Theoretical and Practical Research in Economic Fields

Special Issue

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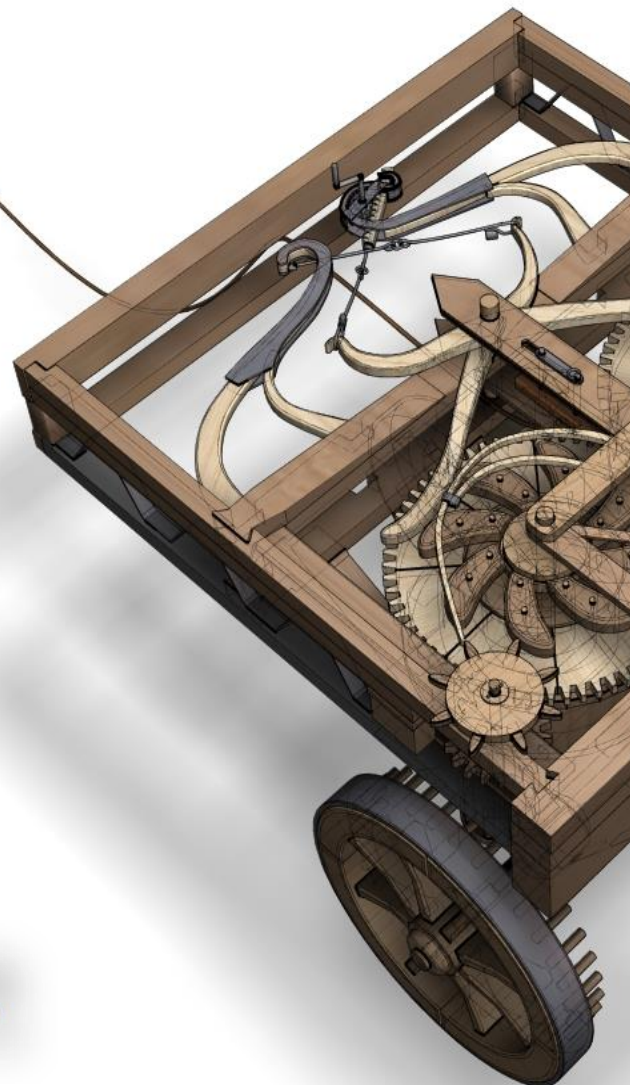
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This Special Issue was created at the request of a group of researchers from Ukraine. It is a response to the challenging situation of Ukrainian scholars due to the Russian invasion as well as the growing demand for knowledge on Ukrainian issues.

We would like to express our endless thank to our colleagues, scholars from Ukraine who are working amid the war on topics that are important for all. Also, we thank all our international authors for their valuable contributions to this Issue.

Deadline for submission of proposals: 10th August 2024

Expected publication date: September 2024

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Modelling the Impact of the Digital Economy on the Development of the Logistics Industry. Study Case of Henan Province

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Abstract: The purpose of the study is to model and analyse the impact of the digital economy on the development of the logistics industry in Henan province. To achieve this goal, the following methods were used: historical analysis to determine the stages of digitalisation of logistics, statistical analysis to assess the dynamics of gross domestic product (GDP) by economic sectors, system analysis and analysis of strengths, weaknesses, opportunities and threats to investigate the impact of individual elements of the digital economy on the logistics sector, and regression analysis to model the relationships between digitalisation and economic indicators of the logistics industry in Henan province. The main results of the study were: identification and analysis of key stages in the development of the logistics industry in China; determination of structural changes in the GDP of Henan province and their correlation with trends in the digital economy; development of a regression model demonstrating the dependence of economic growth in the tertiary sector of the economy, including the logistics industry, on the advancement of digital technologies. The study confirmed the hypothesis of a significant impact of the digital economy on the logistics sector of Henan province, which is reflected in quantitative estimates and confirmed by statistical tests.

Introduction

In today's world, where the boundaries between physical and digital spaces are blurring, the digital economy is becoming a key driver of global economic processes, influencing all spheres, including logistics. The development of digital technologies is redefining approaches to supply chain management, optimising traffic flows and managing customer expectations (Horoshkova *et al.* 2023; Lipych *et al.* 2024).

The relevance of the study is conditioned by the fact that understanding the mechanisms of the digital economy's impact on the logistics industry of Henan province is a prerequisite for effective planning and informed management decisions at the regional level. The growth of the digital economy in China is changing the economic landscape, and the scale of the impact determines the need to examine its real impact on logistics processes. Thus, C. Wang *et al.* (2023), based on panel data, investigated the relationship between the digital economy and logistics efficiency in the context of China's modern industrial system. The innovative system of evaluation indices used by the researchers confirmed the positive impact of the digital economy on improving logistics efficiency, and also allowed to substantiate its role as a catalyst for progress in the modern industrial sector. The study also notes the crucial role of urbanisation and a favourable general economic environment in improving logistics efficiency, which highlights the diversity of factors contributing to improving the situation in this area (Buil *et al.* 2015).

W. Zhang *et al.* (2022) examine the development of integration between the digital economy and the logistics industry in China in the period from 2007 to 2017 using input-output models and social network analysis. The main findings indicate significant growth rates of integration, especially in more developed regions; the authors emphasise the differences between the northern and southern regions of China. W. Gan *et al.* (2022) substantiate the need for China's logistics industry to achieve 'green' development through digital transformation, considering the interaction between the logistics industry, digitalisation and environmental development in four provinces: Fujian, Jiangxi, Guizhou, and Henan.

The impact of digitalisation on logistics efficiency in the context of Industry 4.0 is analysed by A. Moldabekova *et al.* (2021). The study examines the challenges and opportunities associated with the Fourth Industrial Revolution, in particular, in the field of supply chain management, transport, and environmental sustainability. The researchers (Kondratenko *et al.* 2014; Kredina *et al.* 2022) emphasise that the introduction of innovative digital technologies characteristic of Industry 4.0 not only increases the responsiveness to fluctuations in demand and capacity constraints, but also significantly reduces the lead time, improves inventory control.

M. Brzozowska *et al.* (2022) investigate the impact of the digital revolution on modern societies, emphasising its role in the establishment of Society 5.0 and Economy 5.0, where the boundaries between digital and biological are increasingly blurred. The digital revolution, according to the researchers, has significantly changed the functioning of companies and economies due to the development of big data, cloud computing, mobile communications, automation and robotics. The paper notes that technological changes have led to the transformation and integration of vertical and horizontal value chains, as a result of which consumers play a crucial role in the digital transformation of enterprises. The researchers also highlight the growing demand for employees who are able to navigate the digital landscape, especially in the logistics industry, which by its nature is associated with innovative technical solutions and closely interacts with the digital economy.

Thus, noting the relevance of research related to identifying the interrelationships between the development of the digital economy and logistics in China and its provinces, and the role of digitalisation as a driver of economic development, the lack of studies on the problems considered in the example of Henan province with a developed industrial and commercial infrastructure is of interest from the standpoint science and actualises the potential of research to take advantage of the opportunities it opens up for the economic development of the province. In this context, Henan province, which occupies a strategically important position in the economic structure of China, is the region were studying the impact of digitalisation on logistics is appropriate and justified.

The purpose of the study is to analyse and model the impact of the digital economy on the development of the logistics industry in Henan province. The tasks to be solved include:

▪ analysis of structural changes in the gross domestic product (GDP) of Henan province with an emphasis on the tertiary sector, including the logistics industry;

▪ comprehensive analysis of the impact of individual elements of the digital economy on the logistics industry.

1. Materials and Methods

A set of methods was used in the research, which helped to achieve the set goal. Including:

▪ historical analysis – to study past and current data and identify key trends and changes in the logistics industry;

▪ qualitative content analysis – to investigate changes in the logistics industry under the influence of digitalisation;

▪ system and SWOT analysis – in the process of researching the impact of key elements of the digital economy on the logistics sector;

▪ statistical analysis – in the process of using descriptive statistics methods to analyse changes in the structure of GDP;

▪ comparative analysis – when comparing the shares of different sectors of the provincial economy and determining sectoral shifts;

▪ time series analysis is used to assess the dynamics of GDP and the volume of the digital economy, to identify trends in economic development.

In the process of building a mathematical model of the impact of digitalisation on the logistics industry of Henan province:

▪ regression analysis is used to assess the relationship between the variables under study. The estimated regression equation (1) will look like:

$$Y = \beta_0 + \beta_1 X + \varepsilon, \tag{1}$$

where: Y – dependent variable; X – independent variable; β0 – constant term; it represents the value of the dependent variable (Y) when the independent variable is zero. Serves as the base value that the model uses to account for factors not included in the equation; β1 – coefficient for X, reflecting the influence of the variable on the dependent variable; ε – random error;

▪ correlation analysis is used to determine the degree of connection between the development of the digital economy and the indicators of the logistics industry. The interpretation of the correlation coefficient depends on the field of study and the context in which it is applied. In the course of the study, the strength of the correlation relationship between the indicators and the interpretation of the correlation coefficient was estimated based on the gradation (Table 1).

Table 1. Data for interpreting the value of the correlation coefficient

Size of the correlation coefficient (r)	Interpretation of the correlation coefficient value
$0.9 \leq |r| \leq 1$	Very high positive (negative) correlation
$0.7 \leq |r| \leq 0.89999$	High positive (negative) correlation
$0.5 \leq |r| \leq 0.69999$	Moderate positive (negative) correlation
$0.3 \leq |r| \leq 0.49999$	Low positive (negative) correlation
$0 \leq |r| \leq 0.29999$	Insignificant correlation

Source: compiled by the authors based on M.M. Mukaka (2012).

▪ the least squares method (LSM) is used in the process of constructing a regression model estimating the impact of the digital economy on the GDP of the tertiary sector; to determine the coefficients of the regression equation in order to minimise the sum of the squares of the differences between the observed and predicted values of the dependent variable;

▪ assessment of statistical significance of coefficients – in the process of conducting t-tests to check hypotheses about the significance of regression coefficients and estimation of p-values to determine whether the coefficient estimates are statistically significant;

▪ analysis of the adequacy and reliability of the regression model – in the process of performing checks for the presence of autocorrelation, heteroscedasticity, and multicollinearity, and the overall adequacy of the model.

▪ MS Excel software suite was used to build the mathematical model. Thus, the following were calculated: linear correlation coefficient RYX, Student's t-test (tnab, tcrit, tβ0, tβ1), absolute approximation error A, Fisher's F-criterion, coefficient of determination R2, coefficient of autocorrelation r1, Spearman rank correlation coefficient, RS-criterion.

The methods used allow comprehensively approaching the analysis of the problem, providing a comprehensive study of the interaction between the digital economy and the development of the logistics industry, which is key to achieving the goals of the study.

The study used materials and data characterising the state of the digital economy and the logistics industry in China, including Henan province: Ministry of Commerce of the People's Republic of China (2023); National Bureau of Statistics of China (2023); Hunan Government Work Report 2022.

2. Results

2.1. Changes in China's Logistics Industry Under the Influence of Digitalisation: From Theory to Practice

Examining the data to identify key trends and changes in China's logistics industry has highlighted key stages of logistics development depending on the understanding of the current state and prospects of digitalisation in logistics. Thus, according to research on the development of the digital economy (Tao et al 2022; Zhang and Chen 2019; Wu and Yu 2022) and the impact of digitalisation on logistics (Wang *et al.* 2023; Zhang et al 2022), the main stages of changes taking place in China's logistics industry under the influence of the digital economy were highlighted (Figure 1).

Figure 1. Stages of changes in China's logistics industry under the influence of the digital economy
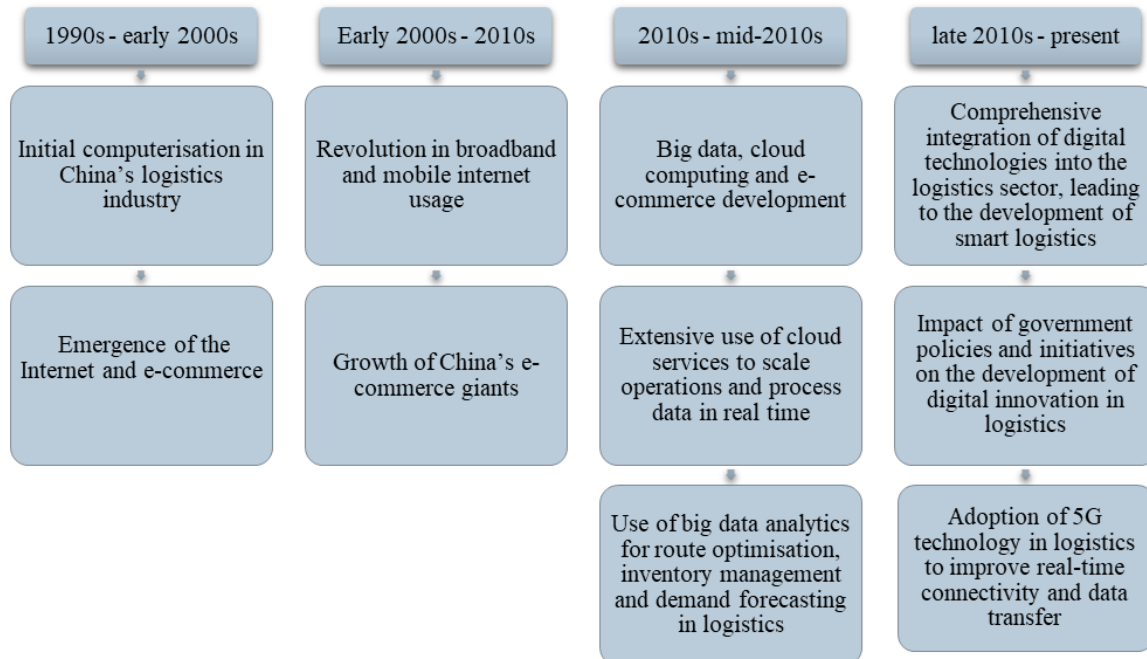
Source: compiled by the authors based on T. Zhao *et al.* (2022).

The periodization shown in Figure 1 highlights that the digital economy in China not only has a direct impact on logistics operations but also constantly shapes the strategic direction of their development. Understanding these stages is important for assessing the current state of the logistics industry and its future potential as part of further digital transformation. Certain elements of the digital economy have a significant impact on the logistics industry, however, a balanced approach is needed in the study of digitalisation, since its results, in addition to opportunities for growth, can be potential carriers of risks and challenges. Table 2 systematises the possible consequences of the impact of elements of the digital economy on logistics.

The considered consequences highlight the complex relationship between the digital economy and the logistics industry, demonstrating both the opportunities and challenges that arise as a result of digital transformation. The applied integrated approach allows us to conclude that limiting consideration of the consequences of the development of the digital economy to exclusively positive manifestations limit the possibility of using the results obtained due to the lack of preventive measures aimed at minimising possible negative impacts (Trushaj 2023; Aubakirova 2024). Thus, Table 2 provides an analysis of how various components of the digital economy affect the logistics industry, which confirms the complexity and multidimensional manifestations of this influence, emphasising both innovative opportunities and challenges faced by the industry in the era of digital transformation.

Table 2. Impact of individual elements of the digital economy on the logistics industry

Components of digital economy	Impact on logistics industry	
	Positive effects	Negative effects
Digital infrastructure	The improvement of the digital infrastructure contributes to the improvement of interaction between various participants in logistics activities, which leads to increased efficiency of coordination and data exchange. Modern networks allow cargo tracking in real time, increasing transparency and reliability of logistics operations.	Reliance on digital infrastructure can make logistics vulnerable to technological disruptions and disruptions.
E-commerce	E-commerce has expanded the scope of activities of logistics companies, increasing the volume of transportation and delivery. The growth of e-commerce has led to the emergence of innovative logistics solutions in the field of delivery.	The demand for faster and more efficient delivery puts pressure on logistics networks, which can lead to overloading and inefficiency.
Digital services and content	Digital services such as cloud-based logistics management systems increase operational efficiency through route optimisation and inventory management.	The integration of various digital services can complicate logistics management, requiring complex coordination and technical know-how.
Mobile and Internet of Thing (IoT) technologies	IoT devices allow better monitoring of the condition of the cargo and the operation of the vehicle, improving the quality of control and maintenance. Mobile technologies allow for better customer interaction and real-time shipment information.	The increasing use of IoT devices raises concerns about data security and privacy in logistics operations.
Big data and analytics	Big data analytics helps optimise routes, predict maintenance needs, and manage inventory more efficiently. Predictive analytics helps to better predict demand, reduce losses, and improve resource allocation.	The need to manage and analyse large amounts of data requires complex systems and qualified personnel.
Cybersecurity	Robust cybersecurity measures are necessary to protect logistics data and digital infrastructure from cyber-attacks.	Implementing and maintaining robust cybersecurity measures can be expensive and difficult.
Digital payments	Digital payments help accelerate and improve the efficiency of financial transactions in the logistics industry.	Digital payment systems can be susceptible to fraud and cyber-attacks, which requires reliable security measures.
Digital talents and education	A skilled workforce proficient in digital technologies can contribute to innovation and improve logistics efficiency.	The rapid development of technology can lead to a shortage of qualified personnel with the necessary digital skills.
Regulatory framework and policy	An effective regulatory framework ensures standardisation and compliance of digital practices in logistics.	Navigating complex and evolving digital regulatory documents can be challenging for logistics companies.
Artificial intelligence and automation	Artificial intelligence and automation can significantly improve efficiency, reduce errors and reduce logistics costs. AI algorithms can predict potential problems and proactively optimise logistics processes.	Automation can lead to the displacement of traditional jobs in the logistics sector.

Source: compiled by the authors based on A. Moldabekova *et al.* (2021), M. Brzozowska *et al.* (2022), W. Zhang *et al.* (2022), Y. Kayikci (2018), N.N. Nordin *et al.* (2023), D.M. Herold *et al.* (2021).

Having assessed the qualitative consequences of the impact of the digital economy components, the study considers the dynamics of the Chinese digital economy market in value terms (Figure 2).

Figure 2. Volume of China's digital economy in the period from 2005 to 2022
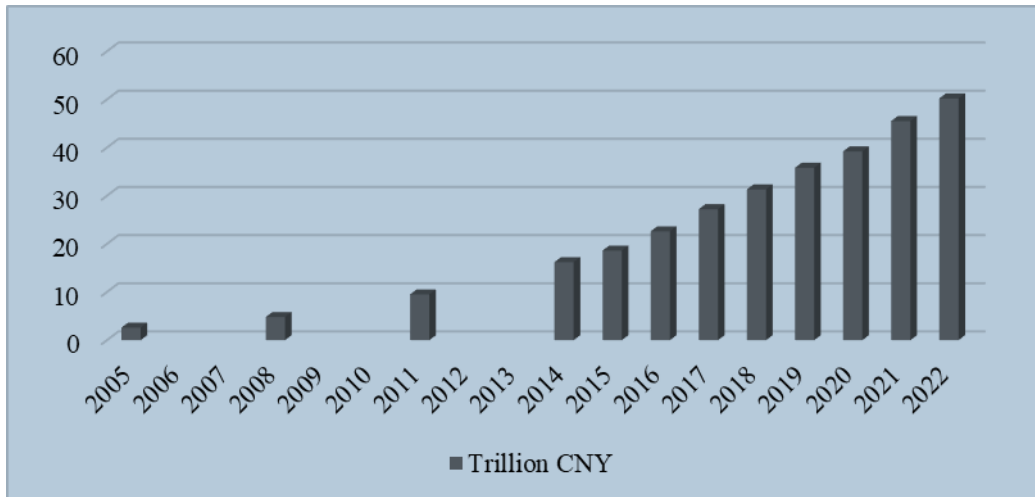
Based on the data presented in Figure 2, the growth of the digital economy in China in the period from 2005 to 2022 amounted to CNY 47.6 trillion. The observed steady upward trend indicates an increase in the impact of digitalisation on all sectors of the economy, including the logistics industry. This increase in the size of the digital economy market can be attributed to a number of factors, including increased Internet access, increased innovation, government incentives and investments in technological infrastructure, which affect efficiency improvements, cost reductions and improved logistics process management (Novanda and Medyawati 2023; Piddubna and Gorobynskaya 2023). In logistics, this manifests itself in improved integration of supply chains, optimisation of routing and inventory management, and the emergence of opportunities for more accurate forecasting and tracking of goods in real-time. These trends highlight the strategic importance of the digital economy for the development and modernisation of the logistics industry in China.

2.2. Transformation of the Structure of the GDP of Henan Province

The analysis of Henan province's GDP by economic sectors and changes in their structure is important for understanding the economic development of the region and its reorientation from traditional industries to modern services and industries. The growth of the share of the tertiary sector is particularly significant (Figure 3), which demonstrates stable growth and is a key engine of the region's economy in the analysed period.

Figure 3. The volume of the GDP of Henan province by economic sector
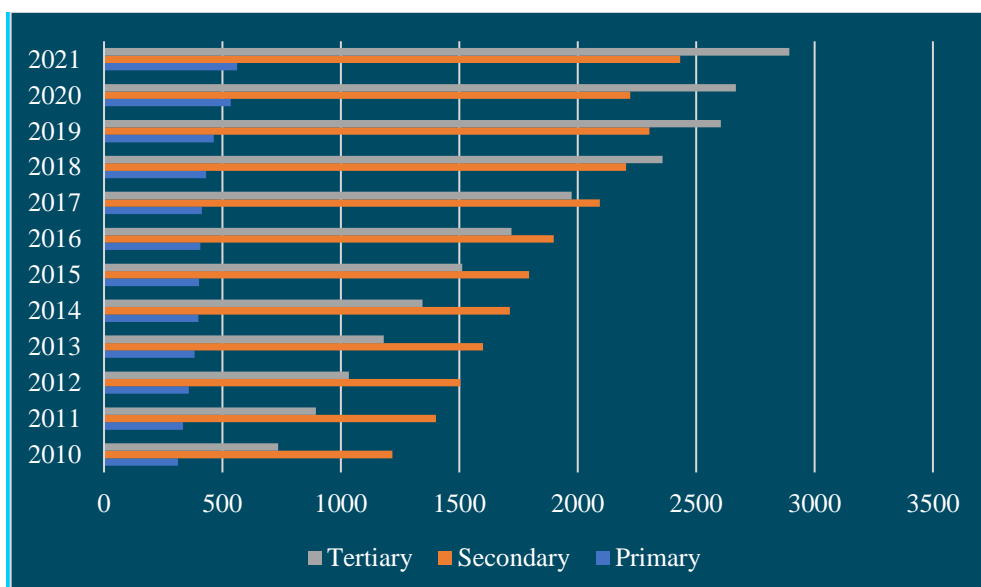
The presented data show that in the analysed period, despite the increase in absolute values of indicators for all sectors of Henan province, the structure of GDP has changed. Thus, the share of the primary sector decreased from 13.80% in 2010 to 9.54% in 2021; the secondary sector – from 53.73% to 41.32%; the share of the tertiary sector increased by 16.67%. In the pre-pandemic period, the tertiary sector showed high annual growth rates (Table 3).

Table 3. The growth rate of the GDP of Henan province by economic sector

Years	Primary sector	Secondary sector	Tertiary sector
2010	6.79%	15.18%	21.67%
2011	7.12%	7.28%	15.58%
2012	6.99%	6.33%	14.19%
2013	4.21%	7.15%	13.86%
2014	0.69%	4.72%	12.45%
2015	1.2%	5.79%	13.74%
2016	1.86%	10.29%	14.81%
2017	4.15%	5.24%	19.45%
2018	7.53%	4.52%	10.43%
2019	15.49%	-3.54%	2.45%
2020	4.98%	9.5%	8.43%
2021	6.79%	15.18%	21.67%

Source: compiled by the authors.

An analysis of the GDP growth rate of Henan province by economic sector revealed significant growth in the tertiary sector, which includes the logistics industry. This growth indicates the transformation of the economic structure of the region and the increasing role of service and logistics services, which is especially important in the context of the growing influence of the digital economy.

2.3. Modelling of the Impact of China's Digitalisation on the Logistics Industry of Henan Province

The algorithm for modelling the impact of the digital economy on the development of the logistics industry (using the example of Henan province) is shown in Figure 4.

Figure 4. An algorithm for modelling the impact of the digital economy on the development of the logistics industry of Henan province
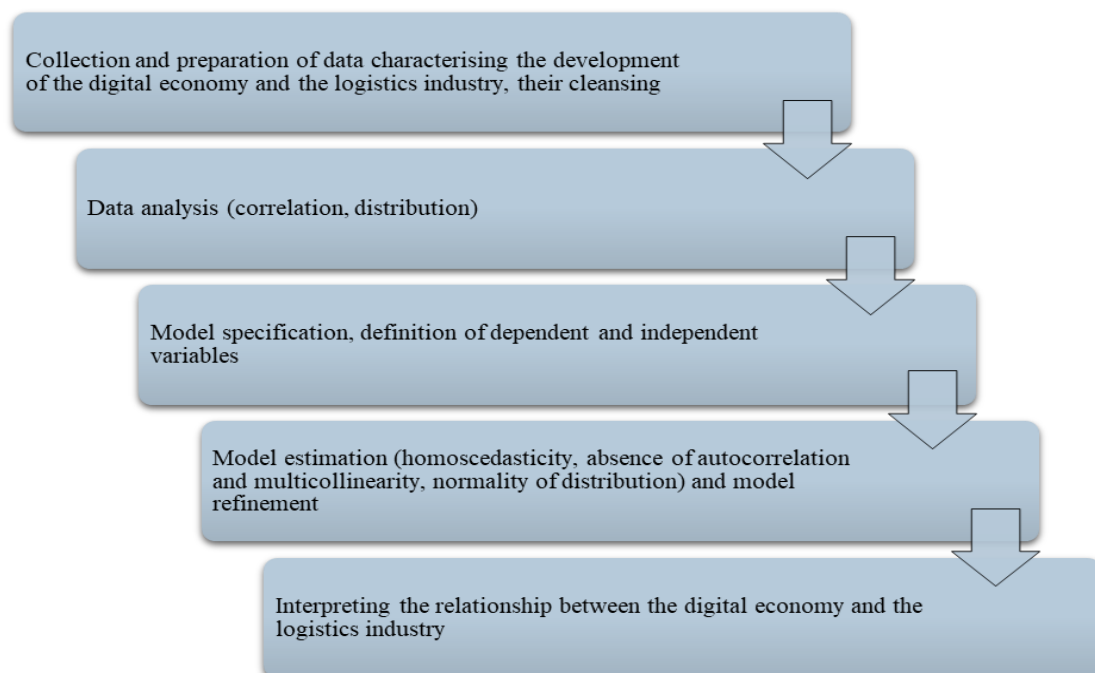
Source: compiled by the authors.

The model of the impact of the digital economy on the development of the logistics industry in Henan province is generally represented by the regression equation (1), where the dependent variable will reflect the volume of GDP attributable to the tertiary sector of Henan province, which, in turn, includes knowledge-based services and activities, and is one of the indicators reflecting the state of the logistics industry. In the context of the digital economy, the tertiary sector is at the forefront of digital transformation (Mann 2023; Melnykova 2023). E-commerce, online commerce, and digital services are becoming an integral part of the logistics industry, directly affecting its operating models and revenue streams. Thus, the choice of GDP of the tertiary sector as a variable for the regression model is justified by its significance as a reflection of the level of development and the scale of the impact of digitalisation on logistics in Henan province. The hypothesis of the study: the growth or decrease in GDP of the tertiary sector of Henan province can be considered as a direct result of changes in the logistics industry under the influence of digitalisation.

An indicator reflecting the size of the digital economy market in China was analysed as an independent variable model, since it is an indicator of the penetration and integration of digital technologies into the economy, reflects the level of technology adoption, including in logistics. Increasing the volume and pace of development of the digital economy provides conditions for the growth of the number of e-commerce operations, which, in turn, requires enhanced logistical support. The choice of an indicator assessing trends in the digital economy at the national level is conditioned by the importance of taking it into account as a predictor reflecting the influence of macroeconomic forces on the formation of the logistics industry in Henan province. The least squares method was used to estimate the parameters $\beta 0$ and $\beta 1$, which provided the most consistent, unbiased estimates of the parameters of the regression equation: $\beta 0=492.631$; $\beta 1=55.564$. Thus, an empirical regression equation is obtained reflecting the impact of the digital economy on the development of the logistics industry in Henan province, which has the form:

$$Y=492.631+55.564X, \qquad (2)$$

where: Y – GDP of the tertiary sector of Henan province; X – size of the digital economy market in China.

To estimate the closeness of Y and X relationship, a linear correlation coefficient RYX=0.989 was calculated. The obtained coefficient value in the range of $0.9\square RYX\square1$ indicates a high degree of coupling. The hypothesis of the significance of the correlation coefficient was tested using the Student's t-test, calculations confirmed the statistical significance of the correlation coefficient RYX, since $|tscore|\square tcrit(tscore=16.321; tcrit=2.969)$. To test hypotheses about the significance of the coefficients of the linear regression equation (2), the Student's t-test were also calculated ($t\beta0=4.66$; $t\beta1=16.32$; tcrit=2.969). Since 4.66>2.969 and 16.32>2.969, the statistical significance of the regression coefficients $\beta 0$ and $\beta 1$ has been confirmed. The quality of the obtained regression equation (2) was estimated by calculating the absolute approximation error A=2.78%. The result shows that, on average, the calculated values deviate from the actual ones by 2.78%. Since the error is less than 5%, equation (2) can be used as a regression. The significance of the regression model was checked using the Fisher F-test at a significance level of $\alpha=0.05$. Since the actual value of F>Ftabl, then the estimation of the regression equation is statistically reliable (F=266.37; Ftabl=5.99). The results of the calculation of the coefficient of determination (R2=0.978) gave grounds to assert that in 97.8% of cases, changes in X lead to a change in Y, confirming the high accuracy of the selection of the regression equation.

An economic interpretation of the model of the impact of the digital economy on the development of the logistics industry in Henan province allows for the conclusion that an increase in the X – volume of the digital economy market in China by 1 trillion CNY leads to an increase in the Y – GDP of the tertiary sector of Henan province by an average of 55.564 billion CNY. The model of the impact of the digital economy on the development of the logistics industry in Henan province, described by the regression equation (2), is constructed using the least squares method, the use of which is possible if a number of conditions are met: absence of autocorrelation; absence of heteroscedasticity; normality of the distribution of the residual component. Checking for the presence of autocorrelation of residues by calculating the autocorrelation coefficient (r1) confirmed that the property of independence of residues is fulfilled, and there is no autocorrelation (-1.05<r1=0.267<1.05). The evaluation of Spearman's rank correlation coefficient, and the Goldfeld-Quandt test, confirmed the absence of heteroscedasticity. To check the normality of the distribution of the residual component, the value of the RS criterion was calculated, which falls within the interval (2.7-3.7), which confirms compliance with the property of the normal distribution. Thus, the model of the impact of the digital economy on the development of the logistics industry in Henan province is adequate in terms of the normality of the distribution of the residual component.

Thus, based on the results of the study, the hypothesis that the growth or decline in GDP in the tertiary sector of Henan province is a direct result of changes in the logistics industry caused by digitalisation is confirmed.

The high values of correlation and determination coefficients in the regression equation indicate a strong relationship between the development of the digital economy and the results of the logistics industry in Henan province.

3. Discussion

The analysis of the impact of key elements of the digital economy, such as digital infrastructure, e-commerce, digital services, IoT technologies, big data, cybersecurity, digital payments, digital talents and education, artificial intelligence and automation, provided a comprehensive study of their impact on the logistics industry. C. Wang *et al.* (2023) investigated the relationship between the digital economy and the logistics efficiency of China's industrial system. The researchers adhere to a strategic approach to improving logistics efficiency, offering four main mechanisms: integrated promotion, joint development, cooperation and exchange of experience, and adaptation to local conditions. The paper notes that by using these strategies, China is striving to form the advantages of a growing digital economy, as a result of which the logistics sector will actively contribute to the country's advancement along the path of high-quality industrial development. This study provides valuable information for stakeholders, including practical recommendations and a comprehensive analysis of the synergy between the digital economy and logistics efficiency.

W. Zhang *et al.* (2022) conducted a detailed analysis of the integration between the digital economy and the logistics industry in China in the period from 2007 to 2017. The study has enriched the existing body of research on industrial convergence in the digital economy of China, the researchers have formed recommendations to promote the synergetic development of the digital economy and the logistics industry. It is necessary to update the results of the study, since data were evaluated that did not include the pandemic period. Accordingly, it is advisable to clarify the conclusions by including in the analysis data characterising the studied phenomena during the pandemic.

The symbiotic relationship between the digital economy and the logistics industry of Anhui province is explored in the study by Y. Guo *et al.* (2022). Using a system of integrated assessment indicators, the researchers proposed a model describing cooperation as a key aspect for assessing the level of coordinated growth of the digital economy and the logistics industry, the practical application of the model is illustrated by data from Anhui province for the period from 2013 to 2020. The results obtained indicate fluctuations in the growth dynamics of the integrated system of the digital economy and the logistics industry in Anhui province. Thus, it can be noted that for Henan province, the observed relationship between the digital economy and logistics is more stable. The use of the methodology of the researchers in relation to Henan province data can confirm the conclusions of the study and focus on regional differences in provincial development.

L. Zhang *et al.* (2023) assessed the impact of digital logistics methods on regional economic growth using the example of the Yangtze River Economic Belt, covering 11 cities. The paper highlights the transformational potential of integrating intelligent infrastructure, data and intelligent technologies into modern supply chains and logistics to optimise the logistics process. At the same time, the researchers note the existence of problems related to transport costs, quality and multinational transportation, especially in remote cities that do not receive the necessary logistical support, which hinders business growth.

In confirmation of the previously presented results, B. Yan *et al.* (2023), having studied how the qualitative development of the logistics sector affects economic development at various stages of industrial development, substantiated that the logistics industry plays a positive role in ensuring high-quality economic growth. The researchers note that the influence of the logistics industry on economic development varies at different levels of the industrial structure, which determines the need to develop special strategies at different stages. The paper emphasises the need to optimise industry structures and deepen integration between logistics and related industries. This approach seems reasonable to ensure the qualitative development of the logistics sector and is consistent with the results of modelling the impact of the digital economy on the development of the logistics industry in Henan province. The analysis of the GDP growth rates of Henan province by economic sectors presented in the paper revealed a significant growth in the tertiary sector, which includes the logistics industry. This growth indicates the transformation of the economic structure of the region and the increasing role of service and logistics services, which is especially important in the context of the growing influence of the digital economy. The choice of GDP of the tertiary sector as a variable for the regression model, in this case, is justified by its significance as a reflection of the level of development and the scale of the impact of digitalisation on logistics in Henan province.

J. Kern (2021) presents a comprehensive analysis of the digitalisation gap in the logistics sector, contrasting recognised industry giants with newcomers and those who resist the introduction of new technologies. The sector-by-sector assessment revealed significant fluctuations in the degree of digital technology adoption in individual

logistics processes and services. It is noted that seaports and airports are lagging in digital transformation, and only a small part of terminals have achieved automation. On the contrary, warehouses and trucking companies are making more significant progress by implementing Industry 4.0 technologies and, accordingly, transportation management systems. In contrast to the previously presented results, the researcher concludes that the overall level of digitalisation in the logistics industry remains low or medium, and most companies lack an understanding of the need for adaptation and development. The paper highlights that companies unwilling to actively adapt their digital strategies risk being left behind, which highlights the need for the logistics industry to embrace digital transformation despite challenges such as high costs, lack of standards, and uncertainty of immediate benefits.

C. Wang (2023), emphasising the key role of logistics in ensuring high-quality economic development, highlighted its basic principles such as increasing customer satisfaction, optimising the activities of enterprises, and focusing business development on information technology. The researcher draws attention to the critical problems faced by the logistics sector: disproportionately high costs of social logistics in relation to GDP, underdevelopment of transport infrastructure and equipment, low level of digitalisation and introduction of intelligent technologies, insufficient integration with related industries (Kondratenko *et al.* 2011). The paper advocates a multifaceted approach to solving these problems, emphasising the need to reduce costs, increase efficiency, and continuously improve and modernise vehicles and equipment. The study also highlights the need to enhance the digital and intellectual capabilities of the logistics sector, promotes a faster and more integrated approach to integrating logistics with other industries, and calls for increased training in logistics to equip staff with the skills and knowledge necessary to navigate the changing landscape of modern logistics. The opinion presented by the researcher is consistent with the results of systematising the potential consequences of the impact of elements of the digital economy on logistics.

The study by N.N. Nordin *et al.* (2022) is devoted to the investigation of the impact of the digital economy on logistics efficiency and economic growth in Asian countries. The study uses panel data from 15 Asian countries. The main conclusion is that the digital economy makes a significant contribution to strengthening the relationship between logistics indicators and economic growth in these countries. The researchers emphasise the role of institutions in the digital economy and conclude that institutions have a moderating effect, increasing the efficiency of logistics and thereby stimulating economic growth. Thus, it is proved that the integration of digital economy practices into the logistics sector, supported by a strong institutional framework, can lead to an increase in the efficiency of logistics operations and make a positive contribution to the economic development of the Asian region.

Summing up, it can be noted that the observed dynamics of the digital economy market and structural changes in the GDP of Henan province reflect the transformational processes taking place in the economy. These processes, combined with the modelling of regression dependencies between the development of the digital economy and the indicators of the logistics industry, create a scientifically sound basis for assessing the current state and forecasting future development trends. Thus, this study represents a contribution to the development of strategic areas for the digital transformation of the logistics industry, given the growing role and importance of these technologies in the economic space of China and beyond.

Conclusions and Further Research

The presented periodization of changes in China's logistics industry under the influence of the digital economy, divided into stages, reflects the introduction and adaptation of new technologies and shows how they influenced logistics. This allowed assessing how logistics has evolved in response to technological changes, which provided the foundation for understanding current trends and predicting future changes.

The results of the analysis of the potential impact of individual elements of the digital economy on the logistics industry, such as digital infrastructure, e-commerce, digital services, IoT technologies, big data, cybersecurity, digital payments, digital talents and education, regulatory framework, artificial intelligence and automation, are summarised. Both positive and negative aspects of the impact of elements of the digital economy are highlighted, which provided a comprehensive analysis, identifying opportunities for growth and potential risks. The assessment of the Chinese digital economy market indicates an increased impact of digitalisation on all sectors of the economy, including the logistics industry, and the indicator characterising the volume of the digital market showed a steady upward trend. The analysis of Henan province's GDP revealed significant changes in the structure of the economy: the share of the tertiary sector covering logistics increased by 16.67%, while the shares of the primary and secondary sectors decreased by 4.26% and 12.41%, respectively. This confirms the strengthening of the role of the service sector and, in particular, logistics, which is a key element of the tertiary sector.

The results of modelling conducted as part of a study of the impact of the digital economy on the development of the logistics industry in Henan province demonstrate that the growth or decline in GDP of the tertiary

sector of Henan province is a direct consequence of changes caused by digitalisation processes. The high values of correlation and determination coefficients obtained during the analysis indicate a significant impact of the development of the digital economy on the dynamics of the logistics industry in this region. Statistical tests (t-test, F-criterion) confirm the statistical significance and reliability of the regression equation. A small approximation error and a high coefficient of determination emphasise the accuracy of the model and its suitability for analysing the interrelationships between the digital economy and the logistics industry of Henan province. The conditions for using the least squares method are met, which guarantees the adequacy and accuracy of the simulation. The absence of autocorrelation and heteroscedasticity, and the normal distribution of the residual component, confirm the correctness of the method application. Thus, the results of the study confirm that the increase in the size of the digital economy market in China leads to a significant increase in the GDP of the tertiary sector in Henan province.

The prospect of future research is to provide a basis for developing strategies and measures to optimise the interaction between the digital economy and the logistics industry by including additional independent variables in the model of the impact of the digital economy on the logistics industry in Henan province and their interpretation.

Credit Authorship Contribution Statement

Azyk Orozonova: Conceptualization, Project administration, Writing – original draft, Supervision, Validation, Visualization;
Shanshan Zhang: Methodology, Formal analysis, Data curation;
Esengeldi Zhumadilov: Investigation, Software, Formal analysis, Writing – review and editing, Visualization;
Xiaomei Sun: Software, Formal analysis, Writing – review and editing, Visualization;
Xueqing Liu: Methodology, Writing – original draft, Data curation, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.
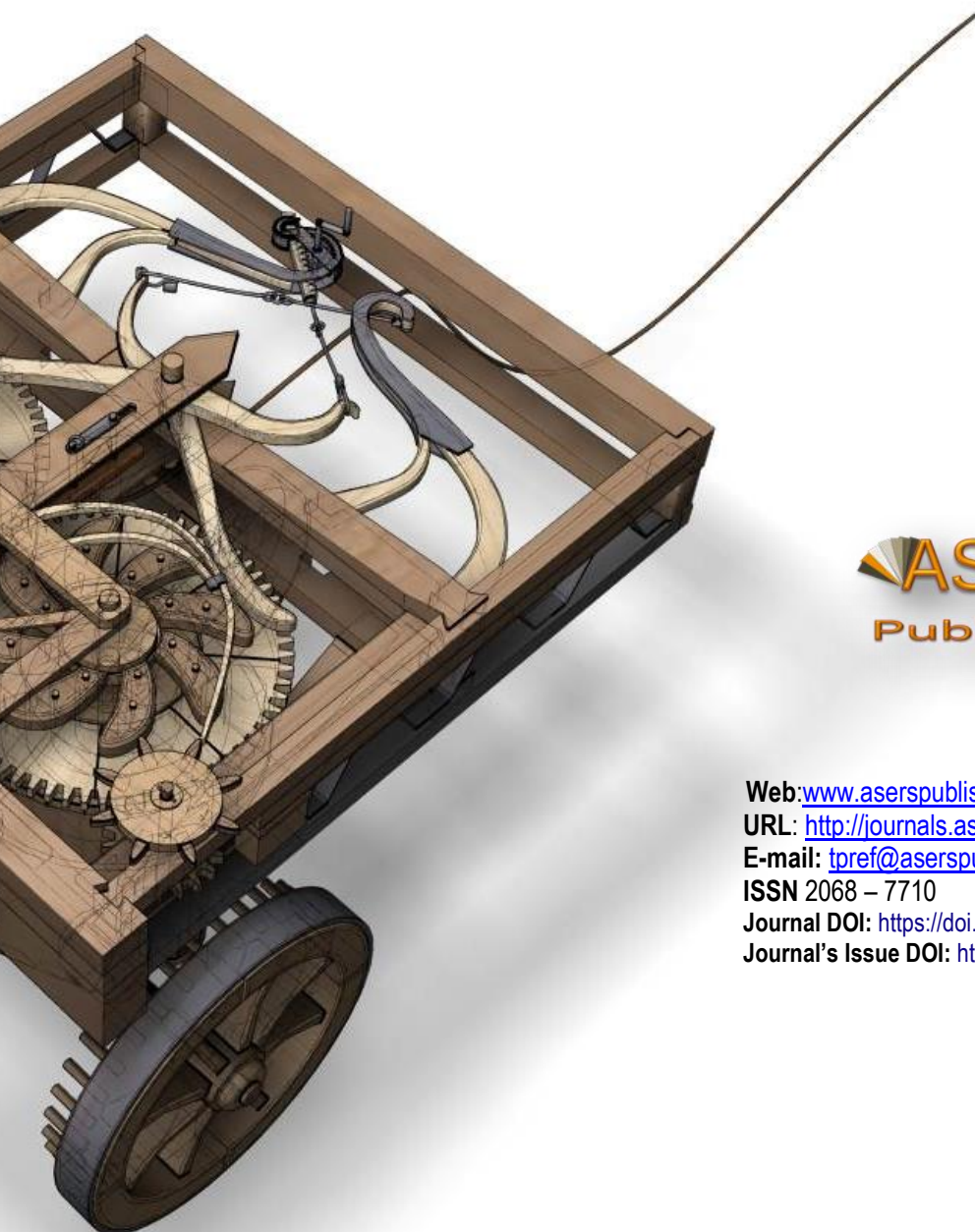
References

[1] Aubakirova, Dinara (2024). Directions for Using Big Data Analytics in Logistics Management. *Development Management,* 23(1): 27-36. DOI: https://doi.org/10.57111/devt/1.2024.27

[2] Brzozowska, Marta *et al.* (2022). Competences 4.0 In the Logistics Sector Against the Challenges of Sustainable Digital Transformation of the Economy in the Polish Perspective. *Scientific Papers of Silesian University of Technology. Organization and Management,* 162: 53-85.

[3] Buil, Roman, Miquel Angel Piera, Marjan Gusev, Egils Ginters, and Artis Aizstrauts (2015). Mas Simulation for Decision Making in Urban Policy Design: Bicycle Infrastructure. *International Conference on Harbour, Maritime and Multimodal Logistics Modelling and Simulation* (pp. 95-102). Bergeggi: I3M Conference.

[4] Gan, Weihua, Wenpei Yao, Shuying Huang, and Yanan Liu (2022). A Study on the Coupled and Coordinated Development of the Logistics Industry, Digitalization, and Ecological Civilization in Chinese Regions. *Sustainability,* 14(11): 6390.

[5] Guo, Yuxia, Huiying Mao, Heping Ding, Xue Wu, Yujia Liu, Hongjun Liu, and Shuling Zhou (2022). Data-Driven Coordinated Development of the Digital Economy and Logistics Industry. *Sustainability,* 14(14): 8963.

[6] Herold, D. Martin, Marek Cwiklicki, Kamila Pilch, and Jasmin Mikl (2021). The Emergence and Adoption of Digitalization in the Logistics and Supply Chain Industry: An Institutional Perspective. *Journal of Enterprise Information Management,* 34(6): 1917-1938.

[7] Horoshkova, Lidiia, Oleksandr Menshov, Olena Vasylyeva, Alexander Sumets, and Ihor Ryshykov (2023). Logistics Technologies for the Potential Management of Marine and River Transport in Ukraine. *University Economic Bulletin,* 18(2): 32-45. DOI: https://doi.org/10.31470/2306-546X-2023-57-32-45

[8] Kayikci, Yasanur (2018). Sustainability Impact of Digitization in Logistics. *Procedia Manufacturing,* 21: 782-789.

[9] Kern, Johannes (2021). The Digital Transformation of Logistics: A Review about Technologies and Their Implementation Status. In: *The Digital Transformation of Logistics: Demystifying Impacts of the Fourth Industrial Revolution* (pp. 361-403). Piscataway: Institute of Electrical and Electronics Engineers, Inc.

[10] Kondratenko, Yuriy P., Leonid P. Klymenko, and Ievgen V. Sidenko (2014). Comparative Analysis of Evaluation Algorithms for Decision-Making in Transport Logistics. *Studies in Fuzziness and Soft Computing* 312: 203-17. DOI: https://doi.org/10.1007/978-3-319-03674-8_20

[11] Kondratenko, Yuriy P., Sylvia B. Encheva, and Eugene V. Sidenko (2011). Synthesis of Intelligent Decision Support Systems for Transport Logistics. *Proceedings of the 6th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, IDAACS'2011* 2: 642–6. DOI: https://doi.org/10.1109/IDAACS.2011.6072847

[12] Kredina, Anna, Mirey Akhtanova, Makpal Bekturganova, Alexander Tsoy, and Lazat Spankulova (2022). The Relationship between Logistics and Information and Communication Technologies and Their Impact on the Economy of Kazakhstan. *Problems and Perspectives in Management,* 20(4): 344–55. DOI:https://doi.org/10.21511/ppm.20(4).2022.26

[13] Lipych, Liubov, Oksana Khilukha, and Myroslava Kushnir (2024). Inventories in an Integrated Supply Chain. *Economic Forum,* 1(4): 62-69. DOI: https://doi.org/10.36910/6775-2308-8559-2023-4-8

[14] Mann, Ruslan (2023). Strategy for Managing Regional Competitiveness Development. *Economic Bulletin of Cherkasy State Technological University,* 23(2): 5-14.

[15] Melnykova, Kateryna (2023). Mechanisms of Achieving Sustainable Micrologistics System Functioning. *Development Management,* 22(2): 30-38. DOI: http://doi.org/10.57111/devt/2.2023.30

[16] Moldabekova, Aisulu, Robert Philipp, Hans-Eggert Reimers, and Bauyrzhan Alikozhayev (2021). Digital Technologies for Improving Logistics Performance of Countries. *Transport and Telecommunication Journal,* 22(2): 207-216.

[17] Mukaka, Mavuto (2012). Statistics Corner: A Guide to Appropriate Use of Correlation Coefficient in Medical Research. *Malawi Medical Journal,* 24(3): 69-71.

[18] Nordin, N. Naddia *et al.* (2022). Digital Economy: Improving Logistics Performance in Asian Countries. In: *Proceedings of the International Conference on Entrepreneurship, Business and Technology (InCEBT) 'Industry Forward and Technology Transformation in Business and Entrepreneurship'* (pp. 459-468). Singapore: Springer.

[19] Novanda, N, and Henny Medyawati (2023). Determinant of Shopee Xpress Consumer Satisfaction in Jakarta Greater Area. *Economics, Entrepreneurship, Management,* 10(2): 25-34. DOI:https://doi.org/10.56318/eem2023.02.025

[20] Piddubna, Liudmyla, and Marianna Gorobynskaya (2023). Digital Transformation as a Factor of Changes in the Organizational Behaviour of International Companies. *Development Management,* 21(4): 25-36.

[21] Trushaj, Aleks (2023). Features of the Foreign Policy of the Republic of Kazakhstan. *Foreign Affairs,* 33(5): 45-51. DOI: https://doi.org/10.46493/2663-2675.33(5).2023.45-51

[22] Wang, Chunjuan, Kaige Guo, and Xiangyu Yin (2023). Research on Improving Logistics Efficiency by Digital Economy from the Perspective of High-Quality Development. In: *Proceedings of the 2nd International Academic Conference on Blockchain, Information Technology and Smart Finance (ICBIS 2023)* (pp. 476-484). Amsterdam: Atlantis Press.

[23] Wang, Cuimin (2023). Research on High Quality Development Path of Modern Logistics Industry. *Industrial Engineering and Innovation Management,* 6(6): 60-66.

[24] Wu, Harry, and Changhua Yu (2022). The Impact of the Digital Economy on China's Economic Growth and Productivity Performance. *China Economic Journal,* 15(2): 153-170.

[25] Yan, Borui, Bo Yao, and Chenjing Zhang (2023). Industrial Structure, High-Quality Development of Logistics Industry and the Economy. *PLoS ONE,* 18(5): e0285229.

[26] Zhang, Liuhua, Tianbao Gong, and Yanan Tong (2023). The Impact of Digital Logistics Under the Big Environment of Economy. *PLoS ONE,* 18(4): e0283613.

[27] Zhang, Longmei, and Sally Chen (2019). China's Digital Economy: Opportunities and Risks. *IMF Working Paper*. Available at: https://www.imf.org/en/Publications/WP/Issues/2019/01/17/Chinas-Digital-Economy-Opportunities-and-Risks-46459

[28] Zhang, Wei, Hongli Liu, Yuan Yao, and Zifu Fan (2022). A Study Measuring the Degree of Integration Between the Digital Economy and Logistics Industry in China. *PLoS ONE,* 17(9): e0274006.

[29] Zhao, Tao, Zhi Zhang, and Shangkun Liang (2022). Digital Economy, Entrepreneurship, and High-Quality Economic Development: Empirical Evidence from Urban China. *Frontiers of Economics in China,* 17(3): 393-426.

[30] Hunan Government Work Report 2022. (2022). Available at: http://222.240.193.190/2022tjnj/indexeh.htm

[31] Ministry of Commerce of the People's Republic of China. (2023). Concise Statistics on China's Outbound Direct Investment Across All Industries from January to April 2023. Available at: http://english.mofcom.gov.cn/article/statistic/foreigntradecooperation/202306/20230603418682.shtml

[32] National Bureau of Statistics of China. (2023). China Statistical Yearbook 2023. Available at: https://www.stats.gov.cn/sj/ndsj/2023/indexeh.htm

[33] Statista. (2024a). Gross Domestic Product (GDP) of Henan Province, China from 1990 to 2022, by Economic Sector (in Billion Yuan). Available at: https://www.statista.com/statistics/1082657/china-gdp-of-henan-by-industry/

[34] Statista. (2024b). Market Size of the Digital Economy in China in Selected Years from 2005 to 2022 (in Trillion Yuan). Available at: https://www.statista.com/statistics/1250080/china-digital-economy-size/