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Digital transformation of international trade and logistics in the conditions of pandemics and military conflicts

Transformacja cyfrowa międzynarodowego handlu i logistyki w warunkach pandemii i konfliktów zbrojnych

Abstract. The purpose of the publication is to provide a scientific and theoretical justification of the cause-and-effect relationships from pandemics and military conflicts to the acceleration of the digital transformation of international trade and logistics and the development of the IT segment in the world for these needs. It has been proven that the COVID-19 pandemic and military conflicts have accelerated and promoted the digital transformation of international trade and logistics, adapting them to the needs of life in a new social reality. It was established that the gaps in the digital transformation of business are related to the differentiation of the digital development phases of companies and the lack of a standardized approach to the functioning of a single digital platform for the implementation of IT changes. The interrelationship and influence of Industry 4.0 on the reformatting of international trade on the Trade 4.0 model is substantiated, and the role of the government in these processes is determined. It has been proven that the emergence of e-commerce retail logistics (e-logistics) is a consequence of the digitalization of international trade. Cyberattacks have been identified as key threats in the field of digital transformation of international trade and logistics during hybrid wars.

Key words: digital transformation, IT, pandemic, military conflict, international trade, Industry 4.0, logistics, cyberattack

Synopsis. Celem publikacji jest naukowe i teoretyczne uzasadnienie związków przyczynowo skutkowych od pandemii i konfliktów zbrojnych do przyspieszenia transformacji cyfrowej międzynarodowego handlu i logistyki oraz rozwoju segmentu IT na świecie dla tych potrzeb. Udowodniono, że pandemia COVID-19 i konflikty zbrojne przyspieszyły oraz sprzyjały transformacji cyfrowej międzynarodowego handlu i logistyki, dostosowując je do potrzeb życia w nowej rzeczywistości społecznej. Ustalono, że luki w cyfrowej transformacji biznesu związane są ze zróżnicowaniem faz cyfrowego rozwoju firm oraz brakiem ustandaryzowane-

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go podejścia do funkcjonowania jednej platformy cyfrowej do wdrażania zmian informatycznych. Potwierdzono wzajemne powiązania i wpływ Przemysłu 4.0 na przeformatowanie handlu międzynarodowego na model Handlu 4.0, określono rolę rządu w tych procesach. Udowodniono, że pojawienie się logistyki handlu elektronicznego (*e-logistics*) jest konsekwencją cyfryzacji handlu międzynarodowego. Cyberataki zostały zidentyfikowane jako kluczowe zagrożenia w obszarze cyfrowej transformacji międzynarodowego handlu i logistyki podczas wojen hybrydowych.

Słowa kluczowe: transformacja cyfrowa, IT, pandemia, konflikt zbrojny, handel międzynarodowy, Przemysł 4.0, logistyka, cyberatak

JEL codes: L81, L86, O14, O33, R40

Introduction

The COVID-19 pandemic and the global crisis caused by Russia's military aggression against Ukraine have become powerful catalysts for deepening the digital transformation processes of international trade and logistics. In pursuit of stability, the management of many companies began to implement the digital transformation of business processes rapidly. The successful decisions of individual global companies have made it possible to identify digitization as a key trend in international trade, transforming it into an e-commerce segment, erasing the boundaries of logistics, and accelerating the transition to the introduction of Industry 4.0 assets.

The study of the economic processes described above is presented in the works of many scientists and practitioners, in particular, a systematic review of the literature was conducted on: factors affecting the digital transformation and internationalization of companies [Feliciano-Cestero et al. 2023]; an analysis of the impact of COVID-19 on digital transformation and the sustainability of small and medium-sized enterprises [Abilova and Aliyeva 2022]; qualitative studies of the impact of the pandemic on improving organizational resilience in business [Aksay and Sendogdu 2022]; cartographic studies in logistics and supply chain management during the COVID-19 pandemic [Montoya-Torres et al. 2023]; new security trends in response to challenges due to Industry 4.0, which has accelerated as a result of the pandemic [Di Nardo et al. 2022]; an assessment of the contribution of Industry 4.0 technologies to industrial productivity [Santos et al. 2018]; the role of intelligent technologies of Industry 4.0 in logistics [Wołczański 2021]; the development of heuristic approaches for TSP last mile delivery using a truck and multiple drones [Rinaldi et al. 2023]; the development of the concept of dronology and 3D printing as catalysts for international trade in Industry 4.0 [Dumanska et al. 2021, 2023]; smart manufacturing and its digital frameworks [Didaskalou et al. 2021]; digitalization prospects for business processes of enterprises in the Industry 4.0 ecosystem as a virtual-real aspect of economic growth reserves [Kraus et al. 2021 and Rut et al. 2020]; the role of integrated IT systems in the management of logistics companies [Rokicki and Ziółkowska 2020]; changes in logistics and international trade during war [Aldemar et al. 2023]; the role of cyber security in digital processes [Guseva et al. 2022].

The purpose of this article is to provide a scientific and theoretical justification of the cause-and-effect relationships between pandemics and military conflicts and their impact on accelerating the digital transformation of international trade and logistics and the development of the IT segment worldwide.

Materials and methods

The main method of this work is an in-depth analysis of the previous literature, based on the research of experts in the field of international trade and logistics. The information and empirical basis of the publication is a generalization of digital transformation practices in the form of a questionnaire, expert materials from Deloitte and McKinsey, and statistical data and analytical reports containing information about digital data and related research on the digital transformation of international trade and logistics in pandemic conditions and military conflicts against the background of the development of the IT segment worldwide.

The publication aims to provide a scientific and theoretical justification for providing answers to solve the following tasks:

- a) research on the analysis of changes in the world regarding the development of the IT segment from the pandemic to the beginning of the war in Ukraine in order to determine cause-and-effect relationships;
- b) establishment of conceptual differences between the concepts of digitization, digitalization, and digital transformation in international trade and logistics in order to identify the possibility of building platforms for joint digitalization of business and their gaps in digital development;
- c) revealing the development of the concept of Trade 4.0 based on the digitalization of international trade in Industry 4.0 and the emergence of electronic commerce of retail logistics (e-logistics) under the influence of the development of electronic commerce, as well as security parameters in the digitalization of trade and logistics in the context of cyberattacks during hybrid wars.

The stated methods and defined tasks of the article are chosen in order to present convincing evidence regarding the existing – but not substantiated from a scientific point of view in the available literature and practical studies – positions regarding the catalytic effect of such crises in the economy as pandemics and military conflicts on the digitalization of international trade and its transition into the e-commerce segment with the further development of e-logistics, as well as the further development of the IT sector to service these processes.

The development of IT from the pandemic to the beginning of the war in Ukraine: analysis of changes in the world

Lockdowns, which were introduced as one of the methods to slow the spread of COVID-19, have caused a sudden and rapid transition to a fully remote working environment. According to the results of the study, with the onset of the pandemic, 62.2% of enterprises around the world have completely switched to a remote work mode, and

32.3% have switched to a partially remote work mode. Only 5.5% of enterprises did not change the mode of operation, working according to the old rules [McKinsey 2020].

Performing work in remote mode is impossible without the use of gadgets and computer equipment, which require digital transformation of business processes at the enterprise for its smooth operation in these conditions. Despite the economic downturn, the pandemic caused an increase in people's spending on computers, video games, online stores, and digital advertising, meaning that not only the performance of work duties became online, but also forms of education, recreation, shopping, and communication.

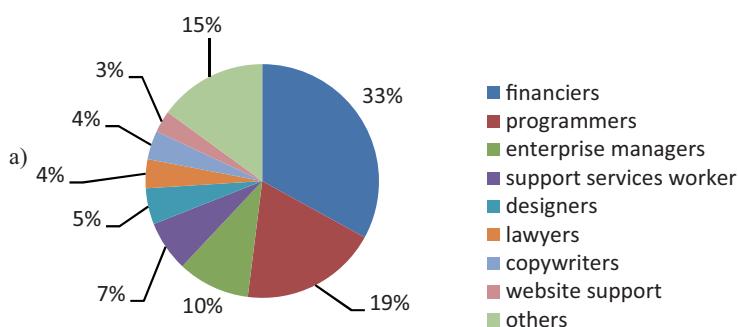
All this led to a rapid increase in the share prices of global IT giants – in one year, the combined capitalization of Apple, Microsoft, Amazon, Alphabet, and Facebook doubled - to 8 trillion dollars. Their revenue increased by one-fifth to 1.1 trillion, and their profits by even more, by 24%. As for specific companies, Apple grew due to increased demand for laptops, tablets, and other devices, and Microsoft - thanks to sales of Xbox consoles, Surface laptops, and cloud services. Amazon is growing due to the increasing popularity of online shopping. For 2020, the company's revenue increased by 38% to 386 billion dollars. Google also benefited from people spending more online. More users staying at home has also benefited Facebook – the company, among other things, introduced the possibility of shopping on Instagram to make money from e-commerce [The World Street Journal 2021].

According to a survey conducted by the author of this article, based on the Google Form tool, a number of questions were asked, answers to which made it possible to conduct research on the labor market during the pandemic regarding the remote work format and established the following trends:

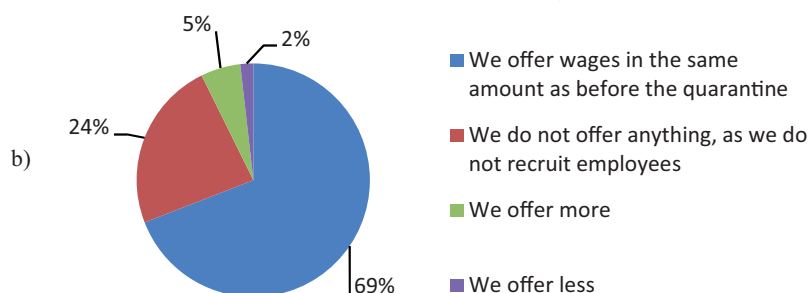
- the key professions that switched to remote format were: financiers (33%), programmers (19%), and managers (15%) (Fig. 1a);
- the predominant invariance of the payment conditions for labor during the transition of the performance of work duties in a remote mode: 69% of companies, when looking for employees, offered the same salary level as before the lockdowns (Fig. 1b);
- among the preferences of remote work is the possibility of saving time spent commuting to the workplace – 32%, and a parallel realization of personal needs: 17% – spending time with family and 14% – time for self-development) (Fig. 1c);
- the organization of the remote workplace was carried out independently by employees – 53%, with the full participation of the employer – 25%, or with their partial help – 22% (Fig. 1d).

The need for remote organization of the workplace provided an opportunity to increase revenues for companies that are owners of services for organizing video conferences. For example, the total value of the shares of Zoom Video Communications, the owner of the popular Zoom video conferencing service, increased to USD 48.8 billion as of May 15, 2020, under lockdown conditions [Barchart data 2020]; for comparison, the company's profit was only USD 623 million before the pandemic. For an even more detailed comparison, we compared the market value of airlines and their losses from the pandemic. Among such air carriers are American and European companies: Southwest Airlines, Delta, United, International Airlines Group, Lufthansa, American, and Air France. Their total value is now USD 46.2 billion, which is \$2 billion less than Zoom's market capitalization (Fig. 2).

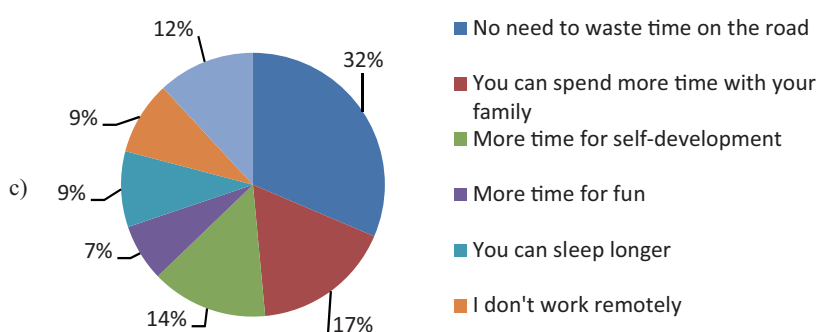
Professions of employees who switched to remote employment under lockdown restrictions %



What salary do you offer job candidates during the COVID pandemic? %



What do you like about remote work? %



How was assistance provided in organizing the workplace for remote work? %

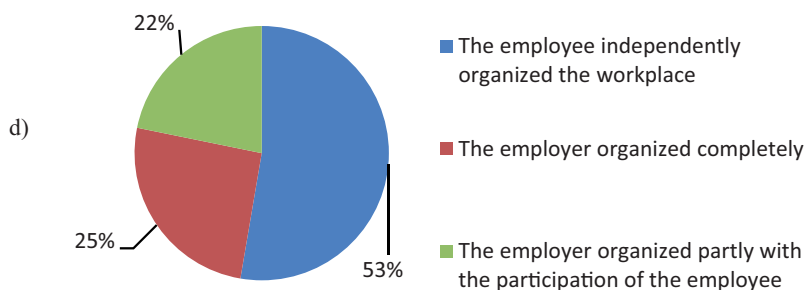


Figure 1. Results of an online survey on the impact of the remote work format on the labor market during the pandemic among retailers and logisticians, March 2020.

Rysunek: 1. Wyniki badania internetowego dotyczącego wpływu formatu pracy zdalnej na rynek pracy w czasie pandemii wśród handlowców i logistyków, Marzec 2020.

Source: [author's research 2020].



Figure 2. Comparative infographic of changes in the market value of Zoom and the largest air carriers under the influence of the pandemic

Rysunek 2. Infografika porównawcza zmian wartości rynkowej Zooma i największych przewoźników lotniczych pod wpływem pandemii

Source: [Barchart 2020].

It is also worth emphasizing the fact that, in parallel with Zoom, the number of users who want to organize their workplace using Google Meet and Microsoft Teams is growing. Among employees, there is an urgent need for digital literacy as one of the features of competitiveness in the labor market.

Thus, the pandemic did not become a crisis, but rather a starting point for the future. Lockdown restrictions contributed to the acceleration of digital transformations at enterprises, changes in business models, and new requirements on the labor market in terms of professions and digital competencies. The following consequences can be summarized:

1. The IT sphere increased its capacities during lockdowns, which made it possible to digitize the activities of many enterprises; therefore, in the future, these enterprises will demand a similar approach to cooperation from counterparties. In general, everyone will move towards digital technologies, but everyone's pace will be different.
2. The acceleration of the automation of production, and the development of Internet technologies that provide communication between personnel and gadgets and computers.
3. The COVID-19 pandemic gave an impetus to the growth of the use of digital technologies and their capitalization; the digital economy and the so-called Industry 4.0 are inevitable.
4. The COVID-19 pandemic has consequently changed many spheres of social reality, transforming social communications and forming new rules related to the issue of social and biological safety in the modern global world [McKinsey 2020].

The lessons of the pandemic and the changes in everyday life were analyzed and formed the basis of the vision and goals for the successful digital transformation of Europe by 2030, which is considered crucial to achieving the transition to a climate-neutral and sustainable closed-loop economy. The EU's ambition is to be digitally independent in an open and interconnected world and to pursue a digital policy that enables people and businesses to achieve a digitally sustainable, people-centered, and prosperous future. This includes addressing vulnerabilities and dependencies and accelerating investments [European Commission, 2023].

The European Commission is implementing the Digital Compass to translate the EU's digital ambitions for 2030 into concrete timelines to ensure that all citizens and businesses have access to the best the digital world has to offer. They will develop around four main points:

1. Digitally literate citizens and highly skilled digital professionals: by 2030, at least 80% of all adults should have basic digital skills, and there should be 20 million employed ICT professionals in the EU, and more women should be employed in such work.
2. Secure and resilient digital infrastructures: by 2030, all EU households should have a gigabit connection, and all settlements should be covered by 5G; the production of advanced and stable semiconductors in Europe should be 20% of world production; 10,000 climate-neutral highly protected edge nodes should be located in the EU; Europe should also have its first quantum computer.
3. Digital business transformation: by 2030, three out of four companies should use cloud computing services, big data, and artificial intelligence; more than 90% of SMEs should reach at least a basic level of digital intensity; and the number of unicorns in the EU should double.
4. Digitization of public services: by 2030, all key public services must be available online; all citizens will have access to their electronic medical records; and 80% of citizens must use an electronic ID (eID) solution.

Such a program of actions will determine the vectors of digital transformation of international trade and logistics, and can also contribute to the security and sustainability of digital supply chains and provide global solutions in the socio-economic sphere. It should be noted that supporting sustainable digital transformation is one of the five policy priorities that the European Commission has highlighted in its proposal for the long-term political goals of the Eastern Partnership for the period after 2020, with support directed through the EU initiative [EU4Digital 2023].

The advantages gained from the pandemic period were smoothly adapted to the conditions of further global crises, one of which is military conflicts. As of the end of 2022, there are about 40 military conflicts in the world in the following forms: war, border conflicts, local conflicts, military coups, terrorist attacks, domestic political crises, and diplomatic confrontations [World Economic Forum 2022]. A new challenge for the IT segment is the hybrid war between Ukraine and Russia, which was implemented not only in the form of military aggression, but also through cyberattacks and the introduction of Industry 4.0 assets in the military sphere (for example, drones and other unmanned aerial vehicles).

It is worth noting that Ukraine is one of the largest exporters of outsourcing IT services in Europe, which provided it with a 5.8% increase in the export of IT services despite the military operations. Examples of high-income European countries that generate a particu-



Figure 3. Poland’s place in the geography of resettlement of IT specialists who left Ukraine for Europe after February 24, 2022

Rysunek 3. Miejsce Polski w geografii przesiedleń informatyków, którzy wyjechali z Ukrainy do Europy po 24 lutego 2022 roku

Source: [IT outsourcing statistics for 2023].

of the entire migration) [IT outsourcing statistics for 2023]. The resettlement locations of IT specialists who left for Europe after February 24, 2022, are presented in Figure 3.

Evaluating the general consequences of the escalated military conflict between Russia and Ukraine, the increase in revenues in the market of IT services is obvious, as the need for them has increased due to the digitization of business processes of enterprises for the needs of military logistics, the development of software for managing navigation systems and monitoring the situation of field combat, and applications for gadgets to inform the population about the danger of missile or drone attacks, etc. Thus, large-scale business digitization processes have become one of the conditions for survival in wartime conditions.

On a global scale, the digital transformation of business started during the pandemic, and according to its pace and forecasts, it has an upward trend (Fig. 4), causing increased

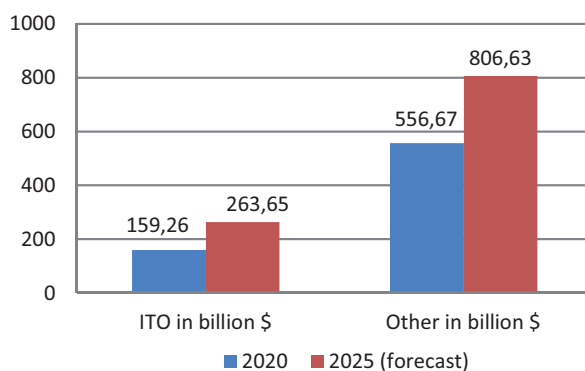


Figure 4. Comparison of the IT services market share in 2020 and the forecast for 2025

Rysunek 4. Porównanie udziału rynku usług IT w 2020 roku i prognozy na 2025 rok

Source: [IT outsourcing statistics for 2023].

ly high proportion of their service exports through IT services include Finland and Ireland, while Ukraine and Belarus are examples of low/middle-income countries. IT services account for more than 30% of export services provided in these countries [IT outsourcing statistics for 2023].

The IT segment is not dependent on a fixed place of work, is mobile, and is the least affected by war losses. At the same time, the military conflict in the territory of Ukraine caused migration processes of IT specialists from Ukraine to Poland, the nearest territorial neighbor (more than 30%

market shares because of global uncertainty due to Russia’s war with Ukraine.

Thus, IT is the only industry that was able to work fully during the pandemic and war because of the increase in the export of services. The adaptive role of the IT segment to the changing needs of society and the introduction of the assets of Industry 4.0 to overcome problems related to supply chains, state borders, and the labor force in light of global changes is clear.

Digitization Vs. Digitalization Vs. Digital transformation in international trade and logistics

One of the positive results of the COVID-19 pandemic was the push for the digitalization of interaction and operations in many sectors of society, which gained further development and adaptation, even in wartime. Digitization processes changed to the digitalization of economic operations, and those subsequently led to larger-scale changes - digital transformation.

Digitization is a relatively easy concept to understand. It is the process of converting information into a digital format, in other words, bits and bytes. A digital version of an object, image, sound, document, or signal (usually an analog signal) is generated by a series of ones and zeroes and can be automatically exchanged between machines without manual intervention. Digitization is a fundamental and necessary condition for digitalization, which in turn creates favorable conditions for digital transformation, a general term to describe the introduction of new technologies and processes to improve business operations, represented by the definition of digitization. So, digital transformation is nothing but solving problems with the best technical means. To some extent, this applies to topics such as agile, design thinking, brainstorming, and other new ways of working because they are needed for a differentiated view of problems. Having understood these problems, they can also be solved by technical means and the use of new technologies [Sen Gupta 2020].

To implement an effective digital strategy, leading economists from Germany developed a sequence of digital transformation phases for a business model based on digital transformation approaches and existing theories on business model innovations [Shalmo et al. 2017]. One of the modern trends in digital strategy is the formation of platform business models since a digital platform allows you to combine two or more independent groups of products to increase the profits of all participants and provides an opportunity for consumers and producers to communicate with each other to exchange goods, services, and information [Federal Ministry for Economic Affairs and Energy 2019]. Platform business models ensure the formation of value for consumers through the widespread use of digital and other advanced technologies of Industry 4.0, which enable the interaction of economic activity in real-time, equal access of producers and customers to information, and reliability. Figure 5 shows the main characteristics and advantages of platform business models.

The implementation proposed in Figure 5 for the use of digital platforms in the interaction of different parties, taking into account the phase of digital transformation, allows for the minimization of the number of intermediaries between them and allows the manufacturer or seller to offer their goods to a huge number of buyers regardless of their geographical location. Buyers have ample opportunities to compare the goods they need according to various characteristics. The following digital business models are distinguished: service, subscription, platform as a service, software as a service, and shared consumption [Yurchenko et al. 2022].

One area of the economy, however, seems immune to this phenomenon even after two years of the pandemic and since the beginning of Russia's military aggression against Ukraine: cross-border trade in goods. In most countries, trade and supply chain data

exchanged between private sector actors (e.g., between a shipper and a financing bank) and between the private sector and the public sector (e.g., between a consignee and customs) are still received in paper format. This data must be manually extracted, verified, and entered multiple times into various IT systems before it can be used. The process is prone to errors, discrepancies, and even fraud, creating risks and inefficiencies that manifest in both economic and environmental costs.

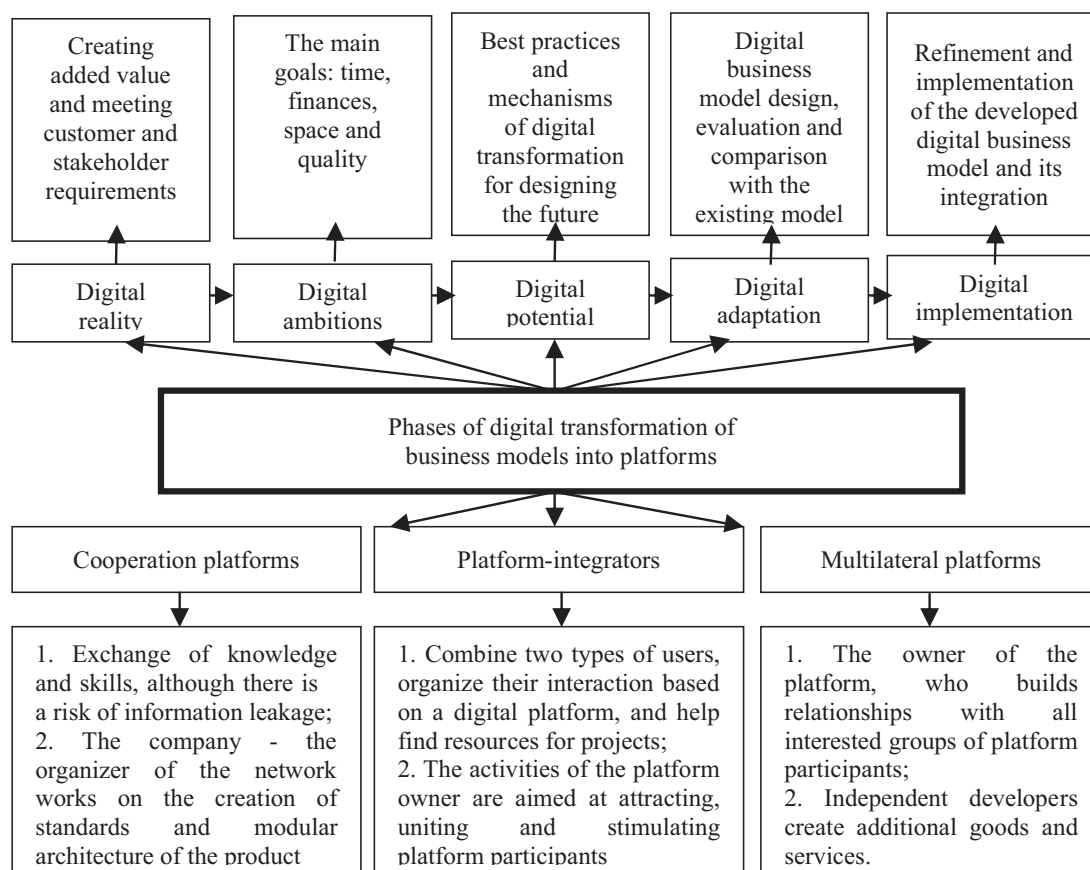


Figure 5. Phases of digital transformation of business models into user interaction platforms
 Rysunek 5. Fazy cyfrowej transformacji modeli biznesowych w platformy interakcji użytkownika
 Source: formed on the basis of [Shalmo et al. 2017, Yurchenko et al. 2022].

A well-known example is the efforts of the global business community over the last 20 years to implement electronic Bills of Lading (eBL), the adoption of which stood at a dismal record of 0.01% as of the end of 2019 [World Customs Organization 2022]. Ideally, international trade should be supported by a common set of globally accepted standards and a legally enabling environment that will enable supply chain participants to share data efficiently across sectors and across borders.

With this in mind, in 2020, the ICC launched the Digital Standards Initiative (DSI) as a cross-industry collaboration to advance digital commerce worldwide. The DSI operates under the guidance of a Governing Council made up of policymakers from governments and international organizations, including the Government of Singapore, the Asian

Development Bank, the World Trade Organization, and the World Customs Organization [International Chamber of Commerce 2022]. The recommendations provided by the latter have been instrumental in ensuring consistency between existing government standards and ongoing private sector efforts to digitize trade and supply chain processes.

We note that expanding international trade is essential for development and poverty reduction to achieve the first UN Sustainable Development Goal of zero poverty. For this reason, it is advisable to reduce trade barriers, especially for the poorest segments of the world's population [UN Ukraine 2023]. One of the most effective ways to sustainably reduce global poverty and promote shared prosperity is to identify ways in which responsible, accelerated, and affordable digitization can facilitate global trade. The relevance of a standardized approach in the use of digital platforms in the interaction of different parties allows for minimizing the number of intermediaries between them and enables a manufacturer or seller to offer their goods to a huge number of buyers regardless of their geographical location, which ensures the regulatory development of cross-border trade in goods based on a single regulatory framework in order to avoid abuses and obstacles. At the same time, varying levels of digital transformation and digitization across digital manifestations, each with its own set of standards and rules on how to digitize and share data, are creating gaps in supply chains and causing redundant regulatory and time control operations.

The concept of Trade 4.0: Digitalization of international trade in Industry 4.0

The digitalization process of international trade has accelerated with Industry 4.0 and has changed the way countries and companies do production and trade. In particular, the volume of international trade and the level of development of countries is gradually increasing with the increase of electronic commerce as a result of digitalization.

In 2020 (the first year of the pandemic), 64% of world trade was realized by developing countries, and 36% by developed countries [Deloitte 2020]. These statistics show that developing countries are important markets for e-commerce. In addition, the fact that the total volume of e-commerce has increased almost 5 times in 8 years shows the importance of digitalization in international trade. With increasing smartphone penetration, mobile communication has become one of the main factors shaping the new generation of commerce. As of 2023, 52% of e-commerce transactions will be made via mobile devices [McKinsey 2020].

Technological trends that blur the lines between offline and online and increase consumer experience and knowledge in many areas are also changing international trade [Deloitte 2020]. Technological trends, such as chatbots (virtual customer representatives), personalized offers, and drone delivery, will significantly affect the near future of businesses, similar to recent trends: lockdown restrictions and military conflicts (Table 1).

Digitalization is at the heart of the Fourth Industrial Revolution, or Industry 4.0, which is ushering in a digital transformation that is revolutionizing manufacturing and the physical world. Industry 4.0 means combining production and operations technologies with advanced digital technologies such as the Internet of Things (IoT), Artificial

Table 1. Technological trends and social challenges of Industry 4.0. in international electronic trade and their effects

Tabela 1. Trendy technologiczne i wyzwania społeczne Przemysłu 4.0. w międzynarodowym handlu elektronicznym, ich skutki

Trend	Effect	Trend	Effect
COVID-19 restrictions	Stimulator of development Internet	Military conflicts	Adapting technical solutions to the needs of wartime and protecting the lives of the population
Augmented and virtual reality	Visualization of the product during online orders	Removal of distinctions between work sites and mobile applications	A symbiosis of the advantages of websites and mobile apps in a single Progressive Web App technology
Visual commerce	Interactive image recognition content	Syndication content	Distribution of identical information to several sites at the same time
Artificial Intelligence	Improving the quality of customer service and increasing personalization through the introduction of chatbots	Product marking and QR codes	Stimulating the sale of goods on the Internet after the initial introduction to them in an offline store
Ecological component of electronic business	Observance of the environmental, economic, and social balance: eco-maps, informing about the composition of products and observing environmental friendliness	Electronic store in the format of drop shipping	Mediation between consumers and producers and/or wholesalers
Activities in the format: search online, buy offline	After receiving complete information about the product, the buyer buys it	Joining social networks to e-commerce	Use of social networks as platforms for selling goods
Development of the taxation system for sales made via the Internet	The appearance of new programmed software solutions for reporting	Restrictions on returns of goods purchased online	An antidote to the pernicious habit of unscrupulous product returns
An increase in the volume of internet retail	Increasing the education level of Internet users, expanding access to broadband and mobile Internet	Personalized communication	Feedback to requests, comments, and suggestions
Popularization of purchases through smartphones	Development of one-click shopping and payment technologies via mobile phones	Contactless payments and trade acquiring	Comfortable and convenient shopping
Double-checking the partner's reliability	Development of an online system based on combined information from the registry	Multichannel	Forming an order for the purchase of goods through various portals chosen by the consumer
Omnichannel	Integration of activities of all sales channels in order to ensure the best customer service	Trade-in goods	The possibility of receiving a significant discount on a new product when exchanging it for an old one
Accumulation of large amounts of data (Big Data) and working with built-in CRM systems	Identification of cause-and-effect relationships regarding stimulating the volume of sales and the increase in the conversion of the store's website	The popularity of messengers (Viber, WhatsApp, Skype, Telegram, social network messengers) and mobile search technologies	Acceleration of decisions on the purchase of goods

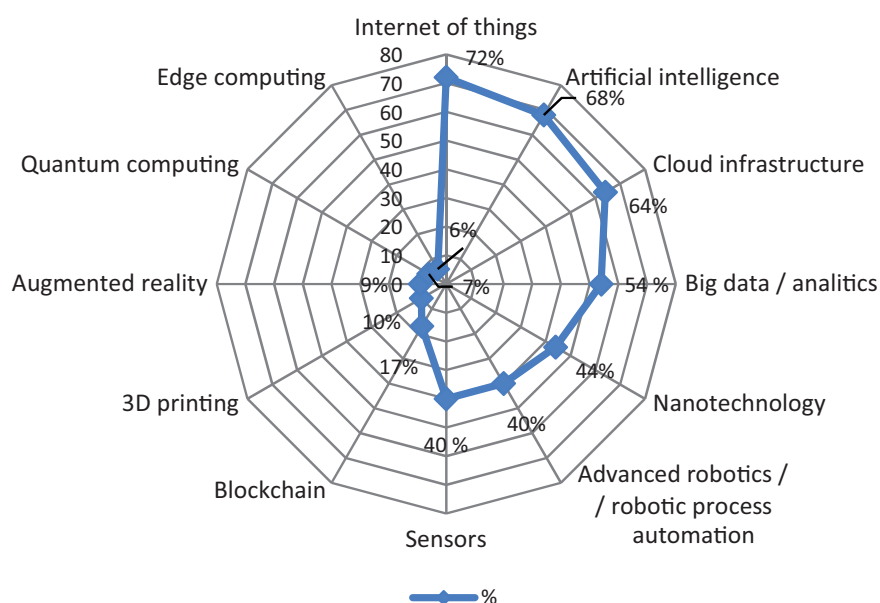
Source: [McKinsey 2020].

Intelligence (AI), robots, drones, autonomous vehicles, 3D printing, cloud computing, nanotechnology, etc. These technologies can transmit, analyze, and act on information, enabling organizations, consumers, and society to be more agile and responsive and make smarter data-driven decisions [Dumanska et al. 2021].

The digitalization of commerce in Industry 4.0 – the application of advanced digital technologies in production and operational techniques – is revolutionizing the way the world produces, transports, and sells goods. An annual survey of more than 2,000 executives from 19 countries explored the intersection of readiness and responsibility to see how leaders are balancing this transition to Industry 4.0 [Deloitte 2020].

The survey results (Fig. 6) clearly show that these technologies, including the IoT, AI, and cloud infrastructure, are expected to have a significant impact on how businesses transact and participate in global trade.

Figure 6. Advanced Industry 4.0 technologies that have had a profound impact on the development of Trade 4.0, in %.



Rysunek 6. Zaawansowane technologie Przemysłu 4.0, które miały głęboki wpływ na rozwój Handlu 4.0, w %.

Source: [Deloitte 2020].

Below, McKinsey provides specific examples of the role that the government can play [McKinsey 2020]:

1. Government as an intermediary. As a facilitator of international trade, the government facilitates the interaction between the private and commercial sectors to import and export products at ports of entry; it also promotes the interests of domestic companies abroad. In its role as an intermediary, the government assesses, assigns, and collects trade tariffs and duties. As cross-border trade becomes increasingly complex and voluminous, government agencies will have an opportunity to strengthen their role in this area, accurately collect duties, and optimize trade facilitation.

2. Thus, Industry 4.0 has crossed borders and become Trade 4.0. To mitigate the risks and reap the benefits, the government must adapt its role as a facilitator, implementer, and negotiator of Trade 4.0 at the intersection of digitalization, globalization, and national interest.
3. Government as law enforcement. In order to enforce laws and protect national and economic security, governments work to ensure that global supply chains are safe, secure, legal, and fair.

Table 2. Manifestations of Trade 4.0. in additive manufacturing, the use of autonomous vehicles, and e-commerce

Tabela 2. Manifestacje Handlu 4.0. w produkcji addytywnej, wykorzystaniu pojazdów autonomicznych i handlu elektronicznym

Manifestations of Trade 4.0	Challenge for the government	Trade facilitation	Trade assurance	Commercial talks
Additive manufacturing (3D printing)	Additive manufacturing has evolved from a prototyping tool to a catalyst for better quality assurance and interoperability in an ever-changing world.	Trade leaders must determine how to deal with the cross-border flow of intellectual property (3D models), which, in some cases, replaces the flow of goods.	Leaders must determine how to authenticate goods produced through additive manufacturing to protect intellectual property rights.	Trade policy leaders should review the rules of international trade formulated in multilateral trade agreements and international organizations to adapt tariff rates and trade preferences to reflect increasingly localized modes of production.
Autonomous vehicles	Artificial intelligence can use autonomous trucks across borders, transporting goods at a lower cost without drivers.	Trade leaders must find ways to deal with more predictable, automated supply chains and inspect goods aboard the unmanned trucks that appear at borders.	Leaders should consider how government and industry can work together to enable innovation at borders and ensure supply chain security for optimal efficiency, even as such partnerships begin.	With fewer physical goods crossing borders and more digital objects, trade leaders must face the challenges of negotiating customs controls and tax revenues.
Electronic commerce	E-commerce products are usually shipped directly to consumers, and products are increasingly shipped around the world in smaller packages that are subject to less regulation.	As global thresholds (the total value of a shipment below which little or no tax is levied) rise, making it easier to ship low-value goods, trade leaders can facilitate the efficient flow of hundreds of millions of small parcels, replacing traditional cargo that was previously transported in bulk across borders in containers.	Trade managers must effectively detect threats in small parcel supply chains where it is difficult to identify opioids and other drugs, weapons, counterfeit products and threats to consumer safety that are shipped in small quantities directly to individual consumers.	Trade policy revolves around tariffs and duty rates applied to bulk goods, and leaders must determine how to apply trade policy to goods that are increasingly shipped in small packages and quantities without paying duty.

Source: [Deloitte 2020].

4. Government as a negotiator. Governments shape trade agreements, resolve trade-related disputes, and represent the best interests of their economies in global trade forums. These agreements are usually incredibly complex and sophisticated, taking considerable time to complete. The process becomes even more complex when it involves multilateral negotiations under the auspices of the World Trade Organization (WTO) and its more than 150 members.

While governments around the world are still figuring out their roles as facilitators, implementers, and negotiators in international trade, there are examples of Trade 4.0 that are already in place [McKinsey 2020]. They are visible in the use of additive manufacturing, autonomous vehicles, and e-commerce in the production, transportation, and sale of goods, respectively.

Table 2 presents the manifestations of Trade 4.0 in additive manufacturing, autonomous vehicles, and e-commerce, taking into account the challenges of national governments and their roles.

Thus, the digitalization of global trade in Industry 4.0 has triggered Trade 4.0, creating opportunities for change and empowerment of governments. Trade 4.0 has been amplified by the COVID-19 pandemic, which has pushed suppliers and forced organizations to shift almost instantly from decades-old production chains to digital, modular value chains. The result is a dramatic change in the supply chain and trade in general. Trade 4.0 is also uncontrollably changing market dynamics and shape in response to macroeconomic uncertainty.

These changes make it more difficult for government agencies to track origin, transshipment, and illicit activities (e.g., forced labor) along the supply chain and leave loopholes for potential cyber intrusions at every point in the disaggregated supply chain. In the absence of a sustained commitment from government agencies to take advantage of the data benefits of Trade 4.0, governments and their citizens could be at risk. Malicious actors are often the first to adopt new technologies and can potentially use them to undermine trade laws.

The emergence of e-commerce retail logistics (e-logistics) as a causal influence of the digitalization of international trade

The significant growth of retail and e-commerce platforms has significantly accelerated the retail logistics business globally. In addition, the growing trend of online shopping is one of the other major factors driving the demand for retail logistics. Online shopping has increased the demand for easy and fast delivery and a selection of products chosen by customers, which is driving the demand for logistics both at home and abroad, and the introduction of Industry 4.0 trends has slowly transformed it into e-logistics [Dumanska et al. 2021].

The sudden outbreak of COVID-19 in early 2020 caused losses for various industries from the lockdown scenario across the country, while retail logistics benefited from a significant growth effect. This has pushed the trend towards online shopping due to social isolation, which in turn has driven the market growth. The global retail logistics market size was estimated at USD 184.5 billion in 2020 and is projected to reach approximately USD 465 billion by 2030. It is expected to grow at a CAGR of 12.4% from 2021 to 2030 [MarketStatsNews 2022].

The supply chain captured the largest market revenue share of 35% in 2020 and continued its dominance in 2023. The significant growth of the segment is mainly attributed to its advantages, such as on-time delivery, optimization of omnichannel operations, personalization of picking and order fulfillment, and effective management of customer returns [MarketStatsNews 2022]. The supply chain also provides direct-to-store and direct-to-customer delivery, which significantly reduces delivery times and improves warehouse efficiency, as well as optimizes inventory. The supply chain segment is also registering a rapid growth rate of approximately 13% due to the penetration of cloud and data analytics solutions in supply chain management. On the contrary, the reverse logistics and liquidation segment is registering significant growth during the forecast period due to the remarkable growth of e-commerce platforms along with the increasing number of e-shoppers globally. Today, the consumer prefers easy exchange and return of any product. This is driving retailers to make the process of returning online products easy and convenient for their customers.

The automotive segment accounted for a major revenue share of approximately 52% in 2020, and is projected to follow the same trend in the coming years [Rodrigue et al. 2020]. The impressive growth of the segment is mainly attributed to the increasing demand for long-distance road transportation, mainly in domestic regions. In addition, the easy and fast delivery and return options available are another important factor contributing to the growth of the segment, as well as various government initiatives to improve the condition of national and international highways. In addition, the government is also focusing on continuous monitoring of highway conditions through cognitive analytics and the IoT. All these factors together support the growth of the segment.

In terms of geography, Asia Pacific is the leader in the global retail logistics market, holding a revenue share of approximately 26% in 2020 and it maintained its dominance in 2023. This is mainly attributed to significant IT developments in logistics infrastructure, especially in emerging countries such as China, India, South Korea, Australia, Singapore, ASEAN countries, and many others. However, North America and Europe are other significant sources of profit in the global retail logistics market due to the notable growth of the food and beverage industry for online delivery. In 2019, the UK food delivery market was worth USD 10 billion, recording a 39% growth over the past three years. Similarly, the US online food delivery market was valued at USD 26.5 billion in 2020 and is expected to grow by 11% during the forecast period [Rodrigue et al. 2020]. The above statistics show a significant contribution to the growth of retail logistics in the North American and European markets.

The emergence of e-commerce has changed the relationship between customers and retailers (e-retailers). Currently, their interaction looks like this (Fig. 7):

Logistics is being influenced by e-commerce, especially its business-to-consumer (B2C) segment. In a conventional retail network, customers are not responsible for purchasing their goods from retailers. They take care of the last mile in the distribution of goods by driving to the store and returning with their own purchases. For large purchases such as appliances and furniture, retailers offer local deliveries for their customers [McKinsey 2020].

Therefore, brick-and-mortar retailers have to incur significant costs to maintain available locations, which defines their market area (customer base). These costs,

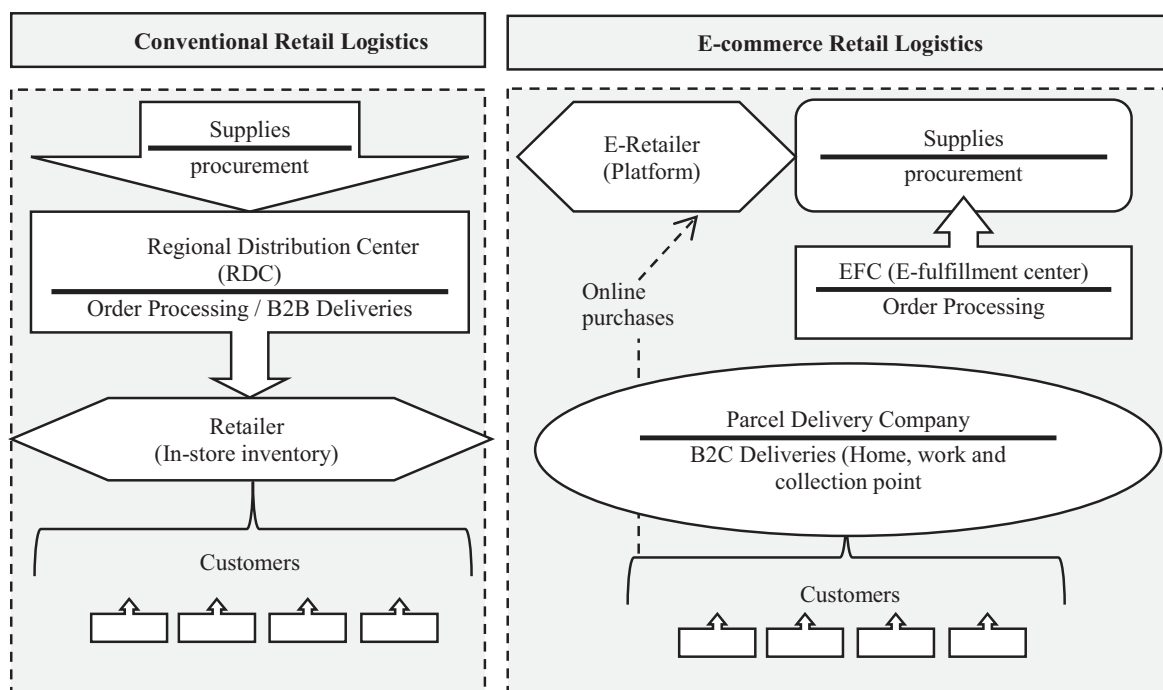


Figure 7. Impact of e-commerce on retail logistics
 Rysunek 7. Wpływ e-commerce na Logistykę Detaliczną
 Source: [Rodrigue et al. 2020].

such as store labor and rent, are reflected in the final cost of the product, which is borne by the consumer. The retailer maintains a level of in-store inventory (in the form of stocked shelves), which is replenished by regional distribution centers (RDCs), where goods from a wide range of suppliers are stored. Many retailers have developed sophisticated logistics strategies that involve global procurement and inventory management, as well as order processing in their RDCs. The most efficient retailers have an extensive network of stores and distribution centers, some of which operate on a cross-docking basis, ensuring that stores are constantly replenished. In addition, in-store goods must be received, unpacked, and placed on store shelves, adding labor and costs. In some cases, entirely new e-retailers have emerged, but conventional retailers have also adopted an online strategy. In the distribution system, the new e-retailer is both a retailer and a distribution center, a purpose served by electronic fulfillment centers (EFCs). Delivery is now the responsibility of the e-retailer (B2C delivery), which is a departure from standard retail where the customer is responsible for the goods they buy [Rodrigue et al. 2020].

Security parameters in the digitalization of trade and logistics in the context of cyberattacks during hybrid wars

In the post-pandemic period and in times of macroeconomic uncertainty in hybrid warfare, most international trade and logistics companies have become fully embedded in advanced technologies, primarily to increase productivity, meet customer demands, and

reduce costs. However, many of these companies do not understand the cyber security risks associated with these technologies and, therefore, lack the resilience to withstand industrial espionage or a cyberattack with their own cyber security parameters.

The results of a cyber security breach lead to significant losses for an enterprise of any size. The average estimate of damage from a data breach in the United States is \$9.4 million per day, and cyberattacks cost \$17,700 per minute [BDO 2022]. It is more important than ever for companies to protect their sensitive information from phishing attacks and data breaches. Cyber security risks must be assessed and addressed to preserve business integrity in the face of digital transformation.

Ensuring compliance with cyber security parameters is also a requirement for the functioning of state resources. An example of this is the case of attacks on the information systems of private enterprises and state institutions of Ukraine by Russia, which were recorded during mass protests in 2013 and became the first conflict in cyberspace, when a successful attack on the power system was carried out, disabling it. According to the U.S. Presidential Administration, the June 2017 hacker attack on Ukraine by Russia using the NotPetya virus was the largest known hacker attack [Pearson, Bing 2022].

Given the dynamic nature of new security threats, cyber security itself must stay one step ahead of cybercriminals and their attacks [Guseva 2022]. Today, almost everything that businesses and governments do takes place online, and as a result, cyber security efforts must cover a wide range of activities.

In Table 3, we summarize the key types of cyberattacks in the international trade and logistics segment and offer solutions to counter them.

Table 3. Cyberattacks in the segments of international trade and logistics: solutions and countermeasures

Tabela 3. Cyberataki w segmencie handlu międzynarodowego i logistyki, rozwiązania i przeciwdziałania

Cyberattacks	Countermeasures	Actions and activities
Phishing and smishing	User training	Employees must be able to recognize phishing attempts and understand that they should not respond to any communication requests. Organizations should encourage employees to report any suspicious activity so that additional security measures can be taken if necessary.
	Intrusion detection systems and spam filters	These existing systems have many options to help and block unauthorized emails from reaching the intended recipient.
	Reliable authentication tools	Multi-factor authentication and strong, regularly updated passwords can slow down would-be attackers.
Malicious software	Security software	Advanced, up-to-date anti-virus and anti-malware software is a must for employee devices.
	System updates	Malware attacks change every day, so make sure your system is always up-to-date, capable of handling new challenges, and able to protect your organization from new threats.
	Network security	Check for malware. To mitigate the threat as much as possible, security must be fully updated.
	Safety training for employees	Data breaches are often the result of human error. Educating your employees about malware and how it gets into your computer systems will help them understand the risks and recognize malware.

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Cyberattacks	Countermeasures	Actions and activities
	Modern systems	Hackers are quick to find holes in older systems, but cyber security improvements are introduced frequently and will keep you one step ahead of hackers.
	Separate backup systems	Back up your data often and don't disconnect it from the network. Attackers have more trouble accessing them if they are secured separately.
Ransomware	Proper cyber hygiene	Create an inventory of all devices connected to your network that downloaded the malware threat.
	Virtual Private Network (VPN) services	Virtual private networks are weak when connected to public Wi-Fi networks and data will be at risk.
	Incident response plans	Plan ahead to try to ensure business continuity in the event of an attack. Review your incident response and identify weak points so you can make adjustments and prepare for a real ransomware attack.
Compromise of corporate email	Strong passwords	Passwords should be changed regularly and employees should monitor what information they share on social media. Simple passwords include pet names and birth dates, making them easy to crack.
	Effective software	Firewalls and anti-virus and anti-malware software make it difficult for cybercriminals to target a victim.
	Verification processes	Telephone or in-person verification is essential when a payment request is submitted, any changes in professional listing details are made, a payment process changes, or the recipient address changes. Carefully check all email addresses for minor discrepancies.
	Multi-factor authentication (MFA)	Prevent hackers from gaining access unless they also have a phone or authentication app to verify their email address.
Insider threats due to loss of privacy	Changes in culture	A strong security culture is vital to mitigating any damage caused by insider threats. Employees will be less prone to random threats and will be more aware of the negative behavior of other colleagues.
	Protection of critical assets	In many cases, several workers must be available. Take digital security measures to protect your own assets and customer data. Whenever an employee leaves the company, take appropriate steps to remove their access to sensitive data as soon as possible.
	Behavior tracking	Increase transparency in your organization so that it is clear what employees are doing. Behavioral analytics and machine learning provide insights into a set of common behaviors across an organization, making it easier to investigate unusual activity.
Inadvertent disclosure	Limited access	Consider the number of employees who need access to your database and limit access to those who don't.
	Anti-leakage and activity monitoring software	The addition of this software provides several solutions to combat the inadvertent disclosure of information and allows an organization to control its data and any associated risks.
Storage exploration	Encryption	The cloud environment service encrypts information in the cloud and on your computers, ensuring that unauthorized persons do not have access to private information.
	Reliable authentication	Multi-factor authentication and strong passwords that are updated regularly can slow down attackers.
	Selection of information	Both organizations and individuals should refrain from storing sensitive information in the cloud (e.g., private bank details).
	Immediate updates	If your cloud system requires an update, install it again. ISPs often roll out updates to fix security flaws.

cont. tab. 3

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Cyberattacks	Countermeasures	Actions and activities
Zero-day attacks	Firewalls	Make sure firewalls are configured correctly or transaction integrity will be lost.
	Effective intrusion prevention software	Firewalls and antivirus programs make it difficult for cybercriminals to select victims.
	Instant updates	Developers often fix weaknesses in their security systems with updates, so if you choose not to install them now, your sensitive information is at risk of a zero-day attack.
	User training	Social engineering centers on fraudulent activities against members of your organization. Make sure team members are aware of the latest random scams, learn about suspicious incidents, and include them.
	Using a VPN	A VPN can prevent your network from being intercepted on mobile or other devices.
Social engineering	Monitoring procedures:	Monitoring can help mitigate the effects of social engineering.
Data leak	Threat management	A dedicated threat management platform allows companies to monitor data access and usage.
	Monitoring of user activity to prevent data leakage	Monitoring of user behavior allows you to track unauthorized data movement and precisely open detected data sources.
	Firewalls	The installation of firewalls is an integral part of blocking unauthorized access to confidential information.

Source: [Wallarm 2022].

Thus, the digital transformation of international trade and logistics, based on remote work and Internet technologies, creates not only benefits, but also a range of dangers in the field of possible cyberattacks. The modern threat environment is constantly changing, adapting to countermeasures and continuing to successfully carry out various missions, ranging from identity theft to criminal and national corporate espionage and hybrid warfare, so the identification of threats and their counteraction should be taken into account at the stage of implementing any digitalization processes for international trade and logistics entities to prevent losses and damages in supply and sales.

Discussion

The evidence presented regarding the catalytic effect of such crisis situations in the economy as pandemics and military conflicts on the digitalization of international trade and logistics contradicts research in the field of business internationalization [Feliciano-Cestero et al. 2023], which determines the role of interaction between companies of different countries as a factor in the development of digitalization and diffusion of IT solutions. Studies of digitalization strategies of individual European countries [European Commission 2023] indicate progressiveness and systematicity in their approaches. Instead, the actual state of digitalization of many economies in the pre-crisis period was declarative and fragmentary at the level of individual public services or the introduction of digital products by individual

companies. This changed with the deepening of crisis phenomena and acquired a global character with the service sectors' transition to the online segment.

Other literary sources strengthen the following conclusions regarding the primary digitization of trade for remote service, which, from the positive practice of the pandemic period, became the basis for the development of Trade 4.0 and the implementation of IT solutions of electronic commerce in the activities of logistics companies, including e-commerce retail logistics and military logistics.

The presented research is limited by practicalities and the uncertainty from the negative consequences of the digital transformation of international trade and logistics, which are insufficiently researched in light of the development of new forms of hybrid military conflicts and the emergence of new forms of cyberattacks on the information bases of private companies and states, which in the case of active development can be a deterrent to digitization and further development of the IT segment.

Conclusion

The results of the conducted research give reasons to claim that the COVID-19 pandemic has significantly affected the digital transformation of international trade and logistics through the development of remote work and the introduction of IT technologies not only in business, but also in the activities of the government and the daily life of citizens. The analysis of changes during the period of lockdown restrictions and the post-pandemic period demonstrated the capitalization of companies engaged in the IT sector and the production of computers and gadgets in view of the increase in the need for their use. It was revealed that the course of military conflicts presents the achievements of the digital transformation of international trade and logistics from the positive side, which were successfully adapted to the needs of life protection in the conditions of armed aggression and the spheres of the new social reality with the implementation of the achievements of Industry 4.0.

It has been established that the gaps in the digital transformation of business today are related to the differentiation of the development phases of the digital transformation of companies and the lack of a single standardized approach in the world regarding the functioning of a single digital platform for the implementation of IT changes in international trade and logistics. As a result, each actor makes digital changes independently rather than in symbiosis, leading to the emergence of several digital manifestations, each with its own set of standards and rules for how to digitize and share data.

The connection and influence of Industry 4.0 on the reformatting of international trade into the Trade 4.0 model is substantiated. Trade 4.0 was found to have intensified due to the COVID-19 pandemic, which pushed suppliers and forced organizations to move from decades-old production chains to digital, modular value chains almost instantaneously. The result is dramatic changes in the supply chain and trade as a whole. Trade 4.0 uncontrollably changes market dynamics and shape in response to macroeconomic uncertainty. To mitigate the risks and reap the benefits, the government must adapt its role as a facilitator, implementer, and negotiator of Trade 4.0 at the intersection of digitalization, globalization, and national interests.

It has been established that the emergence of e-commerce retail logistics (e-logistics) has a causal effect on the digitization of international trade. The advent of e-commerce has changed the relationship between customers and retailers (e-retailers). Logistics is most affected by the business-to-consumer (B2C) segment of e-commerce, with delivery now being the responsibility of the e-retailer (B2C delivery), a departure from standard retail, where the customer is responsible for the goods that they buy.

The digital transformation of international trade and logistics, based on the technologies of remote work and the Internet, creates not only advantages, but also a circle of dangers in the field of possible cyberattacks. Among the possibilities in the different phases of the digital transformation of international trade and logistics are the following: phishing and smishing, malware, ransomware, compromise of corporate email, insider threats due to loss of privacy, inadvertent disclosure, storage reconnaissance, zero-day attacks, social engineering, and data leaks. The identification of these threats and their countermeasures should be taken into account at the beginning of implementing any digitization process of international trade and logistics entities in order to prevent losses and damages in supply and sales from the actions of cybercriminals engaged in espionage, cyber wars or other forms of illegal activity in the field of IT.

Further research will be aimed at identifying and hedging risks from the negative consequences of the digital transformation of international trade and logistics at the level of state interests and developing the parameters of their protection in the field of cyber security in the course of declared and hidden hybrid wars and conflicts.

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