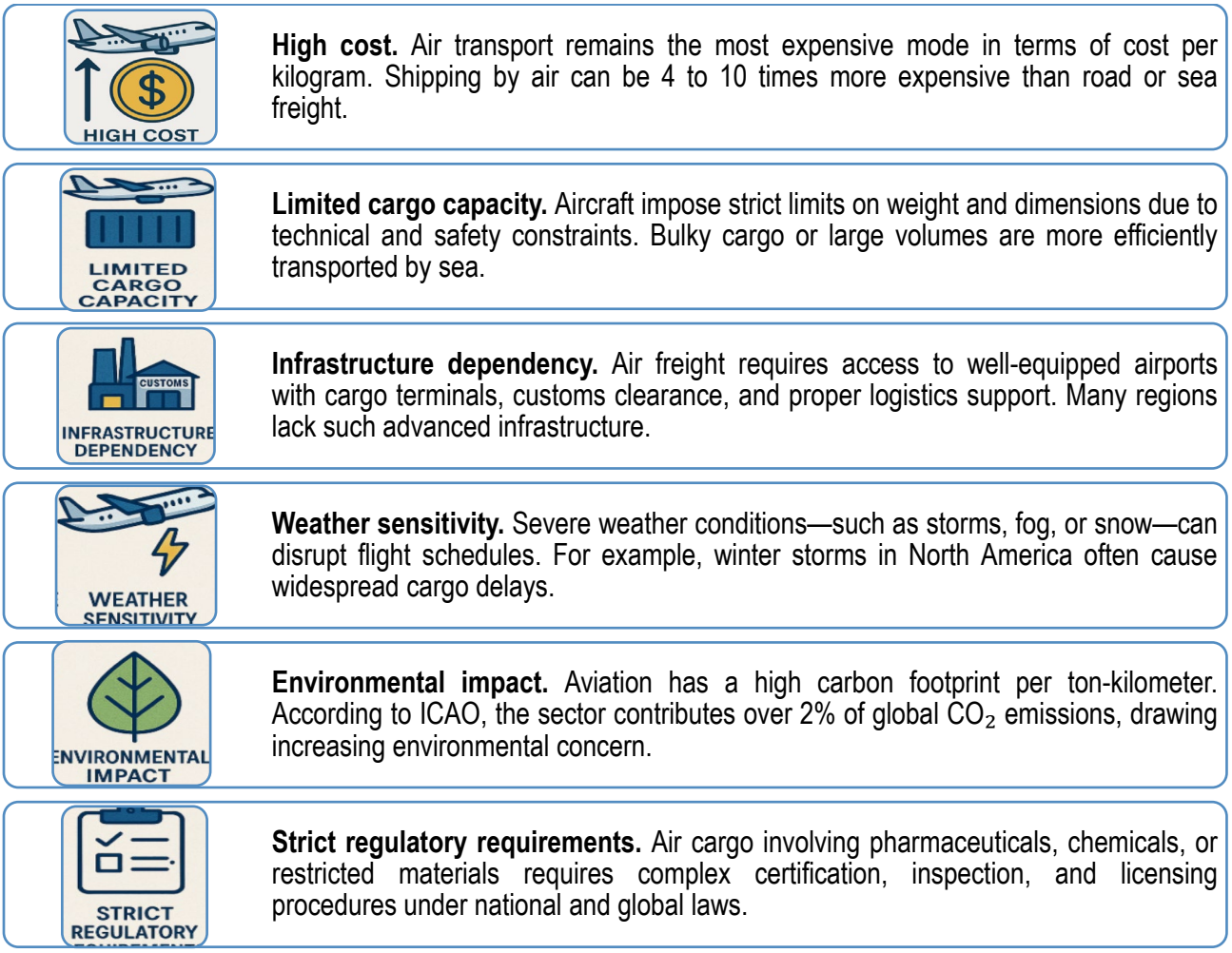

Figure 1. Limitations of air transport in integrated logistics systems
Source: compiled by the authors based on [3,4] [6]

A significant benefit of implementing digital technologies is the substantial reduction of logistics costs through the automation of core operational processes. Specialized IT solutions help optimize transportation routes, accelerate documentation procedures, minimize human errors, and ensure more efficient use of available resources. As a result, companies can enhance the productivity of their logistics units and strengthen their competitiveness within the global air transport environment [6].

Digitalization has become particularly relevant in conditions of global instability and rising risks linked to political, economic, or environmental factors. In such circumstances, the ability of logistics companies to respond quickly, adapt to changes, and maintain supply chain continuity is critically important. Digital tools that support analytics, forecasting, and automated decision-making serve as a foundation for the stable operation of logistics chains even under crisis conditions [7].

Another important aspect is the integrative function of digital technologies, which allows air transport to be combined with other transport modes into a unified multimodal system. Through digital platforms, logistics operators can manage the flow of goods, documentation, and information in a centralized manner across all stages of the supply chain – from dispatch to final delivery – thereby significantly increasing the efficiency of logistics operations.

Building a model for the efficiency of air transport requires consideration of numerous parameters: transport speed, delivery

reliability, costs, level of automation, ability to integrate with other modes of transport, and information interaction between all participants in the supply chain. Therefore, it is essential not only to conduct a technical and economic analysis but also to engage modern digital tools for modeling and tracking logistics operations.

One of the appropriate examples of a digital platform that can be applied to model the efficiency of air transport in integrated logistics systems is the AeroSync system. This platform is specifically designed to coordinate air cargo operations, automate data exchange between logistics stakeholders, and synchronize workflows with airports, customs authorities, warehouses, and ground carriers. AeroSync enables real-time tracking of cargo location, monitoring of handling times at logistics nodes, and calculation of key performance indicators (KPIs), including cost per shipment unit, idle time, and on-time delivery index [11].

Thus, AeroSync is a relevant platform for developing a model to evaluate the efficiency of air transport. It enables visualization and analysis of logistics processes, identification of bottlenecks, automation of reporting, and decision-making. Using AeroSync as the digital foundation of the model facilitates the integration of air transport into the overall logistics system of a company or logistics operator, ensuring transparency and manageability at all stages of the supply chain.

Figure 2 presents the AeroSync model diagram, which visually outlines the core structure and logic of an integrated logistics approach in the aviation sector. The model is divided into four key components: input factors, constraints, the integration process, and expected results. These elements are interconnected through directional flows, emphasizing how aviation-specific resources and external conditions are transformed into measurable economic, marketing, and social outcomes. The diagram also highlights the role of constraint management in optimizing system performance.

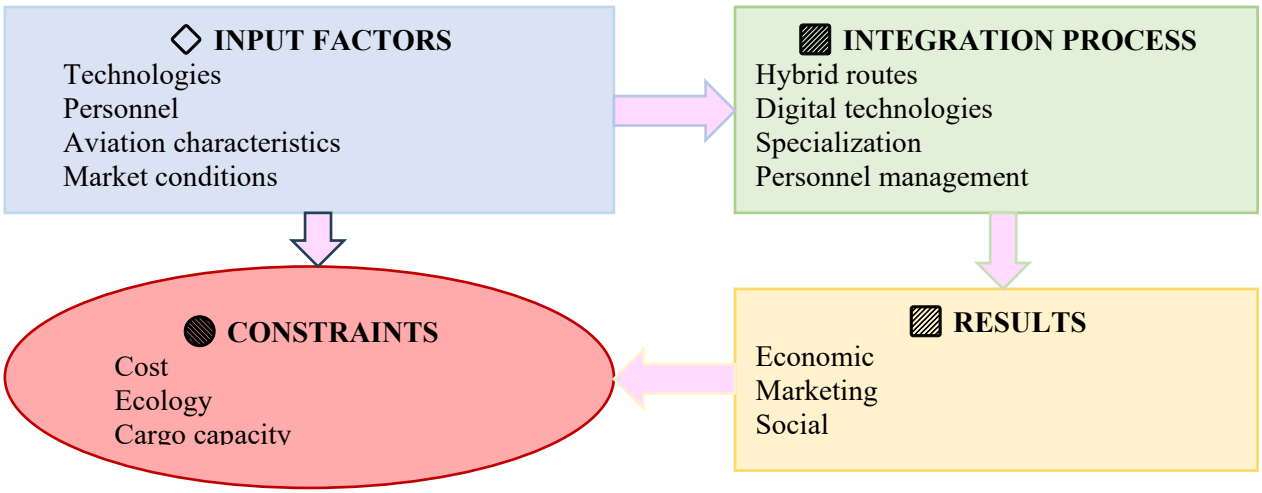

Figure 2. AeroSync model diagram
Source: compiled by the authors based on [11]

Figure 2 illustrates the AeroSync model diagram, which conceptually integrates key structural and functional components of an advanced logistics system tailored for the aviation sector. The model is logically divided into four interconnected blocks, each representing a specific stage or influence in the transformation of initial conditions into targeted outcomes. These blocks include input factors, constraints, the integration process, and final results. The entire system operates on the principle of dynamic

interaction, where each component either initiates, regulates, or enhances the functioning of the next.

The first block – input factors – contains foundational elements such as technologies, personnel, aviation-specific characteristics, and prevailing market conditions. These factors serve as the core inputs that determine the capacity and potential of the logistics system. Their configuration influences the adaptability of the system to external changes and internal goals.

Beneath this block lies the Constraints component, which includes barriers such as cost, ecological impact, and cargo capacity limitations. These constraints may hinder system efficiency and operational feasibility. Importantly, the diagram suggests a feedback mechanism: through constraint management, these limitations can be addressed and minimized within the integration process, rather than treated as static obstacles.

The Integration Process block reflects the transformation stage, where input resources are aligned and optimized through hybrid routing strategies, digital technology adoption, process specialization, and effective personnel management. This is the operational core of the AeroSync model, aimed at achieving coordination and value creation across multiple aviation logistics activities.

The final block – results – captures the intended outcomes of the integrated system, grouped into economic, marketing, and social dimensions. These results reflect not only financial performance but also customer value and broader societal impact. The visual structure of the model emphasizes a forward-moving, value-generating logic, while also allowing for continuous adaptation through feedback from the constraints layer.

Overall, the AeroSync model highlights the importance of a balanced, system-wide approach where technological, organizational, and environmental considerations are all accounted for. The visual representation reinforces the idea that sustainable logistics solutions in aviation must be both strategically designed and operationally responsive.

Table 2 presents the advantages of using the AeroSync model to enhance the efficiency of air transport in integrated logistics systems. The listed benefits highlight the model's potential to improve coordination, adaptability, and performance through strategic integration, digital innovation, and effective constraint management.

Table 2 – Advantages of using the AeroSync Model to enhance the efficiency of air transport in integrated logistics systems

No.	Advantage	Description with Argumentative Examples
1.	Comprehensive integration	AeroSync provides a unified logical framework encompassing all key logistics components – from input factors to final outcomes. This alignment enables a structured connection between technologies, workforce, aviation-specific characteristics, and market conditions with actionable operational and strategic decisions.
2.	Proactive constraint management	The model incorporates not only the identification of critical barriers but also adaptive mechanisms to overcome them through the integration process. For instance, high air freight costs can be mitigated through precise route planning or multimodal transport strategies that optimize cost-effectiveness.
3.	Integration of digital technologies	AeroSync facilitates the implementation of tracking systems, RFID solutions, cloud-based logistics platforms, and analytical tools, enhancing transparency, speed, and real-time control. These technologies reduce cargo handling time, minimize losses, and optimize resource utilization.
4.	Multidimensional result orientation	The model emphasizes not only economic outcomes but also marketing and social impacts. This enables logistics operators to account for customer satisfaction, brand

		perception, service innovation, and corporate social responsibility–factors critical in today's competitive global environment.
5.	Support for strategic decision-making	With its logically interconnected components, AeroSync functions as an effective tool for scenario planning and strategic forecasting. It enables the simulation of network changes, assessment of infrastructure or regulatory shifts, and the formulation of long-term logistics policies.

Source: compiled by the authors based on [11]

The AeroSync model, which integrates key components of logistics systems, has been successfully implemented by several international logistics companies. Its application has contributed to the optimization of operational processes and a significant improvement in efficiency across multimodal transport environments.

SEKO Logistics adopted digital solutions that improved supply chain transparency and reduced transit times. Through the integration of innovative technologies, the company was able to enhance cargo handling efficiency and lower overall logistics costs, ensuring greater responsiveness to customer demands [12].

Omni Logistics applied hybrid routing strategies combined with advanced digital tools. This allowed the company to optimize the flow of goods, streamline scheduling, and improve shipment tracking, which resulted in reduced operational costs and better service quality [13].

Noatum Logistics implemented multimodal transport operations by integrating air, sea, and road freight. This approach shortened delivery times and enhanced the company's ability to adapt to variable market conditions, providing increased flexibility in logistics operations [14].

Logistics Plus leveraged the AeroSync model to strengthen warehouse management and improve supply chain coordination. As a result, the company ensured timely deliveries and maintained a high level of customer satisfaction by aligning logistics execution with strategic performance goals [15].

These cases demonstrate how the AeroSync model supports digital transformation, multimodal coordination, and strategic agility in the global logistics sector.

The AeroSync Efficiency model serves as a comprehensive analytical framework that systematizes the key factors influencing the performance of air transport within integrated logistics systems. It offers a structured approach to managing both internal resources and external challenges, enabling logistics enterprises to develop flexible and adaptive business models.

The model places particular emphasis on the role of innovative technologies, skilled personnel, hybrid routing strategies, and operational specialization. These elements collectively contribute to overcoming major constraints such as high operational costs, environmental impacts, limited cargo capacity, and infrastructure dependency. Through the integration of these components, the model facilitates the achievement of not only economic outcomes–such as cost reduction and optimized delivery times–but also marketing benefits, including improved service quality, enhanced customer loyalty, and strengthened corporate reputation.

AeroSync Efficiency is a universal and scalable tool applicable to a wide range of logistics companies engaged in multimodal transportation involving air freight. Its application enables the design of effective transport solutions that combine high speed, reliability, and operational flexibility. This is particularly relevant in the context of globalization, digital transformation, and intensified competition in the logistics services market. Thus, the AeroSync model not only reflects the current logic of logistics management but also defines a strategic trajectory for its future development.

Conclusions. The efficiency of air transport in integrated logistics systems is determined by its ability to combine speed, reliability, and global reach within a complex multimodal framework. While air freight offers undeniable advantages–such as rapid transit times, secure handling of high-value cargo, and access to remote markets–it also faces notable limitations, including high operational costs and regulatory complexity. The integration of digital technologies and advanced management models like AeroSync enhances the potential of air transport by enabling real-time monitoring, constraint management, and strategic coordination across logistics chains. By aligning technological capabilities with operational needs, the AeroSync model contributes to the development of responsive, resilient, and customer-focused logistics systems, reinforcing the role of air transport as a vital component in modern global supply networks.

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