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Digital Technology in Air Cargo Transportation

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ABSTRACT

The development of modern air transport is inextricably linked with the progressive growth of air cargo transportation volumes. The aviation industry is one of the most knowledge-intensive and sophisticated sectors of the economy. Accordingly, the technological processes taking place in the industry are based on the achievements of science and the improvement of information support, which takes a digital form. End-to-end digital technologies have found wide application in the development of the country's civil aviation. The subject of the research in this article is the analysis of existing digital transformation technologies in organising the cargo transportation process. This process can be divided into the following stages: shipment booking and preparing relevant documents, cargo handling at the departure warehouse, delivery and loading on board an aircraft, transportation, unloading and delivery to the arrival warehouse, cargo handling at the arrival airport's warehouse, and cargo delivery to the consignee. Each of these stages has a discrete set of operations, which together turn a discrete process into a continuous one. The main end-to-end digital technologies include big data; neurotechnology and artificial intelligence; distributed ledger systems; quantum technologies; new manufacturing technologies; industrial internet; robotics components and sensors; wireless communication technologies; virtual and augmented reality technologies.

The problem set in the study is to analyse the world and domestic experience of applying digital transformation, some of the listed digital technologies in organising air cargo transportation, as well as to consider cargo hubs and. consequently, integration of cargo transportation.

The solution to the problem involves the presence of constraints associated with the specifics of cargo transportation, since each mode of transport has its own characteristics associated with the processing of cargo flow, and organisation of the cargo yard activity of a railway station will differ from organisation of the cargo terminal of an airport.

Keywords: *air cargo transportation, digital transformation, technological processes, digital platforms.*

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BACKGROUND

Dynamics of air cargo transportation

The importance of air cargo transportation increases with economic development. Air cargo transportation is an integral part of the global trading system [1]. The analysis of air cargo growth rates presented in the report of the International Air Transport Association (IATA) shows positive dynamics over the past three years. Global air cargo transportation demand, expressed in quantified tonne-kilometres (CTK, Cargo Tonne-Kilometres) in October 2023 amounted to 21,9 billion tkm. This is an increase of 3,8 % compared to the same period of the previous year. Despite this growth, the industry's performance remains slightly below the pre-pandemic level. The steady annual growth of CTK since August 2023 indicates the ongoing recovery of the global air cargo market and is a positive signal for ending the year with higher figures (Pic. 1[1]).

The overall dynamics of growth in cargo tonne-kilometres, considering seasonal fluctuations, according to the IATA report, is presented in Pic. 2.

Approaches to studying the research problem

Cargo handling operations play an important role in air cargo transportation and can be divided into several groups:

– Processing an order for cargo shipment.

– Delivery of cargo to the airport (to the airport cargo terminal).

– Cargo handling at the terminal warehouse, a set of operations for categorising cargo, its weighing, marking, packing, bundling, assembling for the flight, cargo safety check.

– Registration of shipping documents.

– Collection of fees [2].

The discrete nature of the cargo handling process requires a clear and precise organisation of the process; therefore digital transformation processes are increasingly used to ensure the cargo transportation process.

Digital transformation is a process that involves the integration of digital technologies into various aspects of an organisation or industry, fundamentally changing the methods of doing business, optimising processes and creating value [3].

In the context of sustainable transport development, digital transformation involves the use of data-driven technologies and solutions to solve environmental, social and economic problems associated with transport systems [4].

By using digital platforms, real-time data collection and advanced analytics, transport organisations can optimise their operations by minimising congestion, reducing travel times and optimising routes [5].

These few key statements in scientific articles devoted to the issues of digital transformation in the transport sector highlight the importance of the need to study this issue.

RESULTS

Digitalisation of shipping documents

As already noted, transportation of goods begins with proceeding shipping documents. The air waybill (AWB) is the main document regulating the transportation process. AWB implements the following functions in accordance with the information it contains:

– Contract of carriage – an agreement between the shipper and the carrier, which specifies the terms of cargo transportation.

– Certificate of receipt of goods by the airline – once signed, this is legal evidence that the air carrier has received the goods for transportation (in case of any disputes).

– Shipment tracking – the AWB number is an important piece of information that allows you to track the cargo (it indicates also route details and airport codes).

– Contact information for all parties – contact details for all parties involved.

– AWB (shipment bill) – information on the costs associated with the shipment process, so the AWB can serve as an invoice along with supporting documents. It also supports the accounting process.

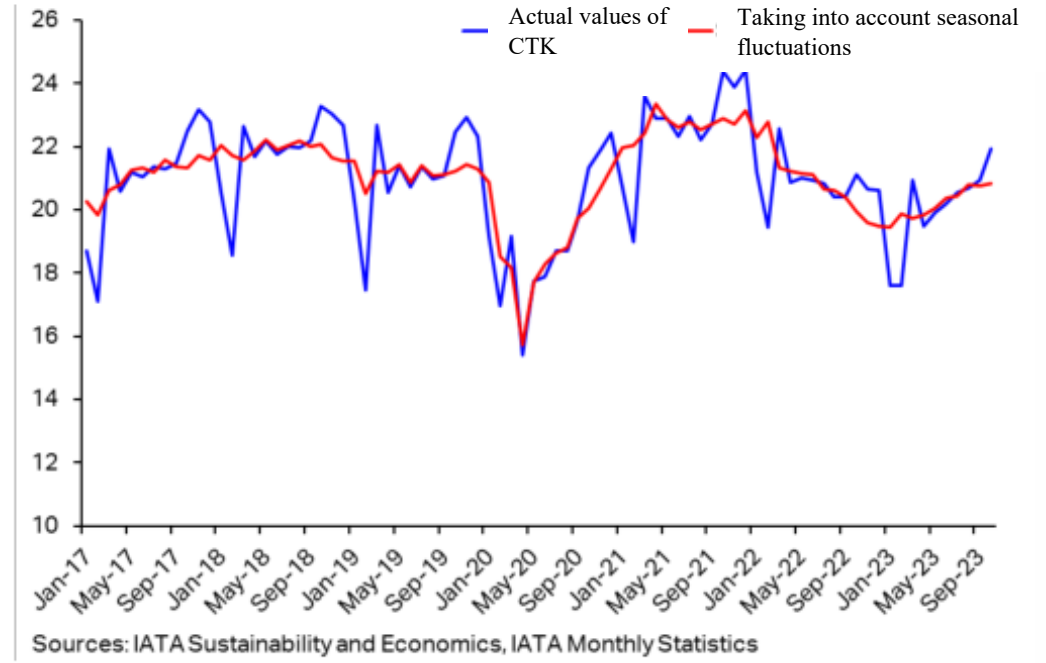
– Customs declaration – this is one of the main documents required by customs authorities to allow the transportation of goods.

– Commodity Description – details of the quantity, weight, dimensions, value and nature of the goods being transported.

– Handling and Delivery Guide – may include special instructions on how to handle the shipment, i. e. as for hazardous, fragile or temperature-sensitive goods.

– Insurance Certificate – evidence that the shipment is insured, containing details of the insurance coverage.

[1] IATA Air Cargo Market Analysis October 2023. [Electronic resource]: https://www.iata.org/en/iata-repository/publications/economic-reports/air-cargo-market-analysis—october-2023. Last accessed 19.05.2024.



Pic. 1. Global CTK (billions of tkm per month)[1].

Every shipment requires a set of accompanying documents that need to be stored, distributed and tracked. In 2010, IATA (International Air Transport Association) introduced the e-air waybill (e-AWB), which became the default contract of carriage for all air cargo shipments from 1 January 2019. It is part of IATA's eFreight programme, which aims to digitise the industry and move it to a paperless format. It aims to improve efficiency, data quality, cost effectiveness and sustainability (eliminating over 7 800 tons of paper documents annually), among other benefits for the air cargo industry.

Today, in accordance with Resolution 672 on Multilateral Electronic Air Waybills[2], paper air waybills are no longer required. This means that they can still be used, but IATA and its members have largely switched to the electronic version, which is faster to process and exchange, easier to store and manage, and much more environmentally friendly. A detailed guide has been developed for freight forwarders on how to integrate e-AWB[3].

Digital platforms

The digital transformation of the air cargo process management is moving towards the creation of software for digital platforms.

For example, «Scope» from Riege Software is a complete freight forwarding platform for managing international sea and air transportation[4]. Air cargo transportation functionalities include automatic e-AWB creation, carrier AWB number administration, connection to cargo community systems for messaging, and much more.

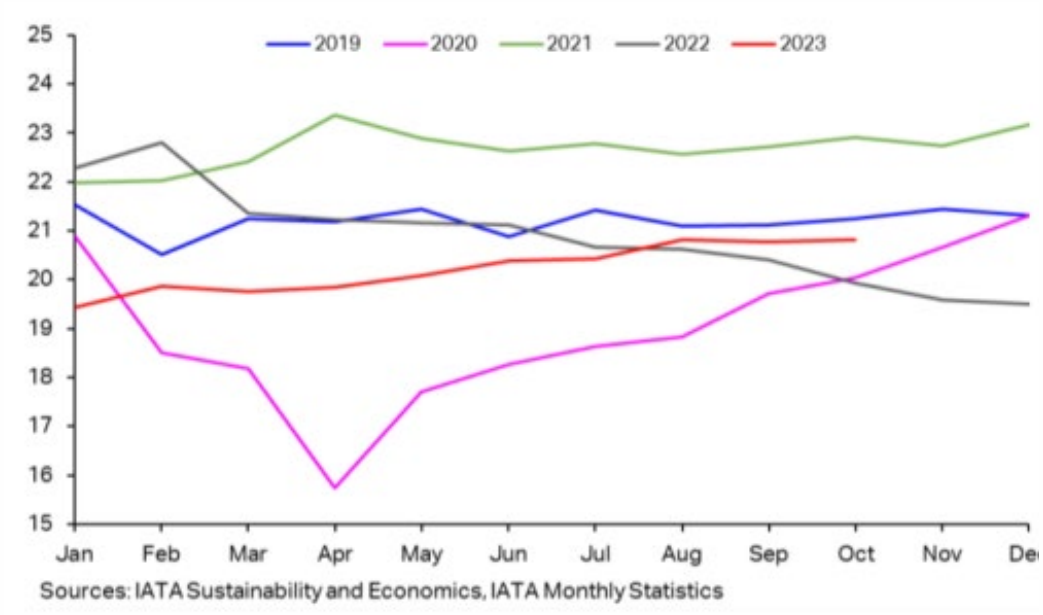
Magaya's digital freight platform[5] automates numerous supply chain workflows, including onboarding carriers via AWB and exchanging electronic AWB messages.

[2] IATA Resolution 672 Form of Multilateral E-Air Waybill Agreement. [Electronic resource]: https://www.iata.org/contentassets/783ac75f30d74e32a8eaef26af5696b6/csc-672-en-28dec2019.pdf. Last accessed 15.03.2024.

[3] Sauv, D. E-AWB Implementation Playbook. February 2022. [Electronic resource]: https://www.iata.org/contentassets/4bc75639b37641ba88f2e81e5516a020/e-awb-implementation-playbook.pdf. Last accessed 19.05.2024.

[4] Logistics Software for Sustainable Growth Scope. [Electronic resource]: https://www.riege.com/. Last accessed 19.05.2024.

[5] Logistics software enabling you to move smarter, faster, and with full control. [Electronic resource]: https://www.magaya.com/. Last accessed 15.03.2024.



Pic. 2. Monthly CTK, seasonally adjusted (in billions of tkm)[1].

Logitude[6] also offers a complete cloud-based freight forwarding platform with robust e-AWB services that include not only e-AWB generation and exchange, but also statistics monitoring, delivery time tracking, reporting, and more.

Smart AWB[7] is a very easy-to-use cloud-based solution that allows freight forwarders to create, print, send, and track electronic AWB.

An alternative to purchasing a specific tool can be to integrate with one or more data exchange platforms. These global air cargo transportation communities enable accurate and efficient information exchange, connecting all parties involved in the transportation process (airlines, freight agents/forwarders, ground handling agents, shippers, customs, etc.).

Examples of some of the largest platforms are as follow.

TRAXON cargo HUB[8] by CHAMP is the largest air cargo service provider, providing electronic communication between more than 100 airlines and more than 3000 freight forwarders. It helps automate booking, operations, document processing and customs processes. TRAXON supports all types of messages, including those related to e-AWB exchange, booking, status check, error messages and others. API (Application Programming Interface) is provided to connect to the platform.

The Worldwide Information Network (WIN)[9] is a platform that mainly serves independent freight forwarders, offering them easy connectivity to over 160 airlines for electronic booking and e-AWB generation, exchange and tracking. WIN can be accessed via the Internet or via web service API integration. In addition, it offers a mobile application for shippers that supports shipment tracking, rate inquiries, etc.

Cargonaut[10] operates the Cargo Community information platform in Schiphol (Amsterdam), the largest Dutch cargo hub. It supports the exchange of data between all cargo parties and optimises the corresponding processes at the airport.

Distributed ledger (blockchain)

The improvement of the cargo transportation management system will be implemented in a distributed ledger system (blockchain). The

[6] Electronic Air Waybill for Freight Forwarders. [Electronic resource]: https://logitudeworld.com/eawb/. Last accessed 15.03.2024.

[7] Smart AWB [Electronic resource]: https://www.smartawb.com/. Last accessed 15.03.2024.

[8] Traxon cargo HUB (digital platform). [Electronic resource]: https://www.champ.aero/products/champ-ecargo/traxon-cargohub. Last accessed 15.03.2024.

[9] FREIGHTOSCOPE ™. [Electronic resource]: https://www.winwebconnect.com/index.html. Last accessed 15.03.2024.

[10] Schiphol and Cargonaut start using updated IT cargo platform. [Electronic resource]: https://www.schiphol.nl/en/cargo/news/schiphol-and-cargonaut-start-using-updated-it-cargo-platform/; https://cargonaut.nl/. Last accessed 15.03.2024.

use of this system will make more efficient the process of cargo tracking and movement of accompanying documents – air waybills, customs declarations, invoices, packing lists, safety data sheets, powers of attorney for receiving cargo and others. Electronic document management system and the Internet of Things are connected in a common distributed ledger system.

Blockchain is a decentralised transaction and data storage technology that helps individuals and businesses store and share value without the use of traditional intermediaries [6]. It is a cutting-edge technology that has the potential to upend traditional economic and social structures and replace them with systems that are more accessible, reliable, and stable. Blockchain technology is based on a globally distributed ledger that records and validates transactions using the properties of a large-scale peer-to-peer network [7]. A blockchain database is a permanent archive of transactions that occur between individuals or between customers and businesses. There are many blockchain implementations that are still under development. The data on the cost of a transaction is available to any user of the network with access privileges, making a blockchain-enabled transaction system extremely transparent [8]. This makes it very difficult to conduct fraudulent transactions. However, when making a transaction, network users choose what information about their identity they want to share with the rest of the network, leading to the use of pseudonyms. Digital technology has the potential to break down these barriers, allowing the supply chain to become a truly interconnected marketplace, fully open to all stakeholders – from producers of raw materials, goods and components to haulers of finished products from these suppliers and, ultimately, to end users [9].

Formation of a target solution to the problem

The integration of the Internet of Things and blockchain technology into intelligent transportation systems has the potential to transform the cargo industry by enabling efficient, secure, and reliable tracking and management of cargo across the entire supply chain. By using IoT sensors to track cargo in real time and storing the data on a decentralised blockchain platform, intermediaries can be eliminated, reducing costs and increasing transparency. The use of smart contracts can automate many processes, reduce manual intervention and increase the speed and accuracy of transactions [10].

Blockchain technology – maintenance of a distributed ledger must correspond to the process of physical movement of cargo, from the point of departure, through the cargo terminal of the departure point, on board an aircraft, to the cargo terminal of the destination. The process of tracking the movement of cargo is not possible without the Internet of Things (IoT). The Internet of Things, or IoT for short, is a term for the concept of connecting a wide range of devices to the Internet – and to each other. Essentially, IoT is a huge global network of connected devices, gadgets, machines, and the people using them. All devices connected to the IoT collect and exchange data about their usage and the environments in which they operate. «The Internet of Things (IoT), as an important part of the new generation of information technology, connects any object to the Internet in accordance with an agreed protocol through radio frequency identification, global positioning system and other information and measurement equipment for the exchange of information and communication. The continuous development of the Internet of Things technology has given new strength to its further development and improvement. The Internet of Vehicles (IoV) is within the focus of IoT» [11].

Supply chain management is a complex and multifaceted area, and, as a business scales, it can become very complex. A single shipment can involve dozens of operations and tasks at once.

The combination of IoT and blockchain technologies will allow managing large volumes of cargo transportation and will become an important step in implementation of new digital methods, including creation of digital platforms, will allow optimising cargo transportation routes. In particular, one of the future vectors of development of air cargo transportation is associated with creation of cargo hubs and the use of a network of cargo airports for these purposes. The idea is far from new, for example, in the USA, cargo

hubs have been developed in Rickenbacker – Columbus (Ohio) and the Stockton Metropolitan (California) airports [12]. In China, a specialised air cargo hub has been opened in Ezhou Huahu International Airport [11]. The history of development of Russian civil aviation records an attempt to create a cargo airport on the grounds of the former military airfield «Veshchevo»; the program for development of the transport system of St. Petersburg and Leningrad region for the period up to 2020 provided for construction of the Ust-Luga cargo airport [12].

The use of a hub network and cargo handling system can lead to significant savings in transportation costs, with the number of hubs and their location being decisive factors.

Digital platforms and technologies will make management of cargo transportation through hub cargo airports transparent for cargo clients and efficient for the carrier.

CONCLUSION

Analysis of technology already implemented in air cargo transportation and the assessment of the outlook for their future developments should be complemented in the course of further research by the study on fields of introduction of the end-to-end technologies like big data; neurotechnology and artificial intelligence; quantum technologies; new manufacturing technologies; industrial internet; robotics components and sensors; wireless communication technologies; virtual and augmented reality technologies.

[11] China opens Asia's first dedicated cargo airport in Ezhou, Central China's Hubei Province. [Electronic resource]: https://www.globaltimes.cn/page/202207/1270695.shtml. Last accessed 15.03.2024.

[12] Program for development of the transport system of St. Petersburg and Leningrad Region for the period up to 2020. Approved by the Coordinating Council for the development of the transport system of St. Petersburg and Leningrad Region: Volume 5, page 16, September 9, 2014.

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